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## New species of *Entolomataceae* from Cameroon

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*Agaricales*

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**Abstract:** Six species of *Entoloma* (*Entolomataceae*, *Agaricales*, *Basidiomycota*) are described from recent Cameroonian collections: *E. bisterigmatum*, *E. brunneoloaurantiacum*, *E. djaense*, *E. intricatum*, *E. versiforme*, and *E. parvistellatum*. These species occur in tropical rainforests dominated by ectomycorrhizal trees in the genera *Gilbertiodendron* and *Uapaca*. Data on macromorphology, micromorphology, DNA sequences, habitat and comparisons with similar taxa are provided for each. This is the first contemporary taxonomic work on the *Entolomataceae* from Cameroon.

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## INTRODUCTION

The Dja Biosphere Reserve in south-central Cameroon is characterized by lowland tropical rainforest of the Guineo-Congolian type (Mbolle 2004, Sonke 2004). During mycological expeditions to the Dja Reserve from 2014–2019, numerous collections of macrofungi were made in monodominant forests of ectomycorrhizal *Gilbertiodendron dewevrei* (*Fabaceae* subfam. *Detarioideae*) and *Uapaca* spp. (*Phyllanthaceae*). Macro- and microscopic analyses of 41 of these collections indicated their placement in *Entoloma sensu lato* (*Entolomataceae*, *Agaricales*, *Agaricomycetes*, *Basidiomycota*) based on their pink basidiospores that are angular or ornamented with bumps or ridges.

The history of *Entolomataceae* from the African tropics is rather patchy. Romagnesi (1941) published the first comprehensive account of *Rhodophyllus* (syn. *Entoloma s. lat.*) in Madagascar. His publication was based on recent collections made by Bouriquet, Decary, and Heim from Malagasy lowland rainforests and earlier collections of Patouillard (1928) and Heim (1936). Forty-five species and four varieties were described, 38 of which were new (Eyssartier *et al.* 2001). Romagnesi (1941) also included sections on ecology and phylogeny, emended the subgenera *Entoloma*, *Leptonia*, and *Nolanea*, described the new subgenera *Paraleptonia* and *Hygropilus*, and used several volumes of Saccardo's *Sylloge Fungorum* from 1882 to 1924 to compile a list of known tropical entolomatoid species including those from Central Africa described by Bresadola (1890), Hennings (1895), and Beeli (1928, 1938).

Several mycologists have collected entolomatoid fungi in equatorial Central Africa. For the Congo, Mme Martha Goossens-Fontana collected, described, and produced watercolors of macrofungi, including *Entolomataceae*, from 1919 to 1953. Her

collections and illustrations were sent to Maurice Beeli, scientific collaborator at the Botanical Garden of the State at Brussels, who used this material to initiate the iconographic flora of Congo series that became the Illustrated Flora of Mushrooms of Central Africa (Fraiture 2006). Beeli published six Central African species in the *Entolomataceae* (Beeli 1928, 1938). Subsequently Romagnesi used the additional materials of Goossens-Fontana to publish 12 taxa of *Rhodophyllus* (Romagnesi 1956, 1957).

Over a ten-year period, Gérard Gilles collected macrofungi from the coastal rainforests near Abidjan, Ivory Coast and Libreville, Gabon. These collections were sent to Romagnesi and subsequently 204 taxa were described in *Rhodophyllus*, 190 of which were new to science (Romagnesi & Gilles 1979). This wealth of new, unique taxa allowed a complete revision of Romagnesi's 1941 classification of *Rhodophyllus* (Romagnesi 1978).

For tropical East Africa, David Pegler spent four months in 1968 collecting and describing macrofungi from Kenya, Tanzania, and Uganda. Subsequently 25 species were described in the *Entolomataceae*. Twenty of these were new and five were previously described from the Congo by Beeli or Romagnesi (Pegler 1977).

The first entolomatoid fungi described from Cameroon were Bresadola's *Entoloma rhodophaeum* and *Entoloma kamerunense* (Bresadola 1890, as *Nolanea kamerunensis*). In 1895 Hennings described *Claudopus camerunensis*, *Eccilia camerunensis*, *Eccilia zenkeri*, and *Leptonia viridula* (Hennings 1895). Since these early works no Cameroonian entolomatoid fungi have been formally described, although a few have appeared in regional checklists (*e.g.* Kinge *et al.* 2013, Teke *et al.* 2017).

Here we describe six *Entoloma* species resulting from our recent collections from Cameroon: *E. bisterigmatum*, *E. brunneoloaurantiacum*, *E. djaense*, *E. intricatum*, *E. versiforme*, and *E. parvistellatum*.

## MATERIALS AND METHODS

### Collections and morphological analyses

Basidiomata were collected in Cameroon during the Aug.–Sep. early rainy seasons of 2014, 2017–2019, and the Nov.–Dec. late rainy season of 2016 from the Dja Biosphere Reserve, Northwest Sector, near the village of Somalomo, Upper Dja River Basin, within a 2 km radius of a base camp located at 3°21'29.8" N; 12°43'46.9" W, 650 m a.s.l., in forests dominated by *Gilbertiodendron dewevrei* or *Uapaca* species. Descriptions of macromorphological features and photographs were made from fresh material in the field. Colors were described subjectively and coded according to Kornerup & Wanscher (1978), with color plates noted in parentheses. Fresh collections were field-dried with silica gel.

Dried basidiomata were sectioned and rehydrated in 3% KOH. A Nikon Eclipse Ci compound microscope with Lumera Infinity 2 imaging software was used to examine and measure microscopic features following Largent (1994). In the taxonomic descriptions, ( $\bar{x}$ ) refers to mean dimensions of structures, E refers to range of length of structures divided by their width, Q refers to the mean quotient of the length of structures divided by their width, and y/x refers to the total number of structures measured (y) and the total number of collections examined (x). Holotypes and duplicate specimens were deposited in YA, Cameroon National Herbarium; isotypes and other duplicates were deposited in HSC, Humboldt State University and PUL, Kriebel Herbarium.

### DNA extraction, amplification, and sequencing

DNA was extracted from dried basidioma tissue of types and additional specimens using the Wizard® Genomic DNA Purification kit (Promega Co., WI, USA) following manufacturer's instructions. For the type specimens, two DNA gene loci were sequenced from the nuclear ribosomal repeat, including the internal transcribed spacer (ITS) and the large subunit (nrLSU). The ITS was sequenced for most of the duplicates to corroborate conspecificity. Primer pairs ITS1F/ITS4B (Gardes & Bruns 1993) and LROR/LR6 (Vilgalys & Hester 1990, Moncalvo *et al.* 2000) were used to amplify ITS and nrLSU, respectively. Amplification reactions included 12.5 µL of Promega PCR Mastermix (Promega Co., WI, USA), 1.25 µL of each primer (at 10 µM) and approximately 100 ng of DNA. The final PCR reaction volume was 25 µL. The recommended cycling conditions for each primer pair were followed. PCR products were sequenced by GeneWiz® (South Plainfield, NJ, USA). Sequences were edited using Sequencher v. 5.2.3 software (Gene Codes Corporation, MI, USA) and deposited in GenBank.

## RESULTS

Fifteen ITS (GenBank accessions: MN069530–MN069544) and four nrLSU (GenBank accessions: MN066545–MN066548) were generated in this study, ranging from 459–721 and 1 042–1 057 bp, respectively. ITS sequences from conspecific collections differed by no more than one percent nucleotide identity. Blastn searches of these ITS sequences yielded top hits of no more than 94.5% nucleotide identity, indicating lack of conspecificity of the new species with any other taxa currently accessioned on GenBank (Hofstetter *et al.* 2019). While *Entoloma djaense* was 98.5% similar to *E. jubatum* the two species are dissimilar morphologically and considered heterospecific.

## Taxonomy

*Entoloma bisterigmatum* Largent, T.W. Henkel & R.A. Koch, *sp. nov.* MycoBank MB831484. Figs 1, 2.

*Etymology*: Referring to the 2-sterigmate basidia.

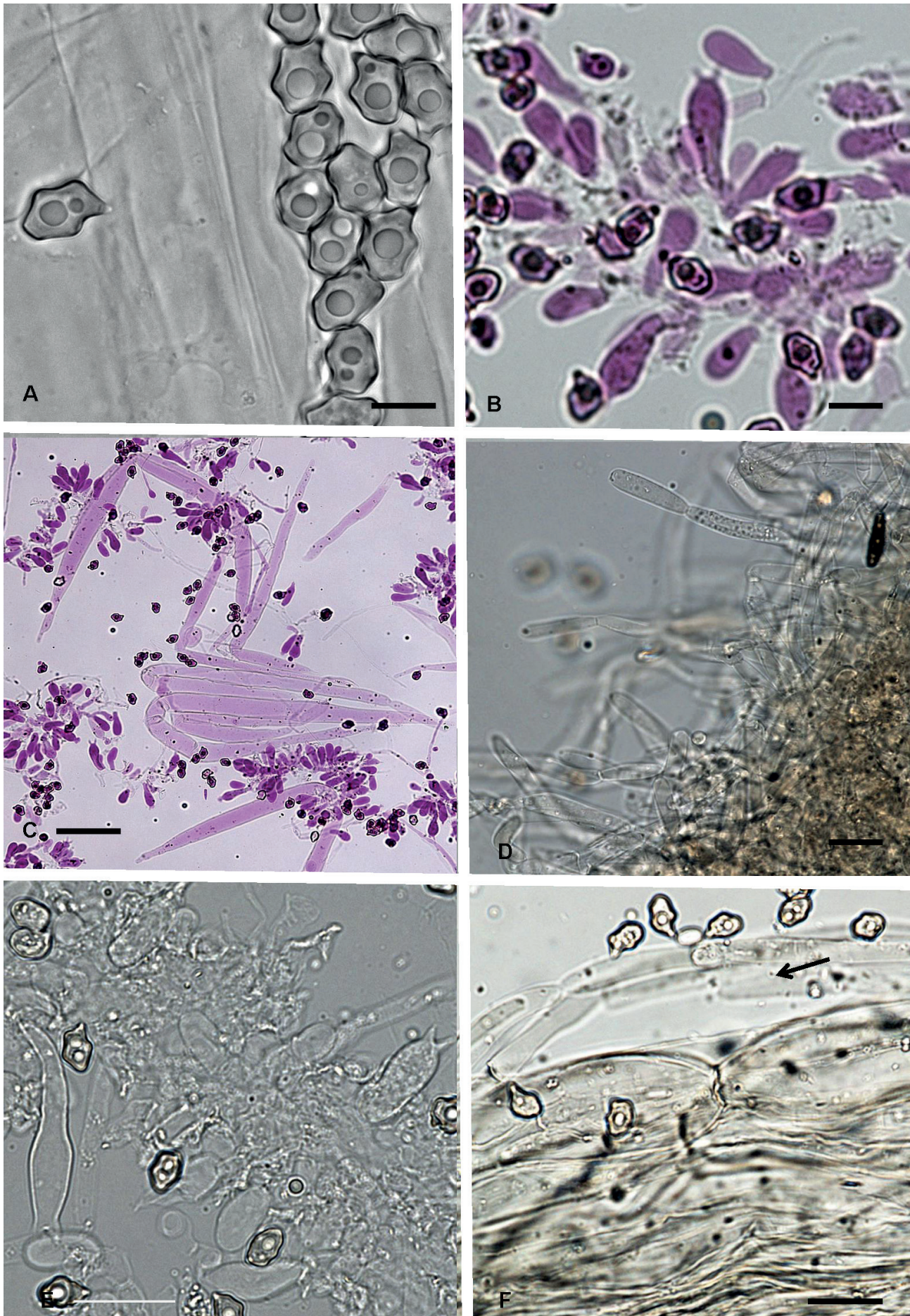
*Diagnosis*: Differs from *Entoloma humicola* in its distinctly hygrophanous pileus, adnexed to nearly free lamellae, broader, fibrous stipe that darkens with age and is pruinose at the apex, presence of caulocystidia, sclerobasidia, and clamp connections.

*Typus*: **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km radius of Dja base camp located at 3°21'29.8" N 12°43'46.9" W, elev. 650 m a.s.l., 0.4 km N of base camp, in troop of four in litter humus in mixed rainforest under *Uapaca* sp., 1 Dec. 2016, *Henkel 10328*, (**holotype** YA 67000; **isotype** HSC G1267); GenBank accessions: ITS MN069530; nrLSU MN066545.

*Basidioma* nolaneoid. *Pileus* 14–60 mm broad, 3–14 mm tall, broadly conic to planoconvex, with age uplifted and undulating, with subacute low umbo, dark brown over disc and umbo (5E4, 5F3–5, 5–6F5), tannish brown (5C3–5D3) to light greyish brown (6D3–6D4) over outer 4/5, hygrophanous to lighter concolorous, only slightly and irregularly translucent striate over marginal



**Fig. 1.** *Entoloma bisterigmatum*. **A.** Mature fresh basidiomata (*Henkel 10328*, holotype). **B.** Overmature, faded basidiomata (*Siegel 2234*). Scale bars: A = 40 mm; B = 42 mm.



**Fig. 2.** *Entoloma bisterigmatum* (Henkel 10328, holotype). **A.** Basidiospores. **B.** One- and two-sterigmate basidia. **C.** Lamellar tramal hyphae pointed at both ends. **D.** Pileocystidia from pileus center. **E.** Sclerobasidia (Henkel 10347). **F.** Pileocystidia (black arrow) above suprapellis composed of inflated cells. Scale bars: A = 10  $\mu$ m; B = 22  $\mu$ m; C = ~128  $\mu$ m; D = 33  $\mu$ m; E = 41  $\mu$ m; F = ~108  $\mu$ m.

1/5; surface subdry, appressed radially fibrillose over outer portion, these elements separating with age, with short, dense tomentum over umbo; margin finely to irregularly crenulate, occasionally splitting; trama 0.5 mm thick at margin, 0.75 mm over lamellae, 2.5 mm at stipe, dull tannish, unchanging. *Lamellae* thin, narrow, subclose to close, sharply adnexed and appearing nearly free, pale pink (6B4, 7A2–7A3) when young, darkening progressively with age to salmon pink (6C5, ~7B4) to dull pink (~8B3 KW) to dull flesh (~8C4); edges concolorous, eroded, unchanging; 1 mm tall at margin, 4 mm centrally, 3 mm at stipe; lamellulae 1–3, 1–15 mm long. *Stipe* 24–75 mm × 2.5–7 mm, subequal, occasionally tapering upward over apex, initially pale yellow to pale orange (4A2–5A2), with age orange-grey (5A2–5A3), browning slowly (5B2, 6C6) with pressure, glabrous macroscopically, under hand lens finely longitudinally striate and appressed fibrillose; apex subpruinose; basal mycelium a moderately dense white bloom over base, this subtended by fine white hyphal cords descending into humus; trama concolorous, cartilaginous-fibrous, unchanging. *Odor* none, faintly clay-like, or mildly fungoid. *Taste* mild, subfarinaceous or slightly chanterelle-like. *Spore print* on stipe apex concolorous with mature lamellae (~8C4 KW), on leaf greyish red (8C5–8D5 KW) in heavy deposit. *Basidiospores* with 5–6(–7) distinct, somewhat rounded angles, at times angles enlarged and nearly nodulose, 7.6–11.9 × 5.4–8.9 μm ( $\bar{x}$  = 10.1 ± 0.8 × 7.3 ± 0.6 μm; E = 1.1–1.7; Q = 1.4 ± 0.1;  $y/x$  = 311/6). *Basidia* clavate, tapering to a narrow to moderately broad base, occasionally cylindric to cylindro-clavate, 18.1–30.2 × 6.2–11.5 μm ( $\bar{x}$  = 23.0 ± 2.9 × 9.0 ± 1.0 μm; E = 2.0–3.8; Q = 2.6 ± 0.4;  $y/x$  = 122/5); (1–)2-sterigmate; sterigmata 1.5–5.3 μm long; when very mature some basidia becoming clavate-elongate, basally tapered, and thick walled, 32.7–46.8 × 7.8–11.5 μm ( $\bar{x}$  = 40.9 ± 4.3 × 9.1 ± 0.9 μm; E = 3.5–5.7; Q = 4.6 ± 0.6;  $y/x$  = 20/1). *Hymenial cystidia* absent. *Lamellar trama* of hyphae typically sharply acuminate at both ends, very long-celled; cells 153.0–518.0 × 2.0–46.0 μm ( $y/x$  = 19/4). *Pileipellis* 16.0–126.0 μm thick, 2-layered; suprapellis on the umbo a compact, entangled layer of hyphae with the distal 3–4 cells semi-erect to erect, elsewhere a cutis 1–5 hyphae thick with scattered prostrate to semi-erect cylindric pileocystidia and a distinct subpellis consisting of chains of inflated, nearly oval cells; pileocystidia 12.2–131.2 × 2.5–23.4 μm (E = 1.8–17.2;  $y/x$  = 73/3), on the disc versiform, ranging from cylindric, cylindro-clavate, clavate, to acuminate, elsewhere cylindrical. *Pileal tramal hyphae* 53.0–639.0 × 3.0–47.0 μm ( $y/x$  = 43/4), usually tapered to occasionally barely tapered at one or both ends; ends rounded, rarely narrowly acuminate. *Stipitipellis* a cutis mostly lacking caulocystidia but occasionally with solitary, scattered, or clustered hyphae with slightly differentiated terminal elements, these cylindrical, clavate, obclavate, or rarely semi-strangulated, 37.8–77.1 × 8.0–15.9 μm (E = 2.5–8.1;  $y/x$  = 22/2). *Stipe tramal hyphae* subparallel; terminal cells rounded, with abundant intracellular globules; broader hyphae in center of stipe 56.0–555.0 × 8.0–57.0 μm ( $y/x$  = 54/4). *Oleiferous hyphae* abundant in all tramal tissues. *Lipid globules* scattered in basidia and pileal tramal hyphae. *Brilliant granules* present in some basidia and in pileal and stipe tramal hyphae. *Pigmentation* brown and cytoplasmic in the pileipellis and occasionally minutely encrusting in stipe tramal hyphae. *Clamp connections* small and obscure, present on pileipellis hyphae.

*Habit, habitat and distribution:* Solitary, gregarious, or scattered in small groups of 2–4 basidiomata on humic mat under *G.*

*dewevrei*, or on litter humus in mixed rain forest under *Uapaca* sp.; known only from the type locality in the Dja Biosphere Reserve.

*Additional materials examined:* **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km radius of Dja base camp located at 3°21'29.8" N 12°43'46.9" W, elev. 650 m a.s.l.; 0.6 km WSW from base camp in GD plot 1, in pair on humic mat under *G. dewevrei*, 26 Nov. 2016, *Henkel 10296* (YA 67001, HSC G1268), GenBank accession: ITS MN069531; 0.5 km N of base camp, solitary on litter humus in mixed rain forest under *Uapaca* sp., 7 Dec. 2016, *Henkel 10326* (YA 67002, HSC G1269), GenBank accession: ITS MN069532; *Henkel 10327* (YA 67003, HSC G1270), GenBank accession: ITS MN069533; 0.4 km N of base camp, solitary or scattered in small groups on litter humus in mixed rainforest under *Uapaca* sp., 27 Aug. 2017, *Siegel 2234* (YA 67004, HSC G1271), GenBank accession: ITS MN069534.

*Notes:* *Entoloma bisterigmatum* is macroscopically distinctive in its combination of nolaneoid basidiomata, a planoconvex, greyish brown pileus that is roughened and dark brown over the umbo and disc and minutely appressed fibrillose elsewhere, pale orange to orange-grey, glabrous stipe that browns slowly upon pressure, and subfarinaceous taste. Microscopically the species is distinguished by its heterodiametric, 5–7-angled basidiospores measuring (8–)9–12 × (5–)6–8.5(–9) μm, consistently 1–2-sterigmate basidia, 2-layered pileipellis with a suprapellis composed of an entangled layer of hyphae with semi-erect to erect pileocystidia and distinct subpellis composed of inflated cells, lack of hymenial cystidia, and small, inconspicuous clamp connections. Although *Entoloma humicola* is morphologically similar to *E. bisterigmatum*, it can be differentiated by its scarcely hygrophanous pileus, sinuate lamellae, 2–3 mm wide, apically glabrous stipe that does not change color, lack of sclerobasidia, and clampless hyphae.

Several entolomatoid species possess bisterigmate basidia but each can be differentiated from *E. bisterigmatum* on other morphological grounds. *Entoloma bisporigerum* from western Europe is differentiated by its umbilicate, brown, smooth pileus, farinaceous odor and taste, and larger basidiospores (10–12(–13) × (7.0–)8.0–9.5(–10.5) μm) (Noordeloos 1992, Kokkonen 2015). *Entoloma bisporiferum* from Gabon has a planate to slightly depressed, bluish grey, non-papillate pileus, slightly larger basidiospores at 10.5–12 × 8–9 μm, and clavate cheilocystidia (Romagnesi & Gilles 1979). *Entoloma bisporum* from Japan contrasts with its delicate, pale yellow-brown pileus and smaller basidiospores at 8.5–9.5(–10) × 6–6.5(–7) μm (Hongo 1957 as *Rhodophyllus bisporus*; He *et al.* 2011). *Entoloma commune* from New York and Florida has an avellaneous pileus and smaller basidiospores at 8–9 × 6.5–7.5 μm (Hesler 1967). Among Chinese taxa, *Entoloma mastoideum* is distinguished by its pinkish flesh-colored pileus, distinctly membranous margin that distinctly extends beyond the lamellae, and abundant cheilocystidia (He *et al.* 2011). *Entoloma praegracile* is differentiated by its small, overall pale orange basidiomata, translucently striate pileus, slender and brittle stipe, (1–)2–3-sterigmate, short, stout basidia, and absence of cheilocystidia (He *et al.* 2011).

Based on the morphological combination of its two-layered pileipellis with well-differentiated subpellis, clamp connections, and two types of pigments, *E. bisterigmatum* would be classified infragenerically in *Entoloma* subgen. *Nolanea* (Noordeloos 1992) or in the segregate genus *Nolanea* (Largent 1994).

*Entoloma brunneoloaurantiacum* Largent & T.W. Henkel, *sp. nov.* MycoBank MB831485. Figs 3, 4.

*Etymology:* *brunneolous* (L. adj. A) = brownish, *aurantiacus* (L. adj. A) = orange, referring to the brownish orange pileus.

*Diagnosis:* *Entoloma brunneoloaurantiacum* is unique within the *Entolomataceae* due to its combination of collybioid stature with a brownish orange, broadly depressed, glabrous, translucent-striate pileus, mild odor, farinaceous taste, subsodiametric to heterodiametric, distinctly angular basidiospores with average width > 11  $\mu\text{m}$ , rare cylindrical cheilocystidia, dimorphic basidia, and abundant clamp connections.

*Typus:* **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp located at 3°21'29.8" N 12°43'46.9" W, 650 m a.s.l.; 1.4 km WSW of base camp in GD plot 2, in *Gilbertiodendron dewevrei* monodominant forest, 28 Aug. 2017, Henkel 10436 (**holotype** YA 66996; **isotype** HSC G1272); GenBank accessions: ITS MN069537; nrLSU MN066546.

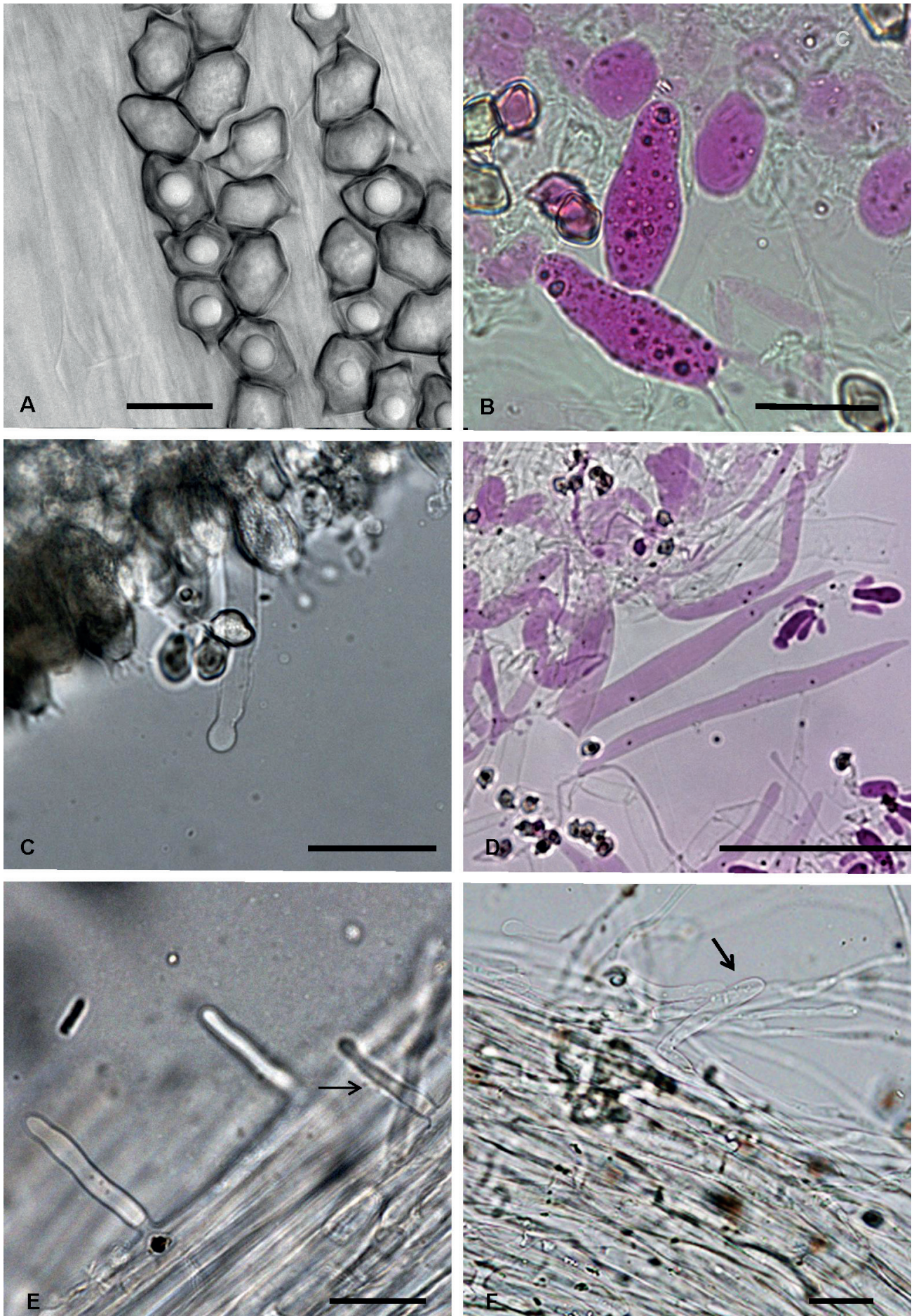
*Basidiomata* collybioid. *Pileus* 22–45(–74) mm broad, 3–10(–17) mm tall, planate to evenly uplifted with a broad, shallow centrally depression; disc immediately over stipe more deeply depressed, occasionally with small umbo, greyish orange



**Fig. 3.** *Entoloma brunneoloaurantiacum*. **A.** Holotype (Henkel 10436). **B.** Mature basidiomata, field habit (Henkel 10817). Scale bars: A = 25 mm, B = 30 mm.

(~6B4–6B5) to brownish orange (7C4–7C5) throughout, with age rapidly hygrophanous to light orange outward from disc to margin, moist, translucent striate from disc to margin, glabrous macroscopically, under hand lens finely appressed-fibrillose; fibrils running radially from disc outward throughout, rarely minutely erect over immediate disc; margin typically downturned and shallowly crenulate; trama 1 mm thick at margin, 2 mm over lamellae, 3 mm at stipe, dull orangish tan, unchanging. *Lamellae* thin, subdistant, sharply adnexed to subsinuate, initially pale pink (6A2–6A3), with age dull reddish pink (~8C4–C5), 3 mm tall at margin, 5 mm centrally, 1 mm at stipe; edges concolorous, finely eroded-serrulate, unchanging; lamellulae 2–3, 2–12 mm long. *Stipe* 57–80(–140)  $\times$  3.5–4.5(–7) mm, subequal, slightly enlarged and pinkish tan at base, otherwise off-white, glabrous macroscopically, under hand lens with fine, twisting longitudinal striations, minutely pruinose at extreme apex; basal mycelium an off-white to pale cream bloom; trama off-white, pale orange toward base, unchanging, cartilaginous-fibrous with a hollow central core. *Odor* none. *Taste* distinctly farinaceous. *Spore print* reddish brown (8D8) in heavy deposit. *Basidiospores* subsodiametric to heterodiametric in profile view and distinctly 5-angled, rarely 6-angled, 8.8–13.4  $\times$  7.1–10.8  $\mu\text{m}$  ( $\bar{x}$  = 11.3  $\pm$  0.7  $\times$  8.9  $\pm$  0.4  $\mu\text{m}$ ; E = 1.1–1.5; Q = 1.3  $\pm$  0.6;  $y/x$  = 119/3); apex acute, rarely obtuse; base occasionally truncate. *Basidia* dimorphic, most often long-clavate and strongly tapered to a narrow base, 30.8–45.2(–50.6)  $\times$  9.3–14.6(–15.3)  $\mu\text{m}$  ( $\bar{x}$  = 37.0  $\pm$  3.0  $\times$  12.8  $\pm$  1.1  $\mu\text{m}$ ; E = 2.5–3.7; Q = 2.9  $\pm$  0.2;  $y/x$  = 52/3), occasionally broadly clavate to broadly cylindrical or nearly ovate and hardly tapered, 24.0–29.8  $\times$  10.5–13.7  $\mu\text{m}$  ( $\bar{x}$  = 26.4  $\pm$  1.7  $\times$  12.4  $\pm$  0.8  $\mu\text{m}$ ; E = 1.8–2.5; Q = 2.1  $\pm$  0.2;  $y/x$  = 22/1), 4-sterigmate. *Lamellar edge* mostly fertile with rare to scattered cheilocystidia. *Cheilocystidia* hyaline, cylindrical to cylindro-clavate, at times capitulate, 34.5–60.3  $\times$  5.7–9.5  $\mu\text{m}$  (E = 5.1–10.5; Q = 7.1  $\pm$  1.9;  $y/x$  = 6/2), often only one or two present per lamella section or absent. *Pleurocystidia* absent. *Lamellar tramal hyphae* subparallel to entangled; hyphae strongly tapered, sharply- or rounded-acuminate on both ends, 72.7–654.3  $\times$  7.6–32.7  $\mu\text{m}$  ( $y/x$  = 44/3). *Pileipellis* on the disc a loosely entangled, suberect hyphal layer 45–150  $\mu\text{m}$  thick, elsewhere a multilayered cutis with rare to scattered, suberect to erect pileocystidia; suprapellis hyphae narrower than those of the pileus trama; subpellis indistinct. *Pileocystidia* cylindrical to cylindro-clavate, 16.7–148.7  $\times$  3.7–25.1  $\mu\text{m}$  (E = 2.6–13.4;  $y/x$  = 29/3). *Pileal tramal hyphae* similar to lamellar tramal hyphae but less tapered and rounded on both ends, 82.5–342.1  $\times$  16.0–44.9  $\mu\text{m}$  ( $y/x$  = 27/3). *Stipitipellis* a cutis with solitary, scattered, or clustered erect caulocystidia. *Caulocystidia* versiform, ranging from cylindrical, cylindro-clavate, broadly cylindro-clavate, irregularly acuminate, once or twice-capitate, to once or twice-substrangulated, 14.7–65.8  $\times$  2.7–15.2  $\mu\text{m}$  (E = 1.6–22.3;  $y/x$  = 24/2). *Stipe tramal hyphae* parallel, of varying lengths, with blunt to rounded ends, 77.7–495.7  $\times$  11.3–28.7  $\mu\text{m}$  ( $y/x$  = 33/3). *Oleiferous hyphae* present in trama of the lamellae, pileus, and stipe. *Lipid globules* and *brilliant granules* present in some basidia. *Pigmentation* cytoplasmic in pileipellis hyphae, minutely encrusting on some hyphae of the stipe trama. *Clamp connections* small, not obvious, present at bases of basidia and caulocystidia, and on pileipellis and stipitipellis hyphae.

*Habit, habitat, and distribution:* Solitary on humic mat under *G. dewevrei* and *Uapaca* spp.; known only from the type locality in the Dja Biosphere Reserve.



**Fig. 4.** *Entoloma brunneoaurantiacum* (Henkel 10436, holotype). **A.** Basidiospores. **B.** Basidia with granules. **C.** Cylindrical capitulate cheilocystidium (Henkel 10330). **D.** Lamellar tramal hyphae pointed at both ends (Henkel 10429). **E.** Stipitipellis with erect cylindrical caulocystidia; **F.** Pileipellis with semi-erect cylindro-clavate pileocystidium (arrow). Scale bars: A = 12  $\mu\text{m}$ ; B = 27  $\mu\text{m}$ ; C = 57  $\mu\text{m}$ ; D =  $\sim$ 120  $\mu\text{m}$ ; E = 40  $\mu\text{m}$ ; F = 43  $\mu\text{m}$ .

**Additional materials examined:** Cameroon, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp at 3°21'29.8" N 12°43'46.9" W, 650 m a.s.l.; 0.4 km N of base camp in mixed rainforest under *Uapaca* sp., 1 Dec. 2016, *Henkel 10330* (YA 67005; HSC G1273), GenBank accession: ITS MN069535; 26 Aug. 2017, *Henkel 10429* (YA 67006; HSC G1274), GenBank accession: ITS MN069536; 30 Aug. 2019, *Henkel 10817* (YA; HSC G1275); 31 Aug. 2019, *Henkel 10823* (YA; HSC G1276); 0.2 km NNE of base camp in riparian forest under *Uapaca guineensis*, 1 Sep. 2019, *Henkel 10827* (YA; HSC G1277).

**Notes:** *Entoloma brunneoaurantiacum* is somewhat similar to *E. mondahense* from Gabon in its brownish, broadly depressed, translucent striate pileus, capitate cylindrical cheilocystidia, and abundant clamp connections. *Entoloma mondahense* differs in its much smaller pileus (6–8 mm broad, 3 mm tall), smaller stipe (15 mm long, 1 mm wide), smaller basidiospores measuring (7.5–)8–9(–10) × 5.5–6.5 μm, and smaller basidia (27–38 × 9.5–11 μm) (Romagnesi & Gilles 1979 as *Rhodophyllis mondahensis*).

Infragenerically, *E. brunneoaurantiacum* is best placed in *Entoloma* sect. *Rhodopolia* due its collybioid stature, adnexed lamellae, intracellular pigmentation, and clamp connections (Noordeloos 1992).

***Entoloma djaense*** Largent & T.W. Henkel, *sp. nov.* MycoBank MB831486. Figs 5, 6.

**Etymology:** Dja, and *-ensis* (L. adj. B), referring to the known distribution of the species in the type locality of the Dja Biosphere Reserve, Cameroon.

**Diagnosis:** Differs from *Entoloma rugiferum* in its larger basidiomata, olivaceous brown pileus, concolorous stipe with fibrils that blacken with handling, sinuate lamellae with a decurrent tooth, shorter basidiospores, and lack of cheilocystidia

**Typus:** Cameroon, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp located at 3°21'29.8" N 12°43'46.9" W, 650 m a.s.l.; 2 km SW of base camp in vicinity of GDP 3, in *Gilbertiodendron dewevrei* monodominant forest, 5 Sep. 2018, *Henkel 10608* (**holotype** YA 66999; **isotype** HSC G1278); GenBank accessions: ITS MN069538; nrLSU MN066547.

**Basidioma** tricholomatoid. **Pileus** planoconvex, with age uplifted with broad, shallow central depression and low rounded umbo, 40–80(–105) mm broad, 10–28(–38) mm tall, initially dark olivaceous brown (5E6–5E8) throughout, slightly lighter concolorous near margin, darker over umbo (5F8–6F8); surface moist, glabrous and shiny macroscopically, under hand lens with a very dense, contiguous, suberect tomentum throughout with no indication of radial orientation, very finely erect tomentose over umbo, faintly translucent-striate over outer 10–15 mm, with a slightly hygrophanous band developing outward from umbo when air-drying; margin finely crenulate; trama white, solid, unchanging, olivaceous immediately beneath pileipellis, <0.5–1 mm thick at margin, 1–12 mm centrally, 1.5–7 mm above stipe. **Lamellae** subthick, subclose, broadly and shallowly sinuate with decurrent tooth, 3 mm tall at margin, 12 mm centrally, 10 mm at stipe, initially white, progressively pale dirty pink (5A2–6A2) with maturation; edges slightly lighter, under hand lens finely roughened-eroded, unchanging; lamellulae usually 5, of irregular length combinations,

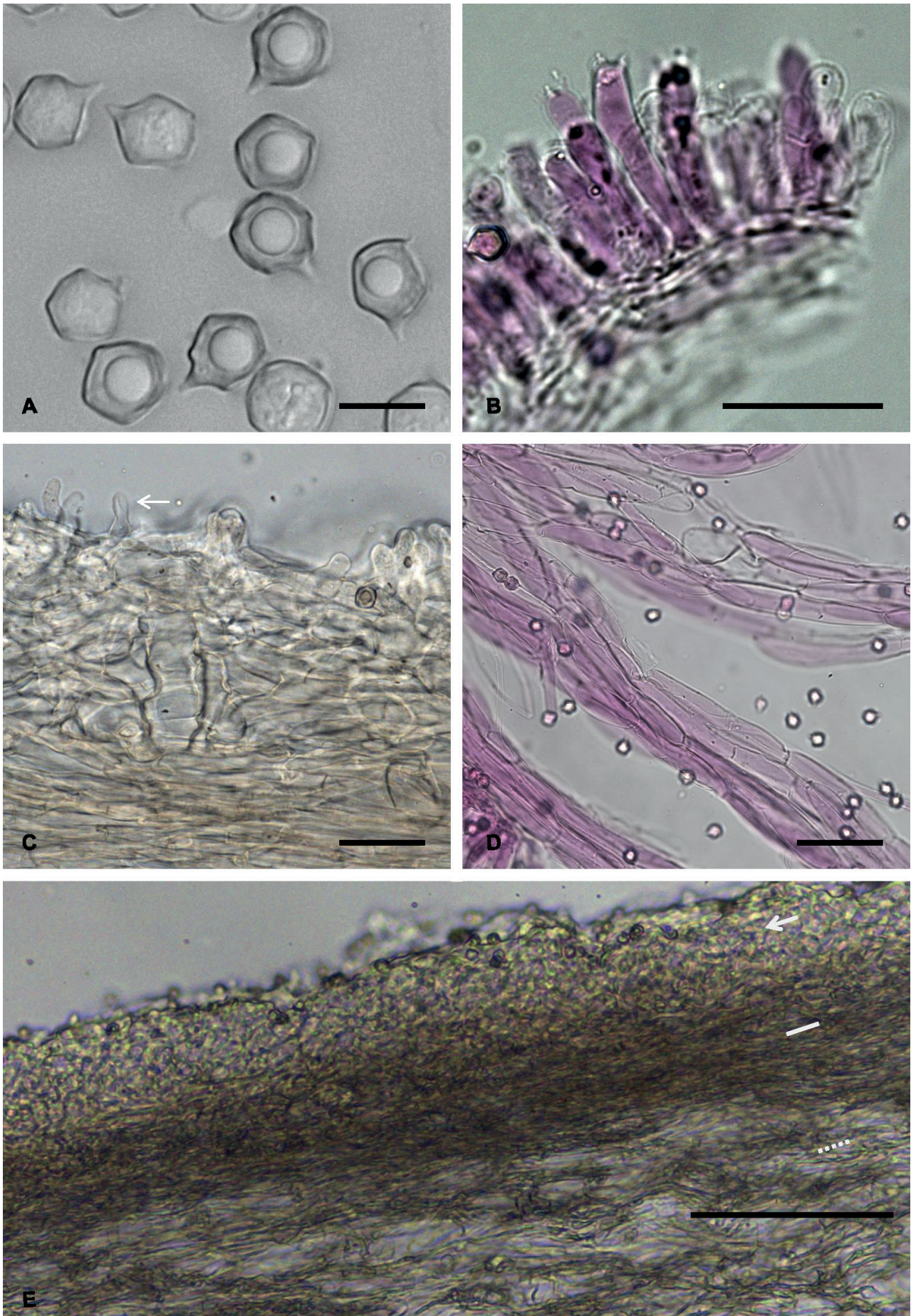


**Fig. 5.** *Entoloma djaense* (*Henkel 10608*, holotype). Scale bar = 35 mm.

1–21 mm long. **Stipe** 80–117 × 6–12 mm, equal, cylindrical to occasionally flattened, yellowish olive (4B4–4C4) to brownish olive (4E8–5E8) throughout, lighter concolorous over apical ~10 mm and there with fine longitudinal ridges contiguous with lamellae; surface subglabrous macroscopically, under hand lens tightly appressed longitudinally fibrillose and striate; fibrils darkening to nearly black with handling; basal mycelium a faint white tomentum at extreme base; trama white, unchanging, yellowish immediately under stipitipellis, solid, longitudinally fibrous. **Odor** minimal, indistinct. **Taste** somewhat nutty, with soapy overtones. **Spore print** dull greyish pink (8C4) in heavy deposit. **Basidiospores** isodiametric to subisodiametric in all views, distinctly 5–6-angled, 6.6–8.5 × 5.9–8.0 μm ( $\bar{x}$  = 7.6 ± 0.4 × 6.9 ± 0.5 μm; E = 1.0–1.2; Q = 1.1 ± 0.1; γ/x = 58/2). **Basidia** cylindric, 27.6–47.5 × 5.7–10.8 μm ( $\bar{x}$  = 38.3 ± 4.0 × 7.8 ± 1.1 μm; E = 3.4–6.5; Q = 4.9 ± 0.7; γ/x = 45/2), 4-sterigmate. **Cheilocystidia** and **pleurocystidia** absent. **Lamellar tramal hyphae** subparallel, relatively short and broad, 22–130 × 3–19 μm (γ/x = 21/1). **Pileipellis** two-layered, overall 56–100 μm thick; suprapellis of frequent but scattered pileocystidia, these versiform, ranging from lageniform to ventricose-rostrate with moniliform apex, rarely clavate, and nearly all narrow and originating from the subpellis, 7.5–50.8 × 2.8–23.1 μm (E = 0.5–8.9; γ/x = 61/2); subpellis compact, 4–6 cells deep; cells globose, vesiculate, napiform, turbinate, or broadly clavate, 16.0–32.4 × 9.3–24.2 μm (E = 0.9–2.4; γ/x = 13/1). **Pileus tramal hyphae** relatively short and broad, 24.0–74.0 × 7.0–18.0 μm (γ/x = 11/2). **Stipitipellis** mostly repent, occasionally with groups of anticlinal hyphae. **Caulocystidia** rare, cylindric to clavate, 14.9–54.2 × 2.0–9.3 μm (E = 2.79–7.07; γ/x = 7/2). **Stipe tramal hyphae** of variable widths, subparallel, 30.0–130.0 × 3.0–10.0 μm (γ/x = 33/2). **Oleiferous hyphae**, **brilliant granules** and **lipid globules** absent. **Pigmentation** brownish and cytoplasmic, not encrusting, soluble in water and in 3% KOH, darker brown in the pileipellis but dissolving rapidly. **Clamp connections** evident on basidioles and on hyphae of the lamellar trama, stipe trama, and pileipellis.

**Habit, habitat, and distribution:** Solitary to scattered on humic mat under *G. dewevrei*; known only from the type locality in the Dja Biosphere Reserve.

**Additional materials examined:** Cameroon, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp at 3°21'29.8" N 12°43'46.9"



**Fig. 6.** *Entoloma djaense* (Henkel 10608, holotype). **A.** Basidiospores. **B.** Basidia. **C.** Hyaline suprapellis of pileocystidia (arrow) and subpellis composed of versiform inflated cells, and pigmented outer pileus trama. **D.** Dissociated lamellar tramal hyphae (Henkel 9985). **E.** Pileipellis with hyaline suprapellis (white arrow), pigmented subpellis (white line), and pigmented outer pileal trama (white dots). Scale bars: A = 7  $\mu\text{m}$ ; B = 40  $\mu\text{m}$ ; C = 13  $\mu\text{m}$ ; D =  $\sim$ 50  $\mu\text{m}$ ; E = 80  $\mu\text{m}$ .



W, 650 m a.s.l.; 2 km SW of base camp near GDP3, under *G. dewevrei*, 17 Sep. 2014, *Henkel 9985* (YA 67008; HSC G1279), GenBank accession: ITS MN069539; 1.4 km WSW of base camp near GDP2, under *G. dewevrei*, 17 Sep. 2019, *Henkel 10908* (YA; HSC G1280); 0.2 km ENE of base camp in riparian forest, under *Uapaca guineensis*, 19 Sep. 2019, *Henkel 10920* (YA; HSC G1281); 0.8 km WSW of base camp near GDP1, under *G. dewevrei*, 21 Sep. 2019, *Henkel 10936* (YA; HSC G1282).

**Notes:** *Entoloma djaense* has a combination of features collectively unknown in any other *Entoloma* species. These include the tricholomatoid stature, rich olivaceous brown pileus and concolorous stipe with blackening fibrils, and a callidermic pileipellis. *Entoloma djaense* resembles *E. rugiferum* from Gabon in its tricholomatoid stature, versiform pileocystidia, globose basidiospores, and clamp connections. *Entoloma rugiferum* differs, however, in its relatively smaller basidiomata that lack olivaceous tones, subfree to uncinat lamellae, stipe punctuated with tiny brown tufts, longer basidiospores, palisadic pileipellis, and polymorphous cheilocystidia (Romagnesi & Gilles 1979). Several other paleotropical *Entoloma* species are similar to *E. djaense* in having a tricholomatoid stature, cylindric basidia, and subglobose basidiospores. These include *E. phaeus* from Gabon and Ivory Coast, and *E. pinque* and *E. fidele* from the Solomon Islands. Each of these species differs from *E. djaense* by their basidioma colors and palisadoderm pileipellis with dense pileocystidia (Romagnesi 1956, Horak 1980).

The neotropical *E. brasiliense* (= *Calliderma fibulatum*; Karstedt & Capelari 2010) is microscopically similar to *E. djaense* in its subglobose basidiospores, abundant clamp connections, and pileipellis structure, but differs in its smaller basidiomata with a dark blue pileus and bluish-grey stipe (Karstedt & Capelari 2010).

Overall consideration of morphological features would lead *E. djaense* to be placed infragenerically in *Entoloma* subgen. *Entoloma* sect. *Calliderma* (Noordeloos & Gates 2012) or in the segregate genus *Calliderma* (Largent 1994). However, the unique pileipellis structure makes either of these classifications doubtful.

***Entoloma intricatum*** Largent, T.W. Henkel & R.A. Koch, *sp. nov.* MycoBank MB831487. Figs 7, 8.

**Etymology:** *intricatus* (L. part. A) = entangled, referring to the entangled hyphae of the pileipellis and stipitipellis.

**Diagnosis:** Differs from *Entoloma nidorosiforme* in its heterodiametric basidiospores, matted, opaque pileus, fragrant odor, pleasant taste, cheilocystidia distinctly different than the basidia, and reaction of surface structures to 3 % KOH.

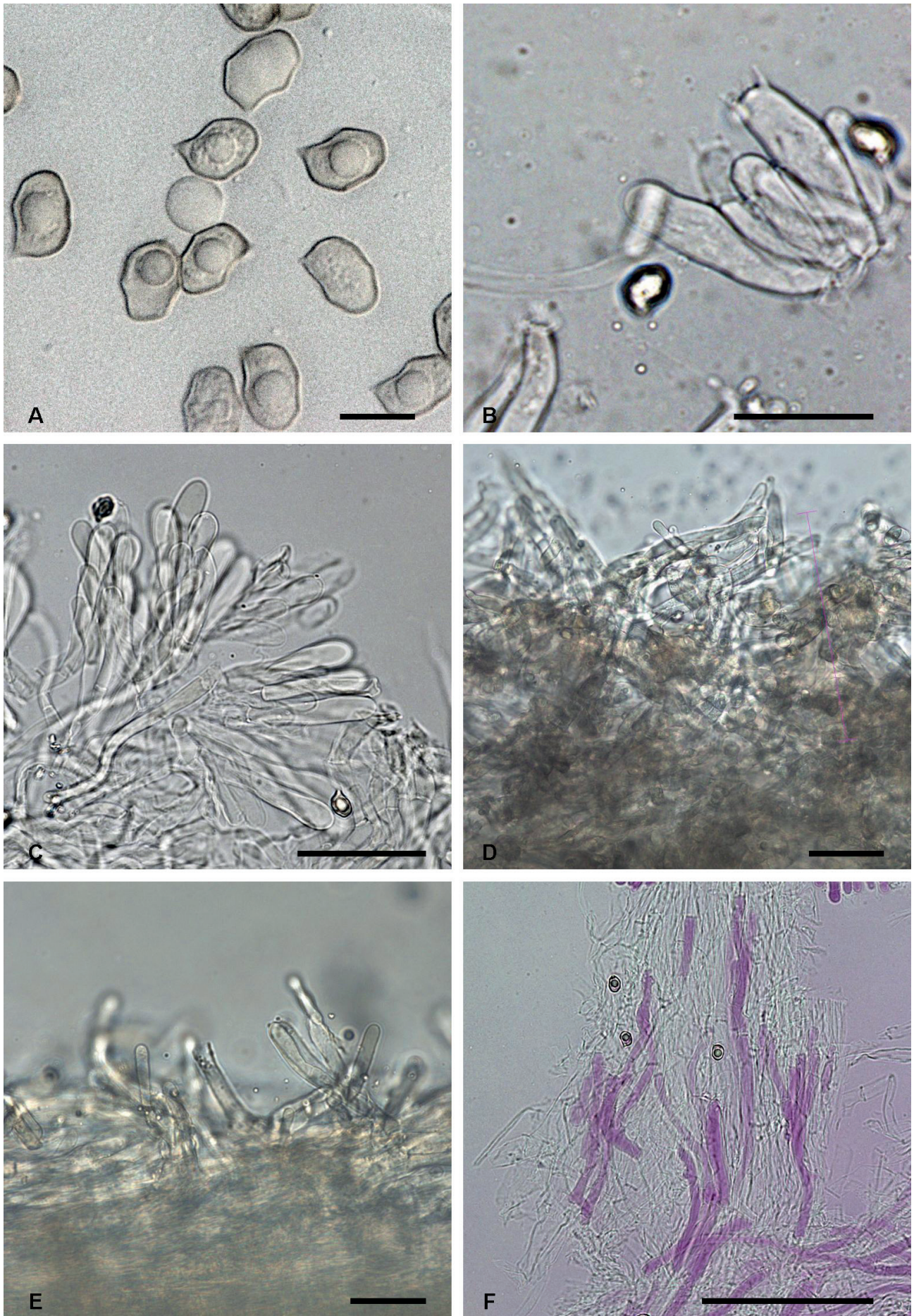
**Typus:** **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 5 km of Dja base camp located at 3°21'29.8" N 12°43'46.9" W, 650 m a.s.l.; ~ 5 km SW of base camp in *Gilbertiodendron* stand 4, in caespitose cluster on upper mineral soil under *Gilbertiodendron dewevrei*, 26 Sep. 2018, *Henkel 10743* (**holotype** YA 66998; **isotype** HSC G1283); GenBank accession: ITS MN069540.

**Basidioma** naucorioid (Largent 1986). **Pileus** 14–58 mm broad, 4–15 mm tall, planoconvex with incurved margin throughout development, with a shallow central depression with age, off-



**Fig. 7.** *Entoloma intricatum* A. Holotype (*Henkel 10743*). B. Mature basidioma, ventral view (*Henkel 10894*). Scale bars: A = 30 mm, B = 40 mm.

white to pale yellow (3A2–3A3 KW) over outer 3/4, yellowish orange (3A5–4A5 KW) over immediate disc, very shallowly sulcate over outer 1/2; surface submoist, subglabrous, under hand lens densely matted-fibrillose throughout; elements erect tomentulose over disc, toward margin repent and separating into irregular, ill-defined striations, unchanging with pressure; margin entire and incurved; trama off-white to pale cream, unchanging, solid, 0.5 mm thick at margin, 1.5 mm over lamellae, 6 mm above stipe. **Lamellae** subthick, subclose including lamellulae, adnate to narrowly adnexed with short decurrent tooth, initially off-white to cream (4A3 KW), with age light, dull pink with a greenish tone, unchanging, 1 mm tall at margin, 4 mm centrally, 3 mm at stipe; edges slightly lighter pink, roughened-cystidiate and finely eroded under hand lens; lamellulae ~2–3 (short-long-short), 4–13 mm long. **Stipe** subequal, enlarging slightly toward base, 25–120 × 4–8 mm, white to yellowish white (3A1–3A2 KW) throughout, discoloring slightly darker slowly with handling, finely longitudinally striate throughout; surface under hand lens of repent, matted fibrils with longitudinal orientation throughout; extreme apex finely floccose-pruinose, concolorous; basal mycelium a white mat at extreme base, subtended by a dense mass of hyphae in substratum; trama off-white, unchanging, solid, longitudinally fibrous. **Odor** faintly fragrant. **Taste** pleasant, slightly nutty, similar to raw *Boletus edulis*. **Spore**



**Fig. 8.** *Entoloma intricatum* (Henkel 10743, holotype). **A.** Basidiospores. **B.** Basidia. **C.** Cylindro-clavate and clavate cheilocystidia. **D.** Pileocystidia at pileus center (Henkel 10568). **E.** Cylindric caulocystidia. **F.** Lamellar tramal hyphae with rounded ends. Scale bars: A = 9  $\mu\text{m}$ ; B = 39  $\mu\text{m}$ ; C = 44  $\mu\text{m}$ ; D = 50  $\mu\text{m}$ ; E = 57  $\mu\text{m}$ ; F = 181  $\mu\text{m}$ .

print dull dark pink in moderate deposit. *Basidiospores* heterodiametric in profile and dorsiventral views with distinct to obscure angles, 5–7(–8)-angled,  $7.5\text{--}11.3 \times 5.4\text{--}8.9 \mu\text{m}$  ( $\bar{x} = 9.0 \pm 0.6 \times 6.6 \pm 0.5 \mu\text{m}$ ;  $E = 1.1\text{--}1.7$ ;  $Q_r = 1.3\text{--}1.5$ ;  $Q = 1.4 \pm 0.1$ ;  $y/x = 204/4$ ). *Basidia* cylindric to cylindro-clavate,  $28.5\text{--}51.1 \times 6.5\text{--}11.0 \mu\text{m}$  ( $\bar{x} = 38.4 \pm 4.8 \times 8.9 \pm 0.8 \mu\text{m}$ ;  $E = 3.0\text{--}6.5$ ;  $Q = 4.4 \pm 0.7$ ;  $y/x = 77/7$ ), 4-sterigmate; sterigmata 0.6–5.4  $\mu\text{m}$  long. *Cheilocystidia* forming a layer 40.3–65.7  $\mu\text{m}$  deep in young basidiomata, collapsing with age except near pileal margin, cylindric, cylindro-clavate, or narrowly clavate,  $29.0\text{--}77.7 \times 4.0\text{--}11.9 \times 5.3\text{--}11.9 \mu\text{m}$  ( $E = 2.9\text{--}12.0$ ;  $y/x = 90/4$ ). *Pleurocystidia* absent. *Lamellar trama hyphae* subparallel, blunt or slightly rounded on both ends,  $28.0\text{--}233.0 \times 2.0\text{--}15.0 \mu\text{m}$  ( $y/x = 499/2$ ). *Pileipellis* a 39.7–340  $\mu\text{m}$  deep layer of entangled suberect to erect hyphae, these in triangular fascicles over the disc. *Pileocystidia* cylindric to cylindro-clavate, sinuous, rarely subcapitulate,  $21.2\text{--}97.2 \times 3.0\text{--}21.0 \mu\text{m}$  ( $E = 3.1\text{--}32.5$ ;  $y/x = 69/4$ ). *Pileal tramal hyphae* similar to lamellar tramal hyphae,  $44.2\text{--}268.0 \times 2.0\text{--}21.0 \mu\text{m}$  ( $y/x = 41/4$ ). *Stipitipellis* a layer of entangled hyphae 30–40  $\mu\text{m}$  deep. *Caulocystidia* cylindric to cylindro-clavate,  $17.7\text{--}109.0 \times 4.0\text{--}10.8 \mu\text{m}$  ( $E = 2.9\text{--}32.5$ ;  $y/x = 50/4$ ). *Stipe tramal hyphae* with blunt to rounded, rarely tapering ends,  $59.0\text{--}570.9 \times 6.4\text{--}16.9 \mu\text{m}$  ( $y/x = 35/4$ ). *Brilliant granules* scattered in pileal trama; other non-brilliant granules abundant in stipe tramal hyphae. *Lipid globules* abundant in hyphae of all tissues. *Pigmentation* cytoplasmic, scattered in hyphae of all tissues, golden brown in water mounts, in KOH orangish yellow in the pileipellis, stipitipellis, and lamellar edge, encrusting only in the stipe tramal hyphae. *Clamp connections* present on most septa at the bases of cystidia and basidia, and on the pellis hyphae.

*Habit, habitat, and distribution:* Solitary, scattered, or in caespitose pairs on humic mat/mineral soil interface under *G. dewevrei*; known only from the type locality in the Dja Biosphere Reserve.

*Additional materials examined:* **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp at  $3^{\circ}21'29.8''$  N  $12^{\circ}43'46.9''$  W, 650 m a.s.l.; 2 km SW of base camp near GDP3, on humic mat under *G. dewevrei*, 13 Sep. 2014, *Henkel 9966* (YA 67009; HSC G1284); 1.4 km WSW of base camp near GDP2, from upper mineral soil under *G. dewevrei*, 22 Sep. 2018, *Henkel 10718* (YA 67010; HSC G1285), GenBank accession: ITS MN069541; 14 Sep. 2019, *Henkel 10894* (YA; HSC G1286); 25 Sep. 2019, *Henkel 10968* (YA; HSC G1287). **Democratic Republic of Congo**, District of Lakes Edward and Kivu, Panzi-Kivu, on soil in coffee plantation, Apr. 1949, *Goossens-Fontana 5092*, *Rhodophyllus nidosoriformis* Romagn.!, **holotype** (BR5020031831157).

*Notes:* *Entoloma intricatum* is similar to the Congolian *E. nidosoriforme* (= *Rhodophyllus nidosoriformis*) because of its naucorioid basidiomata with an off-white to pale yellowish orange, depressed, finely tomentose pileus, concolorous stipe, obscurely-angled basidiospores, and presence of clamp connections. However, *E. nidosoriforme* differs macroscopically in its thin-fleshed, hygrophanous pileus, strongly disagreeable odor, and acrid taste. The protologue description of *E. nidosoriforme* (Romagnesi 1956, p. 160) and our examination of the type indicated the additional differences of subglobose basidiospores and cheilocystidia with similar shape to the basidia and apparent lack of a KOH color change (Romagnesi 1956).

*Entoloma intricatum* also resembles *E. eburneus* from Gabon in its off-white to pale yellow pileus and stipe, variably attached lamellae, heterodiametric basidiospores with obscure angles, and abundant cylindrical cheilocystidia. *Entoloma eburneus* differs in its strong, disagreeable odor, repent filamentous pileipellis, and lack of clamp connections (Romagnesi & Gilles 1979).

A number of *Entoloma* species with white to pale yellow basidiomata differ from *E. intricatum* in the following ways. *Entoloma flavovelutinum* from Vietnam has blunt-angled basidiospores with  $Q = 1.4\text{--}1.7$  and lacks clamp connections (Crous *et al.* 2015). *Entoloma flavidum* from Singapore and Malaysia has clitocyboid basidiomata with a cuticular pileipellis with encrusted hyphae (Horak 1980). *Entoloma perflavidum* has a cuticular pileipellis and lacks clamp connections (Manimohan *et al.* 2006).

Morphologically, *E. intricatum* would be infragenerically classified in *Entoloma* subgen. *Inocephalus* (Noordeloos & Gates 2012) or in the segregate genus *Inocephalus* (Largent 1994).

***Entoloma versiforme*** Largent, T.W. Henkel, M.C. Aime & R.A. Koch, **sp. nov.** MycoBank MB831488. Figs 9, 10.

*Etymology:* *versiformis* (L. adj. B) = of different shapes, referring to the versiform hymenial cystidia.

*Diagnosis:* Differs from *Entoloma granulocystidiatum* in its broadly conic pileus, slowly peppery taste, typically 5–6-angled, isodiametric to subisodiametric basidiospores, versiform hymenial cystidia, slender, long, tapered lamellar trama hyphae, and presence of caulocystidia and clamp connections.

*Typus:* **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp located at  $3^{\circ}21'29.8''$  N  $12^{\circ}43'46.9''$  W, 650 m a.s.l.; 2 km SW of base camp in GDP3, clustered on humic mat/mineral soil interface under *Gilbertiodendron dewevrei*, 9 Dec. 2016, *Henkel 10366* (**holotype** YA 66997; **isotype** HSC G1288); GenBank accessions: ITS MN069542; nrLSU MN066548.

*Basidioma* mycenoid. *Pileus* 15–33(–70) mm broad, 13–22 mm tall, broadly conic, with age evenly uplifted with narrow short umbo, greyish brown (6E4), darker concolorous (6F4) over immediate umbo; surface dry, densely appressed radially fibrillose from disc to margin; fibrils separating progressively toward margin over lighter concolorous ground and appearing striate; disc and umbo with compact, erect-fibrillose tufts; margin entire to minutely crenulate, slightly undulating with age; trama pale cream, unchanging, < 0.25 mm thick at margin, 0.25 mm centrally, 2 mm above stipe. *Lamellae* thin, close, narrowly adnexed, initially pale orange (6A3), with age dull pink (8A4–8B4), 1 mm tall at margin, 4 mm centrally, 3 mm at the stipe; edges concolorous, finely eroded, and cystidiate under hand lens; lamellulae 2–5, 3–7 mm long. *Stipe* 45–112 mm  $\times$  2–5 mm, light brownish grey (6D3), cylindric, equal with a slightly bulbous base, finely longitudinally striate throughout, under hand lens with appressed to suberect brownish grey fibrils over lighter concolorous ground; basal mycelium a whitish bloom at extreme base, subtended by a dense white hyphal mass descending into substratum; trama off-white, unchanging, fibrous, with narrow hollow central core. *Odor* indistinct to spermatic. *Taste* indistinct to slightly sweet, then slightly peppery. *Spore print* dull pink (8A4–8B4) in moderate deposit. *Basidiospores* in profile view



**Fig. 9.** *Entoloma versiforme* A. Holotype (Henkel 10366). B. Mature basidioma (Henkel 10969). Scale bars: A = 35 mm, B = 40 mm.

subisodiametric to isodiametric, with 5–6 subdistinct to distinct angles,  $6.8\text{--}9.9 \times 5.6\text{--}8.5 \mu\text{m}$  ( $\bar{x} = 8.4 \pm 0.6 \times 7.3 \pm 0.5 \mu\text{m}$ ;  $E = 1.0\text{--}1.3$ ;  $Q = 1.2 \pm 0.1$ ;  $y/x = 66$ ). *Basidia* broadly cylindrical, cylindro-clavate, or clavate, somewhat tapering toward base, some filled with brilliant granules,  $24.7\text{--}48.7 \times 6.9\text{--}12.8 \mu\text{m}$  ( $\bar{x} = 30.9 \pm 3.7 \times 9.7 \pm 1.2 \mu\text{m}$ ;  $E = 2.2\text{--}6.3$ ;  $Q = 3.3 \pm 0.6$ ;  $y/x = 73/2$ ), 4-sterigmate; sterigmata  $1.8\text{--}4.3 \mu\text{m}$  long. *Cheilocystidia* abundant, versiform, ranging from ventricose-rostrate, ventricose and acuminate, acuminate, aculeate, subulate, to lanceolate, originating from outer part of subhymenium, with a very pale greenish, finely granular contents in KOH,  $20.2\text{--}72.0 \times 4.9\text{--}15.7 \mu\text{m}$  ( $E = 3.0\text{--}9.1$ ;  $y/x = 28/2$ ). *Pleurocystidia* abundant, versiform, similar in range of shapes to cheilocystidia but longer,  $40.7\text{--}105.6 \times 3.3\text{--}32.5 \mu\text{m}$  ( $E = 2.0\text{--}21.2$ ;  $y/x = 28/2$ ). *Lamellar tramal hyphae* subparallel, long and slender, many with central swellings, often tapered and rounded at both ends,  $23.1\text{--}280.5 \times 4.9\text{--}13.5 \mu\text{m}$ ;  $y/x = 24/2$ ). *Pileipellis* a densely entangled layer of hyphae  $173.7\text{--}206.9 \mu\text{m}$  thick; hyphae erect on and near the pileus disc, semi-erect centrally, and prostrate at the margin; subpellis absent. *Pileocystidia* cylindrical to cylindro-clavate, often tapering to a rounded point,  $16.0\text{--}217.0 \times 5.4\text{--}17.3 \mu\text{m}$  ( $E = 2.4\text{--}16.2$ ;  $y/x = 34/2$ ). *Pileal tramal hyphae* typically somewhat tapered toward the ends; ends rounded or occasionally blunt,  $46.4\text{--}138.5 \times 5.1\text{--}9.3 \mu\text{m}$ ;  $y/x = 4/1$ ). *Stipitipellis* a cutis throughout,  $51.3\text{--}89.7 \mu\text{m}$  thick, overlain at the apex with abundant clustered or solitary caulocystidia. *Caulocystidia* broadly cylindrical, cylindro-clavate,

or clavate,  $13.3\text{--}65.0 \times 3.2\text{--}10.8 \mu\text{m}$  ( $\bar{x} = 35.83 \pm 15.13 \times 7.08 \pm 1.89 \mu\text{m}$ ;  $E = 1.84\text{--}10.86$ ;  $Q = 5.22 \pm 2.19$ ;  $y/x = 39/2$ ). *Stipe tramal hyphae*  $3.3\text{--}393.0 \times 5.1\text{--}15.7 \mu\text{m}$  ( $y/x = 16/2$ ). *Oleiferous hyphae* scattered in lamellar trama. *Lipid globules* rare. *Brilliant granules* present in some basidia and scattered elsewhere. *Pigmentation* dark brown, cytoplasmic, blotchy and particularly obvious in pileal tramal hyphae, becoming colorless in 3% KOH. *Clamp connections* somewhat obscure in the pileipellis hyphae, scattered in lamellar tramal hyphae, inevident in basidia.

*Habit, habitat, and distribution:* Scattered on humic mat under *G. dewevrei*; known only from the type locality in the Dja Biosphere Reserve.

*Additional materials examined:* **Cameroon**, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp at  $3^{\circ}21'29.8'' \text{ N } 12^{\circ}43'46.9'' \text{ W}$ , 650 m a.s.l.; 2 km SW of base camp in GDP3, on soil and litter under *G. dewevrei*, 23 Sep. 2017, Aime 7537 (YA 67011; PUL F23114); GenBank accession: ITS MN069543; 26 Sep. 2019, Henkel 10969 (YA; HSC G1289).

*Notes:* In the field *E. versiforme* is recognized by its mycenoid basidiomata, broadly conic pileus with an erect fibrillose umbo contrasting with the appressed fibrillose surface elsewhere and light brownish grey, longitudinally striate stipe. Microscopically *E. versiforme* is distinguished by its combination of subsodiametric to isodiametric, 5–6-angled basidiospores, abundant versiform cheilo- and pleurocystidia, and obscure, rare to scattered clamp connections.

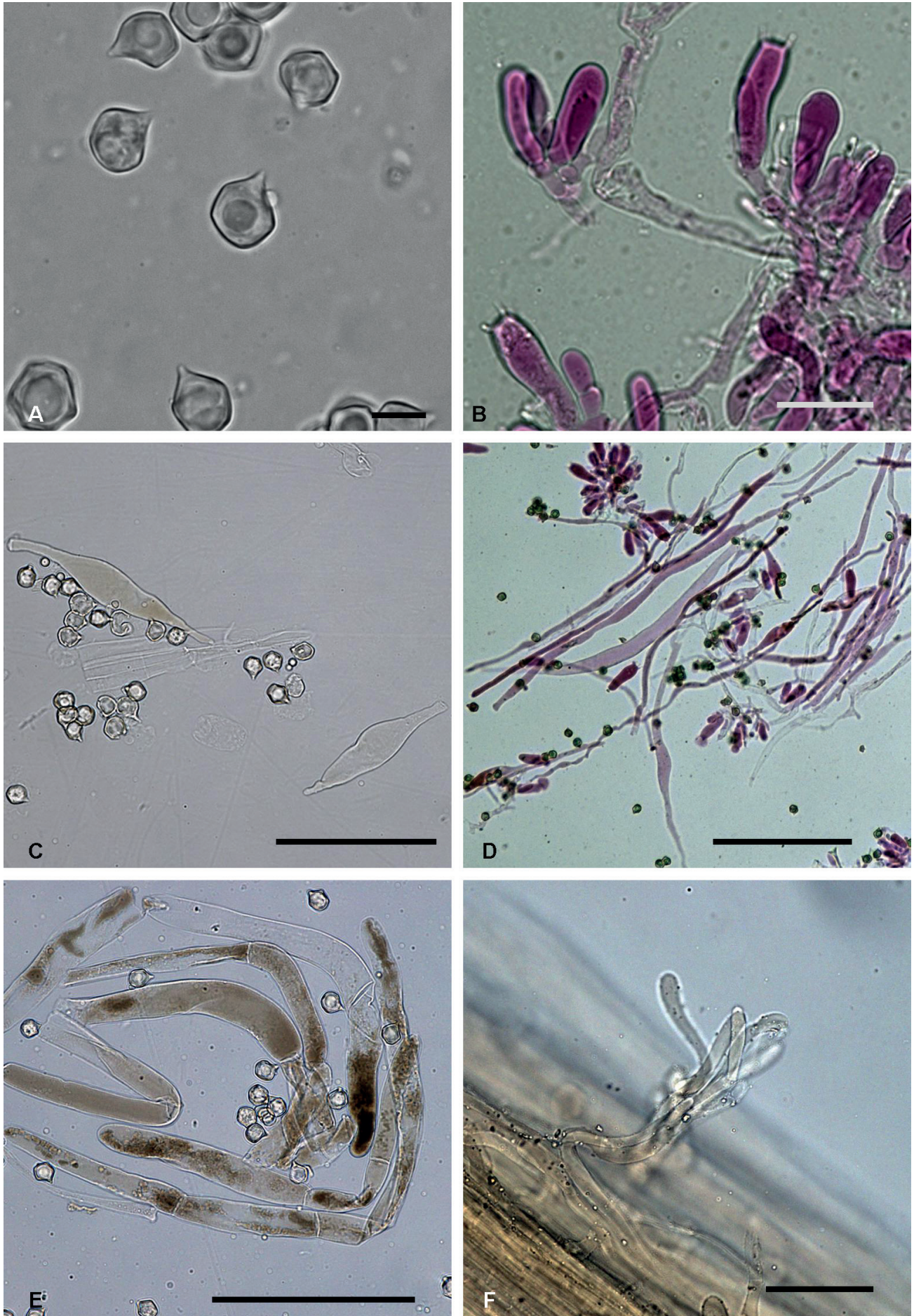
*Entoloma versiforme* is morphologically similar to *E. granulosocystidium* from Mauritius (Noordeloos & Hausknecht 2016), *E. heimii* from Madagascar and Gabon (Romagnesi 1941, as *Rhodophyllus heimii*), *E. pseudoheimii* from Madagascar (Eyssartier *et al.* 2001), and *E. nigropapillatum* from Gabon (Romagnesi & Gilles 1979, as *Rhodophyllus nigropapillatus*). Pileus and stipe colors, pileipellis structure, basidium shape, cytoplasmic pigment color, and the shape and size of the basidiospores are nearly identical for these four species. *Entoloma granulosocystidium* can be separated from *E. versiforme* by its slightly lighter brown pileus center, lack of taste, glabrous stipe base, lageniform or conical hymenial cystidia, very long and broad lamellar tramal hyphae, and lack of caulocystidia. *Entoloma heimii* differs in its planoconvex pileus, typically 4-angled basidiospores, fusoid to lageniform hymenial cystidia, and lack of caulocystidia. *Entoloma pseudoheimii* differs in its larger, cuboid spores, larger basidia, straw-colored stipe, and lack of caulocystidia. *Entoloma nigropapillatum* differs in its pale yellowish brown stipe, and larger basidiospores. The three aforementioned species also lack clamp connections.

*Entoloma versiforme* would be classified infragenerically in *Entoloma* subgen. *Inocephalus* (Noordeloos & Gates 2012) or in the segregate genus *Inocephalus* (Largent 1994).

***Entoloma parvistellatum*** Largent, N. Siegel & T.W. Henkel, *sp. nov.* MycoBank MB831860. Figs 11, 12.

*Etymology:* *parvum* (L. adj. A) = small, *stellatus* (L. adj. A) = stellate, referring to the substellate basidiospores.

*Diagnosis:* Differs from *Entoloma semilanceatum* in its densely radially fibrillose, pale greenish grey pileus with a papillate umbo, white to pale yellow, deeply adnexed lamellae, orange-



**Fig. 10.** *Entoloma versiforme* (Henkel 10366, holotype). **A.** Basidiospores. **B.** Basidia. **C.** Pleurocystidia with greenish subgranular contents. **D.** Lamellar tramal hyphae pointed at both ends. **E.** Pileocystidia with brown cytoplasmic pigment (*Aime* 7537). **F.** Stipitipellis with caulocystidia (*Aime* 7537). Scale bars: A = 8  $\mu$ m; B = 30  $\mu$ m; C = ~80  $\mu$ m; D = 95  $\mu$ m; E = 207  $\mu$ m; F = 40  $\mu$ m.



Fig. 11. *Entoloma parvistellatum* (Siegel 2283, holotype). Scale bar: A = 30 mm.

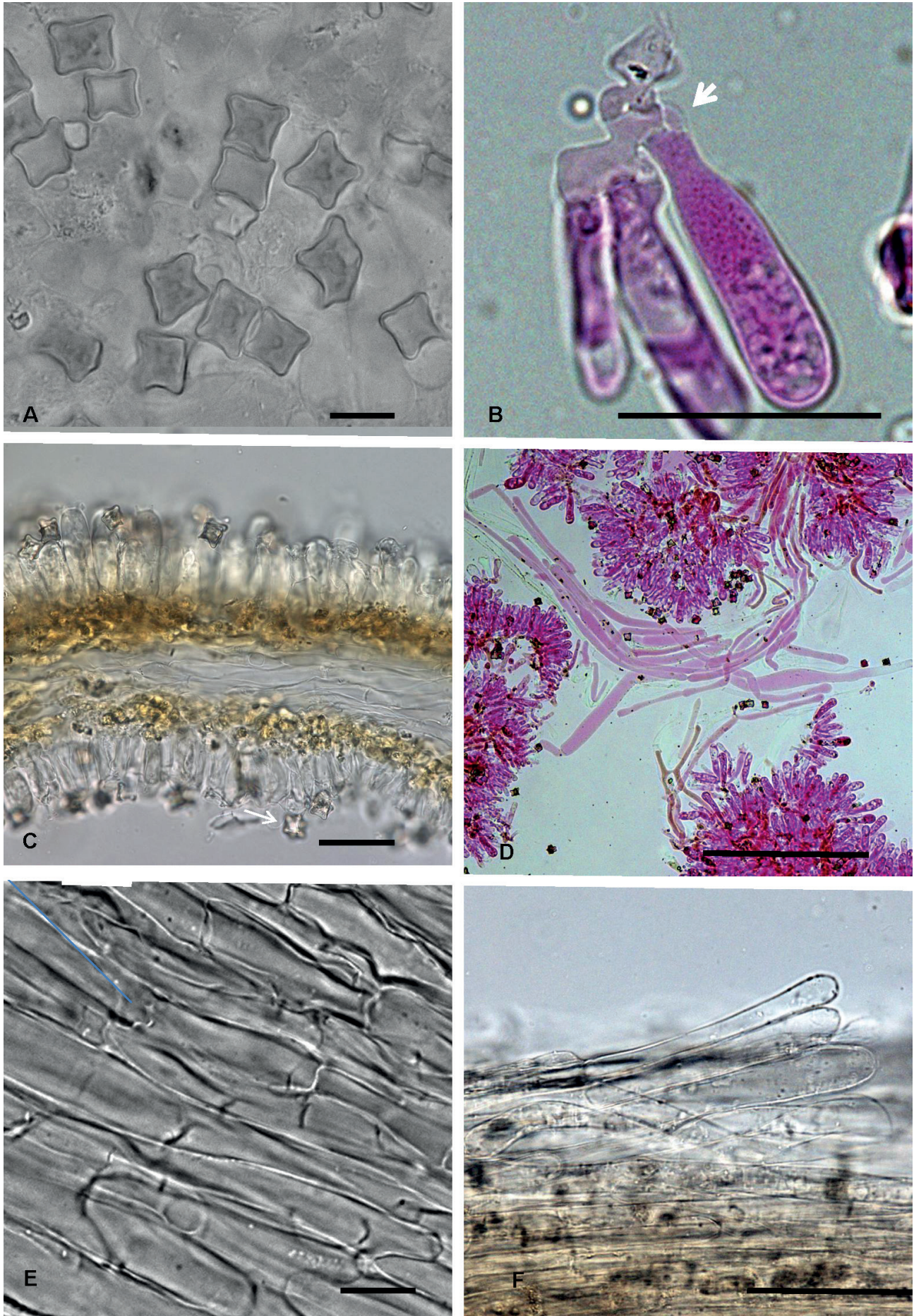
staining stipe, mild taste, substellate basidiospores, and distinctive pseudocystidia and subhymenial elements.

**Typus:** Cameroon, East Region, Dja Biosphere Reserve, Northwest Sector near the village of Somalomo, Upper Dja River Basin, within 2 km of Dja base camp at 3°21'29.8" N 12°43'46.9" W, 650 m a.s.l.; 50 m N of base camp in mixed rainforest under *Uapaca* sp., on litter humus, 11 Sep. 2017, Siegel 2283 (holotype YA 67012; HSC G1290), GenBank accession: ITS MN069544.

*Basidioma* mycenoid. *Pileus* 16–36 mm broad, conic with a papillate umbo retained throughout development, with age planate to evenly uplifted, initially pale greyish green (30B2–30B3) and slightly brighter concolorous over the disc (30A3–30A4), with age more greyish (5B2–5C2) with disc remaining greyish green (30B2); surface densely radially fibrillose; fibrils matted or occasionally recurved; trama thin, watery grey above stipe. *Lamellae* thin, subdistant, broadly and deeply adnexed with a decurrent tooth, initially off-white to pale yellow (2A2), with age pale pink (5A2–6A2), ~1 mm tall at margin, 3–5 mm centrally, 0.5 mm at stipe; lamellulae 1–4, 0.5–1.5 mm long. *Stipe* 34–96 × 2–4 mm, equal, twisted striate with appressed fibrils, pale creamish yellow (2A2–2A3) throughout, slightly darker concolorous with age; trama hollow, concolorous, staining dull orange-brown (5C6) slowly with exposure. *Odor* indistinct. *Taste* mild. *Basidiospores* subsodiametric to isodiametric, in profile view cuboid or substellate (*i.e.* with projections of variable length and arranged asymmetrically); edges frequently concave; ends usually rounded, occasionally subnodulose, rarely irregular or triangular, 7.3–10.0 × 6.1–9.4 μm ( $\bar{x}$  = 8.8 ± 0.7 × 7.9

± 0.7 μm; E = 1.0–1.3; Q = 1.1 ± 0.1;  $\gamma/x$  = 36/1). *Basidia* cylindrical to cylindro-clavate, tapering toward base to a hyaline subtending cell, 47.7–55.9 × 11.6–15.2 μm ( $\bar{x}$  = 52.3 ± 2.6 × 13.1 ± 0.9 μm; E = 3.6–4.5; Q = 4.0 ± 0.2;  $\gamma/x$  = 15/1), 4-sterigmate; sterigmata 1.9–5.3 μm long. *Cheilocystidia* and *pleurocystidia* absent. *Pseudocystidia* cylindrical, 9.4–67.5 × 4.5–9.9 μm (E = 3.6–8.6; Q = 5.9 ± 1.7; N = 16), bright orangish brown in 3 % KOH. *Subhymenial elements* tightly interwoven in two distinct layers, bright orangish brown in 3 % KOH. *Lamellar tramal hyphae* subparallel, rounded on both ends, rarely tapered, 61.2–349.8 × 6.7–20.9 μm ( $\gamma/x$  = 19/1). *Pileipellis* a cutis of several layers of slightly entangled hyphae with repent or occasionally suberect pileocystidia. *Pileocystidia* cylindrical to narrowly cylindro-clavate, 37.4–167.8 × 9.5–15.7 μm (E = 3.2–14.8; Q = 7.4 ± 2.7;  $\gamma/x$  = 20/1). *Pileal tramal hyphae* similar in shape to lamellar tramal hyphae but shorter and wider, 37.9–168.9 × 9.2–23.7 μm ( $\gamma/x$  = 17/1). *Stipitipellis* a cutis with rare to scattered, hyaline, suberect, cylindrical to cylindro-clavate caulocystidia, these 23.4–48.8 × 8.3–14.4 μm (E = 2.0–5.9;  $\gamma/x$  = 4/1). *Stipe tramal hyphae* with blunt to rounded edges, 48.8–340.4 × 4.9–14.9 μm ( $\gamma/x$  = 13/1). *Oleiferous hyphae* and *lipid globules* rare. *Brilliant granules* abundant in some basidia. *Pigmentation* cytoplasmic and golden brown in subhymenium, otherwise hyaline in main lamellar trama, pileipellis, and stipitipellis; stipe tramal hyphae with minute encrustations. *Clamp connections* frequent on hyphae of most tissues.

**Habit, habitat, and distribution:** Gregarious on humic mat in mixed rainforest under *Uapaca* sp.; known only from the type locality in the Dja Biosphere Reserve.



**Fig. 12.** *Entoloma parvistellatum* (Siegel 2283, holotype). **A.** Cuboid to irregularly-shaped basidiospores at 1000 $\times$ . **B.** Clamp connection at basidiole base. **C.** Reddish orange subhymenium in 3 % KOH; substellate basidiospore (white arrow) at 200 $\times$ . **D.** Lamellar tramal hyphae. **E.** Pileus tramal hyphae. **F.** Pileipellis with suberect pileocystidia. Scale bars: A = 8  $\mu$ m; B =  $\sim$ 44  $\mu$ m; C = 52  $\mu$ m; D =  $\sim$ 100  $\mu$ m; E =  $\sim$ 100  $\mu$ m; F = 96  $\mu$ m.

**Additional material examined:** Democratic Republic of Congo, Central Forestry District, Binga, scattered in ground in dry forest, Oct. 1923, *Goossens-Fontana 900*, *Entoloma semilanceatum* (Romagn.) E. Horak!, **holotype** (BR5020031832161).

**Notes:** *Entoloma parvistellatum* is recognized in the field by its mycenoid stature, conic to planate-uplifted, pale greenish grey pileus with papillate umbo, whitish to pale yellow young lamellae, and slender, pale cream stipe. Microscopically the species is distinguished by its isodiametric, cuboid to substellate basidiospores, cylindrical pseudocystidia, lack of cheilocystidia, bright orangish brown subhymenial layers in KOH, and clamp collections on hyphae of all tissues.

*Entoloma parvistellatum* is most similar to the Congolian *E. semilanceatum* (= *Rhodophyllus semilanceatus*) in having a conic umbonate pileus, similarly colored and sized pileus and stipe, and adnexed to uncinately lamellae. *Entoloma semilanceatum* differs, however, in its bitter taste and smooth pileus with a delicate narrow umbo (Romagnesi 1956, 1957). While pseudocystidia, caulocystidia and color of the subhymenium were not mentioned in the protologue description of *R. semilanceatus* (Romagnesi 1956, p. 144), our examination of the type revealed an absence of pseudocystidia and hyaline subhymenial elements, contrasting with *E. parvistellatum*. Romagnesi described the basidiospores of *R. semilanceatus* as prismatic or tetrahedral-cruciform, measuring  $8\text{--}11 \times 8\text{--}10 \mu\text{m}$ , and basidia  $40\text{--}45 \times 10\text{--}15 \mu\text{m}$ . In his type study of *R. semilanceatus*, Horak (1976) reported slightly smaller cuboid basidiospores ( $7.5 \times 9.5 \mu\text{m}$ ) and basidia ( $32\text{--}43 \times 8\text{--}9 \mu\text{m}$ ) and no clamp connections, but he did not describe the basidiospores as “prismatic”. Our examination of the type revealed basidiospore dimensions similar to those for *E. parvistellatum*, at  $7.0\text{--}9.4\text{--}(10.3) \times 6.2\text{--}8.7 \mu\text{m}$  ( $\bar{x} = 8.4 \pm 0.6 \times 7.6 \pm 0.61 \mu\text{m}$ ;  $E = 1.01\text{--}1.32$ ;  $Q = 1.11 \pm 0.08$ ;  $y/x = 44/1$ ), but a strongly contrasting cuboid shape with straight edges and acuminate angles. Basidia of the type, while similarly shaped, were shorter than those of *E. parvistellatum*, at  $36.6\text{--}49.7 \times 9.4\text{--}15.3 \mu\text{m}$  ( $x = 42.6 \pm 4.3 \times 11.4 \pm 1.9 \mu\text{m}$ ;  $E = 2.89\text{--}4.99$ ;  $Q = 3.84 \pm 0.72$ ;  $x/y = 11/1$ ), and had inconspicuous basal clamp connections.

*Entoloma parvistellatum* is similar to *E. pallidoflavum* from Gabon in having a conic umbonate pileus and cuboid to substellate basidiospores. *Entoloma pallidoflavum* differs from *E. parvistellatum*, however, in its yellowish pileus that lacks greyish green tones, larger basidiospores ( $8.5\text{--}12.5 \times 8\text{--}11.5 \mu\text{m}$ ), and abundant cheilocystidia (Romagnesi & Gilles 1979 as *R. pallidiflavus*). *Entoloma kamerunense* from Cameroon and *E. phleboides* from Madagascar (Romagnesi 1941) have basidiospores that are similarly-sized, but consistently cuboid-shaped, relative to those of *E. parvistellatum*, and also differ in their overall brown basidiomata and presence of cheilocystidia.

Other somewhat similarly-colored *Entoloma* species such as *E. plicatum* from Australia (Largent *et al.* 2013, as *Inocephalus plicatus*), *E. pseudomurrayi* from New Caledonia (Eyssartier *et al.* 2010), and *E. murrayi* from eastern North America and Costa Rica (Baroni 2017, as *Inocephalus murrayi*) each differ from *E. parvistellatum* by their presence of cheilo- and pleurocystidia and lack of greenish tones in the pileus.

Based on its cuboid or substellate basidiospores and absence of cheilocystidia *E. parvistellatum* would be classified in *Entoloma* subgen. *Nolanea* sect. *Staurospora* (Noordeloos & Gates 2012).

## DISCUSSION

In this study, multiple collections were used to describe *E. bisterigmatum* (6), *E. brunneolaurantiacum* (6), *E. djaense* (5), *E. intricatum* (5), *E. versiforme* (3), and *E. parvistellatum* (1). Morphological characters were identical between collections of most of these species and ITS barcode sequence data corroborated their conspecificity. In the case of *E. bisterigmatum* morphological variation between the six collections was informed by molecular-based confirmation of conspecificity. The macro- and micromorphological differences among the six collections were likely related to varying environmental conditions and basidioma maturity levels at the time of collection. For example, the five overmature basidiomata of *Siegel 2234* collected in the drier early rainy season have thick-walled sclerobasidia, which were lacking in the four submature basidiomata of the type *Henkel 10328* collected in the wetter late rainy season. Strictly utilizing morphology, presence of sclerobasidia may have justified segregation of two species. The single unifying anatomical character present in all collections of the species is the 1–2 sterigmata basidia.

Basidioma macro- and micromorphology is notably variable among members of the agaricoid *Entolomataceae* (Noordeloos & Gates 2012). Basidiospore morphology has recently been re-emphasized as an important character for infrageneric taxonomy in the *Entolomataceae* when *Cubospora* and *Cuboeccilia* were described as new subgenera (Karstedt *et al.* 2019). In the current study basidiospores between the six Cameroonian *Entoloma* species also varied considerably in shape, size, and angularity (see Figs 2A, 4A, 6A, 8A, 10A). The cuboid to substellate basidiospores with elongated angles of *E. parvistellatum* are particularly unusual (Fig. 12A; see Karstedt *et al.* 2019, p. 18–19).

The northern Congolian specimens for the twelve *Rhodophyllus* taxa described by Romagnesi (1956) were collected by Mme Goossens-Fontana from four localities, three of which were *Gilbertiodendron*-dominated rainforests near Binga, Lisala, and Eala. Three of these were new combinations of species originally described by Beeli (1928): *R. lisalensis* from Lisala, *R. ealaensis* from Eala, and *R. cuboidosporus* from Lisala. Romagnesi (1956, p. 182) excluded four Beeli taxa from his paper, including *Nolanea goossensiae* (1928, p. 83) with regularly elliptic basidiospores lacking angles, likely a species of *Mycena*, and *Eccilia ealaensis* (1928, p. 83) with decurrent lamellae and non-angled, hyaline basidiospores, likely a species of *Omphalia*. Our study of the types of *N. goossensiae* (GF 230, BR5020032042323) and of *E. ealaensis* (GF 191, BR5020032190833) confirmed the observations of Romagnesi. Perplexingly, both of these species were recently treated as synonyms for new combinations in *Entoloma* (Blanco-Dios 2017).

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