

Observations on some enigmatic *Cantharellus* (*Cantharellales, Basidiomycota*) with lilac-violaceous tints from Africa and Madagascar

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Abstract – This paper deals with some extremely rare African and Malagasy chanterelles that have dark lilac-violaceous colors on the cap and/or stipe surface. *Cantharellus longisporus* ssp. *littoralis* and *C. longisporus* ssp. *isaloensis* are provisionally described as new subspecies from Madagascar. The identity of *C. goossensiae* needs to be investigated further and appropriate epitypification is urgently needed for these earlier described rain forest chanterelles. *C. subcyanoxanthus* is newly described as a possible close relative of *C. goossensiae* from woodland. The confusion surrounding the concepts of *C. cyanoxanthus* and *C. longisporus* is discussed. Morphological features, variability and species delimitation are discussed in detail.

Biodiversity / Cantharellaceae / new taxa / taxonomy

INTRODUCTION

Chanterelles with distinct lilac-violaceous tints on the cap and sometimes also on the stipe surface have been described from several continents. In Europe, there are *Cantharellus amethysteus* (Quél.) Quél. and *C. ferruginascens* f. *lilacinopruinatus* (Hermitte, Eyssart. & Poumarat) Eyssart.; in North America the recently described *C. lewisii* Buyck & V. Hofst. (Buyck *et al.* 2011a); in Central-America *C. atrolilacinus* Eyssart., Buyck & Halling; in Malaysia *C. subamethysteus* Eyssart. & Stubbe and *C. diminitivus* Corner (Eyssartier *et al.* 2009), and in tropical Africa *C. cyanoxanthus* Heinem., *C. longisporus* Heinem. and *C. goossensiae* Heinem. (Heinemann 1958, 1959). With the exception of *C. amethysteus* and close allies (*C. lewisii*, *C. subamethysteus* – see Buyck *et al.* 2011a), most of these chanterelles are extremely rare taxa.

We will discuss here the long-standing confusion that surrounds the lilac-violaceous African taxa and which dates back to the time of their original description. This paper is part of our ongoing revision of *Cantharellus* in Africa

(Tibuhwa *et al.* 2008, De Kesel *et al.* 2011). It is based on the discovery of some of Heim's original material in the Paris' herbarium and collections made by the senior author and collaborators in Madagascar and tropical Africa over the past 25 years. There have been no reports of these taxa since their original description. Unfortunately, most of the collections for these taxa have been dried in unfavorable conditions and are unfit for DNA-extraction and successful sequencing. This morphological revision allows for a more precise circumscription of the concerned species; it deals with the earlier confusion and outlines the most important aspects that need attention for future collecting.

MATERIAL AND METHODS

The color notations indicated in the descriptions are from Kornerup and Wanscher (1978). Microscopic features of recent collections were examined and sketched by B. Buyck. Type studies for the older taxa had been made available previously (Eyssartier 2001). All microscopic observations and measurements were made in ammoniacal Congo red, after a short aqueous KOH pretreatment to improve tissue dissociation and matrix dissolution. Original drawings for all elements of the hymenium or pellis were made at $\times 2400$. Measurements are based on 20 spores (n) per specimen and the measurements in italics represent the average values. The mean length/width ratio (Q) gives minimum, mean, and maximum values. All studied specimens are deposited in the mycology herbarium of the Paris' Natural History Museum unless otherwise indicated.

A general description of the habitats in which we collected *Cantharellus* in Madagascar can be found in Buyck (2002).

TAXONOMY

Cantharellus cyanoxanthus R. Heim ex Heinem., *Bulletin du Jardin botanique de l'État*, Bruxelles, 28 (4): 407 (1958) **Figs 1, 3**

Basionym: *C. cyanoxanthus* R. Heim, *Traité de Pathologie exotique vétérinaire et comparée*, 3: 301 (1936), *nom. inval.*, *sensu* Heinemann 1958, 1959, non Heim 1936.

Iconography: Heinemann (1958, fig. 43; 1959, pl. XXVII, fig. 5).

Original diagnosis: *Pileus carnosus, infundibuliformis, margine sulcatus, atrovioleaceus deinde aurantiacus +/- violaceo- et coeruleo-variis, leviter squamulosus. Stipes validus, solidus, albidus, +/- violaceo- et aurantiaco-variis. Lamellae distantes, latiusculae, decurrentes, roseolae vel luteolae, furcatae, intervenulatae. Caro fibrosa, luteola. Sporae ellipticae, 7,5-9,3 \times 4,4-5,4 μ m.*

Type: Central Africa. Democratic Republic of Congo (ex-Zaire). Guineo-congolian rain forest, near Binga, on the soil of the dry forest, March 1942, *M. Goossens-Fontana* 2082 (BR).

Holotype revision (Figs 1, 3): **Spores** (7) 8-8.83-10 \times 4-4.87-5.5 (6) μ m. Q = 1.45-1.82-2.0 narrowly ellipsoid, sometimes slightly bent or constricted in the middle and slightly peanut-shaped to reniform, smooth, hyaline. **Basidia** slender but hardly inflating. **Cystidia** absent. **Suprapellis** composed of repent, intertwined, thin-walled hyphae, measuring mostly (3)5-7(10) μ m diam., but some more ampullaceous and up to 16 μ m diam., the terminal cell often attenuated upward

to subfusiform. Some of the more narrow hyphae with distinct parietal encrusting pigment. **Clamps** abundant.

Examined material: DEMOCRATIC REPUBLIC OF CONGO (ex-Congo Belge or Zaïre). Central forest district, near Binga, sur le sol de la forêt sèche, March 1942, Miss Goossens-Fontana 2082 (BR holotypus).

Commentary: *C. cyanoxanthus* develops distinct and vividly yellow tints on the cap, and is usually more thin-fleshed than the other species here discussed. The type was collected in the Guineo-congolian Central rain forest district but “on soil in the dry forest” and differs from the other taxa here by its more voluminous spores, although the difference with *C. longisporus* is quite small. More collections may reveal whether the two species are really different.

Cantharellus goossensiae (Beeli) Heinem., *Bulletin du Jardin botanique de l'État*, Bruxelles, 28 (4): 406. 1958 **Fig. 5**

Basionym: *Hygrophorus goossensiae* Beeli, *Bulletin du Jardin botanique de l'État*, Bruxelles, 61: 99. 1928.

Iconography: Buyck 1994, figs. 63-64; Heinemann 1959, pl. XXVII, fig. 6.

Original diagnosis: “*Pileo carnosio crasso, convexe, glabro levi, atro-violacea, 5-6 cm lato; stipite crasso solida dein cavo, sulcato, ochraceo, 3-4 × 2 cm; lamellis crassis decurrentibus venoso connexis, ochraceis; sporis ellipsoideis, hyalinis, levibus, 8-9 × 4-5 μm; carne ochraceopallida contactu aeris rubescente.*”

“Chapeau charnu épais, convexe bosselé, glabre et lisse, violet sombre, 5-6 cm de diamètre; pied épais, plein puis caverneux, sillonné, ochracé, 3-4 × 2 cm; lamelles épaisses, décourbées, réunies par des veines, jaune-ocre; spores ellipsoïdes, hyalines, lisses, 8-9 × 4-5 μm; chair devient rosée au contact de l'air.”

Type: Central Africa. Democratic Republic of Congo (ex-Zaire). Guineo-congolian rain forest district, Selenge-Lukolela, on soil in swamp forest, Aug. 1925, M. Goossens-Fontana 372 (BR).

Holotype revision (Fig. 5): **Spores** 5.5-6.72-8 × 3-3.97-5 μm, Q = 1.37-1.71-2.0 (which is distinctly shorter than in the original description), narrowly ellipsoid, sometimes slightly bent adaxially or sometimes also laterally and then often more or less peanut-shaped with a slightly wider lower half, smooth, hyaline. **Basidia** slender, mostly (50) 60-75 × 8 μm, (4) 5-6 spored. **Cystidia** absent. **Suprapellis** difficult to inflate, apparently composed of repent, intermingled, thin-walled hyphae. **Clamps** abundant.

Examined material: DEMOCRATIC REPUBLIC OF CONGO (ex-Congo Belge or Zaïre). Central forest district, Guineo-congolian rain forest district, Selenge-Lukolela, on soil in swamp forest, Aug. 1925, Miss Goossens-Fontana 372 (BR holotypus).

Commentary: The essential difference between this species and *C. cyanoxanthus*, as mentioned by Heinemann (1958) in the same paper, are the pinkish tints developing in the context of the former as opposed to the yellowing context of *C. cyanoxanthus*. Our revision of the types reveals, however, important differences in spore dimensions between both species that were not evident from the original descriptions.

The type specimen of *C. goossensiae* only consists of a single, young fruit body (in very bad condition) that possesses a dark violaceous cap and a yellow stipe. The latter feature is also observed in the other species that are here discussed and is probably an indication that the context of *C. goossensiae* is also yellowing. *C. goossensiae* is clearly in need of recollecting and epitypification as an unambiguous interpretation of this species from a single young fruit body is impossible, as is the case for so many other rain forest chanterelles that were described in the past (Buyck 2012).

***Cantharellus subcyanoxanthus* Buyck, Randrianjohany & Eyssart. sp. nov. Figs 9-14**

Diagnosis: *A C. goossensiae* ac *C. cyanoxantho* differt sporis parvioribus, minus latis ac consociatione silvae clarioris arboribus. **Holotypus:** Madagascar, sub *Uapaca bojeri*, *Sarcolaenaceae* ac *Asteropeia*, Buyck 00.1173 (PC0084746).

Mycobank: MB 800548.

Cap 30-80 mm diam., fleshy and firm, convex to hardly depressed in the center, with the margin longtime incurved, finally irregularly lobed, dark violet (8EF3-4, locally 8F8), particularly towards the cap margin, discoloring with age to orange yellow (4A5-6, 5B5-6), locally even brownish (6DE5-6), or with localized dark violet to even bluish colors with the rest of the cap having "cibarius"-yellow colors, dry becoming more greasy with age, smooth to locally squamulose with appressed squamules. **Stipe** firm and fleshy, short to rather slender, 20-50 × 5-15 mm, often slightly narrowing downward, more rarely widening downward, cream to pale yellow with distinct lilac-violet hues in the upper part, yellowing particularly in the lower part, dull, smooth. **Hymenophore** decurrent, of well-developed gill-folds of different length ($L+l = 6-9/cm$), 1.5-3 mm high, forked essentially close to the cap margin, usually hardly anastomosed-interveined in between, violet-pink (8A2, 9AB3) at least when young, strongly yellowing when handled or with age. **Context** firm, whitish, lavished with yellow and pinkish violet when cut (7B3, 6AB3), gradually yellowing with age. **Taste** often slightly but distinctly acrid. **Smell** typically fruity as in most *Cantharellus*. **Spore print** not obtained.

Spores (6.5) 7.2-8.02-8.8 (9.6) _ (3.1) 3.2-3.50-3.8 (4.2) μm , $Q = (1.6)$ 2.0-2.29-2.6 (2.9), narrowly ellipsoid to curved adaxially, sometimes slightly reniform to weakly peanut-shaped, smooth, hyaline. **Basidia** slender, 55-80 × 7-9 μm , clavulate, (4) 5-6 (7)-spored. **Subhymenium** composed of long and slender cells; underlying trama of narrow hyphae with distinct inflations near septa. **Cystidia** not differentiated. **Pileipellis** composed of repent, intermingled, thin-walled hyphae, (5) 7-10 (13) μm diam.; the terminal cell usually slightly attenuating upward, mostly 50-100 μm long. **Clamps** abundant in all tissues.

Examined material: BURUNDI. Nkayamba, near Rumonge, in dry and rocky *Brachystegia microphylla* woodland, March 1992, Buyck 4654, 4747 (PC0085046), 4968 (PC0084823); Nyamirambo, near Rumonge along road to Bururi, in secondary *Brachystegia utilis*-*B. spiciformis* woodland, 25 Feb. 1994, Buyck 5514 (PC0085167), *ibid.* 4 March 1994, Buyck 5520 (PC0085168). ZAMBIA. 14 Jan 1992, along road from Kabwe to Kiposhi, in *Brachystegia* woodland, Buyck & Eyssartier leg., Buyck 96.004 (PC0085170). TANZANIA. Near Msanga village, Dar-es-Salaam area, on sandy soil in degraded *Brachystegia* woodland, 24 Apr. 1998, Buyck 98.014 (PC0084745). MADAGASCAR. Central Highlands Plateau. 60 km south of Ranohira along the RN7 road to Tulear, near the TV antenna, on sandy soil in *Tapia* woodland with old *Uapaca bojeri*, *Sarcolaenaceae* and *Asteropeia*, 16 Jan. 2000, Buyck, Randrianjohany & Eyssartier leg., Buyck 99.126 (PC 0085169); *ibid.*, 3 Feb. 2000, Buyck 00.1173 (PC0084746, **holotypus**).

Commentary: The microscopic description above is solely based on the type; the macroscopical description presents also the variation within our material.

Because of its much smaller spores as compared to *C. longisporus* and *C. cyanoxanthus* (Figs 3-5), this is a distinct species and not just a synonym of *C. cyanoxanthus* as we assumed previously (Buyck, 1994). *C. goossensiae* is much closer when it comes to spore dimensions, but as the type is in too bad a condition to observe the pileipellis, the most prominent microscopical difference between our species and *C. goossensiae* resides in its slightly smaller but distinctly more

narrowly ellipsoid to subcylindrical spores. Furthermore, our collections come from a very different vegetation type (open tree savannah versus swamp forest for *C. goossensiae*) and although we have no precisions as to the soil type for the Central African type specimen, nearly all of our collections (whether from mainland Africa or Madagascar) have been made on sandy soils and may point to a habitat preference for the new species. These morphological and ecological differences prevent us from epitypifying Heinemann's species with one of our specimens. In this context, it should be noted that we have collected in Madagascar several morphologically identical specimens for typical Guineo-congolian species in various ectomycorrhizal genera (e.g. *Lactarius*, *Russula*), but always in dense forest types, never in open savannah woodland. *C. subcyanoxanthus* and *C. goossensiae* may nevertheless be very closely related and share the presence of a clear pinkish-lilac tint of the context when fresh.

Whereas the Malagasy and Burundi specimens possess identical microscopical features of pileipellis and spores, our collection 98.014 from Tanzania differs slightly in the much more "cibarius"-like coloration of the cap with very limited lilac tints, as well as by the shorter and wider terminal elements of the pileipellis and slightly more ellipsoid spores (Figs 6-8). It is provisionally considered here as "aff. *subcyanoxanthus*". We have chosen the specimen 00.1173 from Madagascar as holotypus because we obtained good sequence data for some ribosomal and protein coding genes.

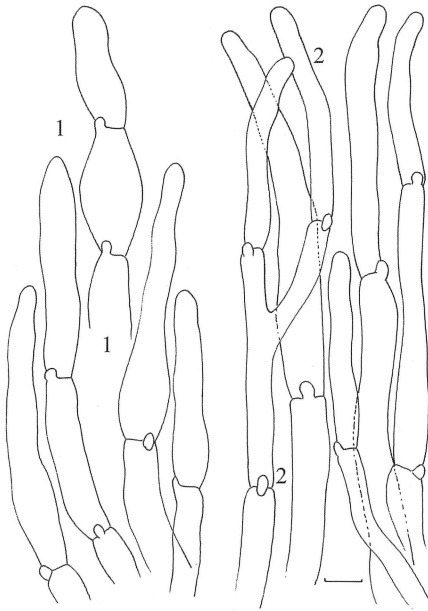
Cantharellus longisporus Heinem., *Bulletin du Jardin botanique de l'État*, Bruxelles, 28: 409. 1958 **Figs 2, 4**

Original diagnosis: *Pileus carnosus, centro depressus, lobatus, tomentosus, glabrescens, lilacinoarmeriacus. Stipes solidus, lilacino-roseus, deorsum luteus, pallescens. Lamellae latiusculae, distantes, armeriacae, aciem versus aurantiacae, pallescentes, furcatae, leviter intervenulatae. Caro alba, in pileo dilute armeriaca, basi stipite luteola; sapor pungens. Sporae subcylindricae vel leviter arcuatae, 8-10,5 × 3,8-4,8 μm.*

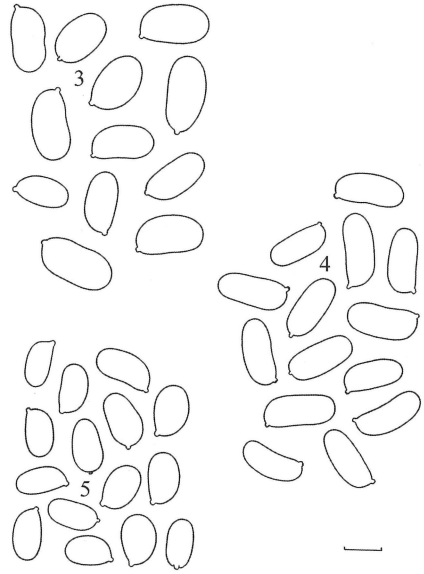
Iconography: Heinemann (1958: fig. 44; 1959: pl. XVII, fig. 4).

Cap large, 6-12 cm diam., fleshy and firm, first convex or with a slightly elevated center and a margin that remains incurved for a long time, later becoming plane with more or less depressed center and often strongly lobed or undulating margin, dull, tomentose, pink to pinkish lilac near the margin, towards the center with dark violaceous to vinaceous tints or locally discolored and then more ochraceous or yellowish, with age becoming gradually more orange or brownish, but remaining very dark violaceous in the center. **Stipe** 5-9 × 0.9-2.5 cm, subcylindrical or curved in the lower half, sometimes longitudinally wrinkled, pale off-white but lavished with reddish lilac to violaceous tints in the upper half, distinctly yellow at the base, compact. **Gills** up to 5 (7) mm high, not thick, unequal and forked, weakly interveined-anastomosed by interstitial transversal ridges, young pinkish orange to bright orange, later becoming more pinkish lilac. **Flesh** firm, white, yellowish near the stipe base, with pink or orange shades near the cap surface. **Taste** acid. **Smell** weak. **Spore print** very pale (white?).

Holotype revision (Figs 2, 4): **Spores** subcylindrical, sometimes slightly reniform, 8-8.89-9.5 × 3.5-3.78-4 μm, Q = 2,12-2,35-2,57, smooth, thin-walled, hyaline. **Basidia** narrowly clavate and undulating, 65 × 7.5 μm for ex., most likely not four-spored, but 5-6 spored. **Cystidia** absent. **Pileipellis** composed of cylindrical, long, (5) 7-10 (15) μm diam., thin-walled to slightly thick-walled hyphae and yellowish-refringent from an encrusting parietal pigment. **Clamp connections** abundant in all tissues.



Figs 1-2. Revision of Heinemann's types. Terminal elements of the pileipellis for **1.** *Cantharellus cyanoxanthus* (Type= GF2082) and, **2.** *Cantharellus longisporus* (Type, GF692). Scale bar = 10 μ m.

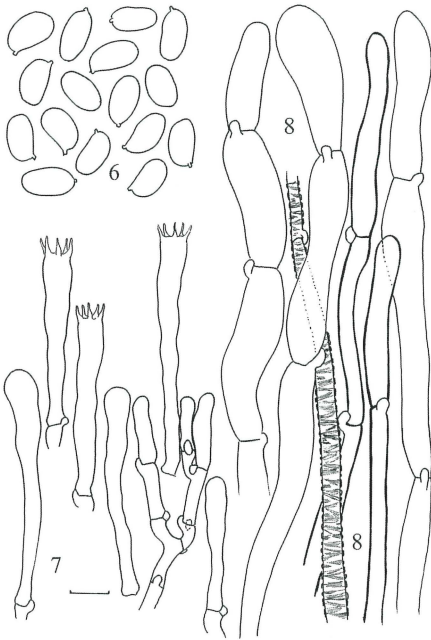


Figs 3-5. Revision of Heinemann's types. Spores for **3.** *Cantharellus cyanoxanthus* (Type, GF2082), **4.** *Cantharellus longisporus* (Type, GF692) and **5.** *Cantharellus Goossensiae* (Type, GF372). Scale bar = 5 μ m.

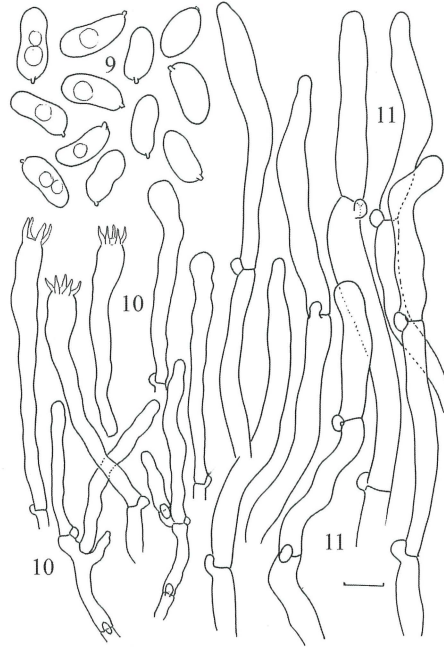
Examined material: DEMOCRATIC REPUBLIC OF CONGO (ex-Congo belge or Zaïre), Central forest district, near Binga, in groups on the soil in *Gilbertiodendron dewevrei* – forest, April 1928, *M. Goossens-Fontana* 692 (BR holotypus).

Commentary: The macroscopic description is based on the notes and watercolor by Miss Goossens-Fontana. *Cantharellus longisporus* was described (Heinemann, 1958) on a single collection made in the Central African evergreen rain forest by Miss Goossens-Fontana, the wife of the former director of the botanic garden of Yangambi in the first half of the 20th century. To our knowledge, this very large and beautiful species has never been collected again, notwithstanding continuing inventories in the Guineo-Congolian forest and in the Yangambi area, not far from the type locality (Eyi Ndong *et al.*, 2011).

The name has been misapplied by Pegler (1980) for a chanterelle that probably corresponds to *C. symoensii* Heinem. (Eyssartier, 2001), a widespread and common species in the surrounding Guineo-Soudanian miombo woodlands (Buyck, 1994). Pegler's misinterpretation was later reiterated in the literature (Morris, 1987; Ryvarden *et al.*, 1994). Nevertheless, *C. longisporus* is easily distinguished by the presence of abundant clamps, the narrow and longer spores and its general coloration which is similar to *C. cyanoxanthus*, at least when young. The only surprising element in the description is the yellow-orange color of the young gills, becoming more pinkish-lilac with age. This is exactly the opposite for the other taxa described here and needs to be verified on future collections.



Figs 6-8. *Cantharellus* aff. *subcyanoxanthus* (Buyck 98.014). **6.** Spores. **7.** Basidia, basidiola and elements of the subhymenium. **8.** Terminal elements of the pileipellis. Scale bar = 5 μ m for spores and 10 μ m for all other elements.



Figs 9-11. *Cantharellus subcyanoxanthus* (Buyck 00.1173, holotypus). **9.** Spores. **10.** Basidia, basidiola and elements of the subhymenium. **11.** Terminal elements of the pileipellis. Scale bar = 5 μ m for spores and 10 μ m for all other elements.

***Cantharellus longisporus* subsp. *littoralis* Buyck & Randrianjohany subsp. nov.**
Figs 15-17

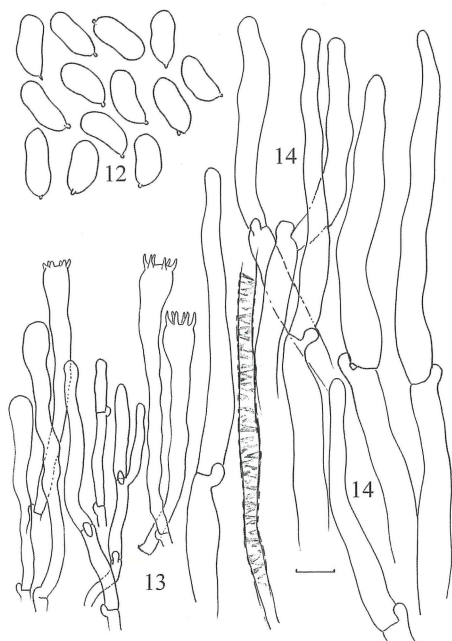
Diagnosis: *A typo differt carpophoris valde parvioribus, pilei stipitique coloris saturate violaceis dein decolorantibus, pilei hyphis interdum leviter incrassatis, consociatione arboribus silvae littoralis Madagascariensis. Holotypus: Emile Randrianjohany HE01-02 (PC 0085174).*

Synonym: *C. cyanoxanthus* R. Heim, *Traité de Pathologie exotique vétérinaire et comparée* 3: 301 (1936) *nom. inval.*, non *C. cyanoxanthus* R. Heim ex Heinem. 1958.

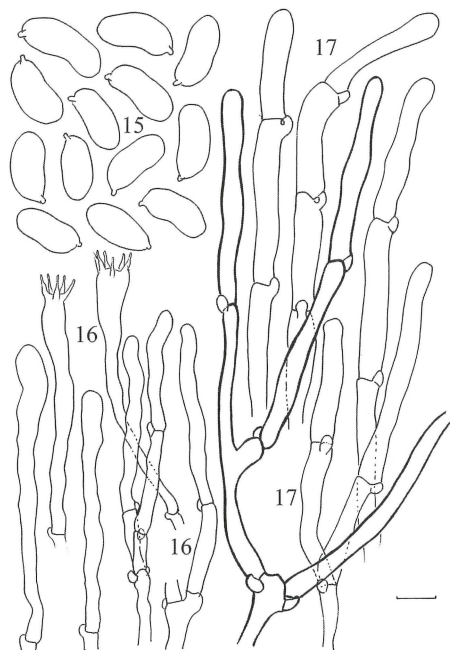
Mycobank: MB800549.

Etymology: referring to its occurrence in littoral forest on Madagascar's East coast.

Cap fleshy and firm, for a long time remaining 30-50 mm diam., when old up to 75 mm diam., plano-convex or slightly concave in the center, remaining so until maturity, not becoming infundibuliform; the margin first inrolled but becoming uplifted and minutely crenulate to undulate or coarsely wavy-lobed with age; surface dull, dry, entirely of a sometimes very dark, dull violet colour when young, with age discoloring irregularly to a pale yellowish cream with only some dark violet patches remaining in the center and near the extreme margin and taking a more or less greasy-viscous consistency. **Hymenophore** decurrent, of well-developed, firm, 2-4 mm high gill folds, unequal with dispersed lamellulae, not anastomosing in between, sparsely forked, pale cream to off-white at first,



Figs 12-14. *Cantharellus subcyanoxanthus* (Buyck 4747). **12.** Spores. **13.** Basidia, basidiola and elements of the subhymenium. **14.** Terminal elements of the pileipellis. Scale bar = 5 μ m for spores and 10 μ m for all other elements.

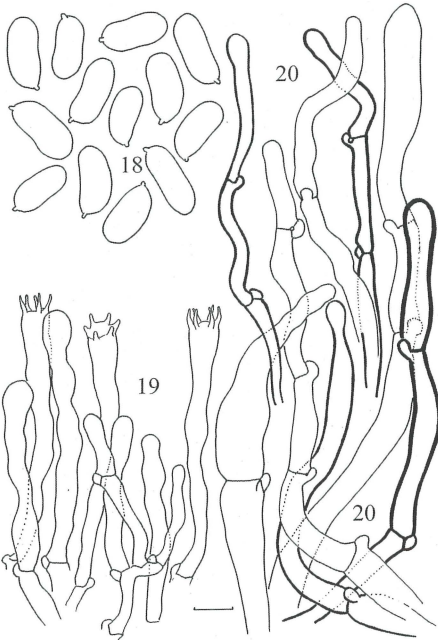


Figs 15-17. *Cantharellus longisporus* subsp. *littoralis* (holotypus). **15.** Spores. **16.** Basidia, basidiola and elements of the subhymenium. **17.** Terminal elements of the pileipellis. Scale bar = 5 μ m for spores and 10 μ m for all other elements.

later becoming more yellowish. **Stipe** quite slender but firm, 50-70 \times 7-13 mm, subcylindrical or slightly attenuating toward the base, often also with a more coriaceous, abruptly constricted base, with a pruinose aspect but finely covered with minute violet squamulae, strongly yellowing when handled. **Flesh** firm, pale yellowish to cream but rapidly yellowing when cut or handled. **Taste** mild. **Smell** agreeable. **Spore print** not obtained but evidently very pale.

Spores elongate ellipsoid to subcylindrical, often slightly curved or reniform, (8.1) 8.5-9.01-9.5 (9.8) \times (3.5) 3.8-4.07-4.4 (4.8) μ m, $Q = (1.9) 2.0-2.21-2.4 (2.5)$, smooth, thin-walled, hyaline, with a narrow apiculus. **Basidia** 60-65 (70) \times (7) 8-10 μ m, narrowly clavate, 5-6-spored. **Subhymenium** composed of narrowly cylindrical hyphae, 3-4 μ m diam., with rather distant septa. **Cystidia** not observed. **Pileipellis** of slender intermixed hyphae measuring (3) 4-5 (7) μ m diam., with slightly thickened walls that are refringent - yellow because of an encrusting pigment, others thin-walled and sometimes up to 10 μ m diam.; terminal cells mostly 20-60 μ m long, subcylindrical to slightly clavate or subapically constricted, often more or less undulate in outline. **Clamp connections** abundant in all tissues.

Examined material: MADAGASCAR. Prov. of Toamasina, East Coast, 15 km south of Brickaville, on a private property near Ambila Lemaitso, growing in groups of 5 to 10 individuals under *Uapaca littoralis* in the deep sandy soils of the littoral forest, 20 Dec. 2009, E. Randrianjohany 107 (PC 0085175) & 108



Figs 18-20. *Cantharellus longisporus* subsp. *isaloensis* (holotypus). **18.** Spores. **19.** Basidia, basidiola and elements of the subhymenium. **20.** Terminal elements of the pileipellis. Scale bar = 5 μ m for spores and 10 μ m for all other elements.

smaller size, the darker coloration of the cap and stipe and different gill color, in addition to its ecology, growing in association with endemic host trees in the deep sandy soils of Madagascar's East coast.

***Cantharellus longisporus* subsp. *isaloensis* Buyck & Eyssart. subsp. nov. Figs 18-20**

Diagnosis: *A typo differt carpophoris valde parvioribus, pilei stipitique coloris roseis haud decolorantibus, pilei hyphis interdum leviter incrassatis, consociatione arboribus silvae clarioris Madagascariensis. Holotypus: Buyck 00.1172 (PC0085172).*

Etymology: named after the type locality.

Mycobank: MB 800550.

Pileus 15-25 mm diam., fleshy, first regularly convex, then flattened in the center, not becoming infundibuliform, with the margin remaining typically inflexed and not radially striate; surface smooth to locally slightly pruinose, dull, peachy pink or locally more ochraceous. **Hymenophore** of well-differentiated gill folds, reaching 2-3 mm high, forked and anastomosing in between, cream-colored (fresh butter) then becoming more yellowish with age, developing locally even yellow-orange tints. **Stipe** 15-25 \times 3-4.5 mm, subcylindrical or somewhat widening close to the hymenophore, attenuated near the base; surface longitudinally fibrillose or finely pruinose, reddish orange, becoming paler and almost off-white towards the base and there yellowing with age or when bruised. **Flesh** thick and

(PC 0085176); *ibid.*, 07 Jan. 2010, E. Randrianjohany 121 (PC 0085177) & 122 (PC 0085178); *ibid.*, 29 June 2010, Emile Randrianjohany HE01-02 (PC 0085174 **holotypus**); *ibid.*, 28 June 2011, Buyck & Hofstetter 11.043 (PC 0085574); East coast littoral forest, no locality, Heim 110 (ut *C. cyanoxanthus*).

Commentary: This is the taxon that was initially described by Heim (1936) as *C. cyanoxanthus*, unfortunately lacking a Latin diagnosis and therefore invalid. The name was later validated by Heinemann (1958). However, Heinemann indicated for holotype an African specimen of similar coloration but in our opinion belonging to a different species (see above under *C. cyanoxanthus*) with more inflated spores, wider caps that do not remain typically convex or umbonate and that have distinct yellow colors on the cap.

The Malagasy subspecies "*littoralis*" is by all means a very rare taxon in Madagascar that has only been collected in the type locality near Ambila Lemaitso, notwithstanding numerous collecting trips by the authors along the East coast. It differs from the Central African *C. longisporus* subsp. *longisporus* in the much

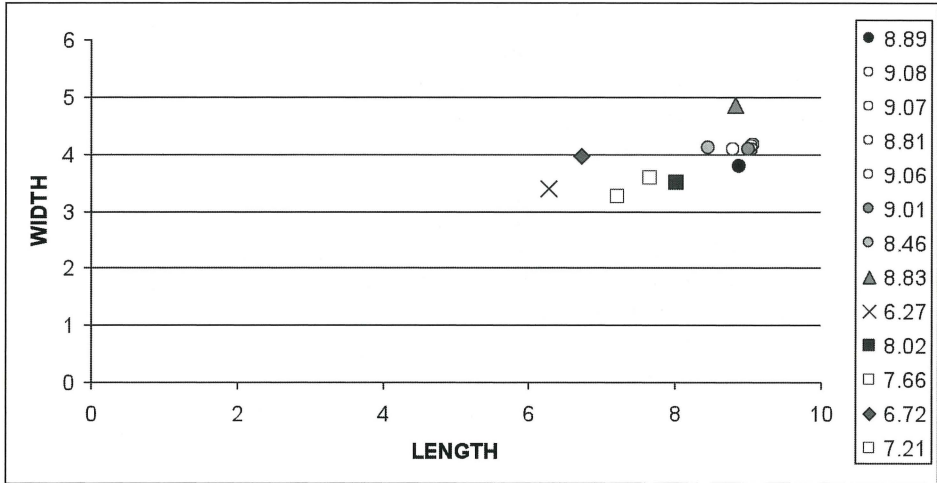


Fig. 21. Diagram comparing spore measures for the examined specimens of *C. cyanoxanthus* (triangle), *C. goossensiae* (■), *C. subcyanoxanthus* (◆), *C. aff. subcyanoxanthus* (BB98.014, x) and *C. longisporus* (●). Type specimens have filled contents. The legend on the right shows mean length values (compare with table below).

<i>Taxon</i>	<i>Specimen</i>	<i>Mean length</i>	<i>Mean width</i>	<i>Mean Q</i>
<i>C. longisporus</i> subsp. <i>longisporus</i>	Type	8.89	3.78	2.35
<i>C. longisporus</i> subsp. <i>littoralis</i>	H110	9.08	4.15	2.2
	EJ107	9.07	4.13	2.21
	EJ108	8.81	4.06	2.18
	EJ122	9.06	4.08	2.14
	Type	9.01	4.07	2.21
<i>C. longisporus</i> subsp. <i>isaloensis</i>	Type	8.46	4.11	2.06
<i>C. cyanoxanthus</i>	Type	8.83	4.87	1.82
<i>C. aff. subcyanoxanthus</i>	BB98.014	6.27	3.40	1.85
<i>C. subcyanoxanthus</i>	BB00.1173	8.02	3.50	2.29
<i>C. subcyanoxanthus</i>	BB5520	7.66	3.59	2.14
<i>C. subcyanoxanthus</i>	BB4747	7.21	3.26	2.21
<i>C. goossensiae</i>	Type	6.72	3.97	1.71

firm in the cap center, narrowing quickly toward the margin, hygrophanous and mottled with off-white, cream and reddish tints. **Odor** slightly fruity. **Taste** not observed. **Spore print** not obtained.

Spores ellipsoid-elongate to cylindrical, usually more or less reniform, (7) 7.5-8.46-9 (10) × 3.75-4.11-4.5 μm. Q = (1.75) 1.85-2.06-2.25 (2.5), smooth, thin-walled, hyaline. **Basidia** narrowly clavate and slightly undulate in outline, 63-75 (85) × 7-8.5 (9) μm, (4-5) 6-spored. **Subhymenium** composed of narrowly cylindrical hyphae, mostly 3-4 μm diam., with rather distant septa. **Cystidia** not observed. **Pileipellis** of intermixed, slender and more or less undulate hyphae measuring (3.5) 5-8 (13) μm diam., some with refringent-yellow walls that are

clearly thickened, but most hyphal endings thin-walled; the terminal cell ca 25-60 (75) μm long and more or less clavate or apically or subapically constricted.

Clamp connections abundant in all tissues.

Examined material: MADAGASCAR. Central Highlands Plateau. Isalo national Park, 60 km south of Ranohira along the RN7 road to Tulear, near the TV antenna, in *Tapia* woodland with old *Uapaca bojeri*, various *Sarcolaenaceae* and *Asteropeia*, 3 Feb. 2000, Buyck 00.1172 (PC0085172 holotypus).

Commentary: This subspecies shares with subspecies *littoralis* the presence of slightly thickened cell-walls in the hyphal extremities of the cap, but differs in its very different ecology, being associated with endemic savannah trees on the Central Plateau, as well as by the general coloration of the fruit bodies lacking any trace of violet or lilac and being less susceptible to discoloration.

DISCUSSION

From our experience with other ectomycorrhizal fungi in Africa and Madagascar, the presence of a single species in both the rain forest area and the surrounding savannah woodlands, two climatically very different areas, is not common at all (Buyck 2012). The important differences in size between the African rain forest collections and those from Madagascar or the African miombo woodlands is in our opinion habitat related: the giant, emergent, ectomycorrhizal trees of the *Gilbertiodendron* rain forest being responsible for larger fungal fruit bodies whereas the thick litter layer in dense forest is most probably responsible for a longer than usual stipe.

The type descriptions for the discussed taxa were based on some discriminating features that are in our opinion unreliable. Especially the description of *C. goossensiae* on a single young fruit body is unfortunate, because we are convinced that all of these taxa exhibit a strong yellowing context (although this is only suggested here for *C. goossensiae*). This yellowing of the context, together with the discoloring of the purple-lilac pigments with age is responsible for the impressive variation in color of all parts. In this respect the original description mentioning more pronounced violet-lilac colors in the gills of *C. longisporus*, compared to the more yellow-orange young gills is very surprising. We have noted local presence of lilac, pinkish tints (not only on cap and stipe, but also on gills or in the context) in many collections discussed here, but these gradually disappear when the yellowing of the fruit body sets in as it matures.

We opt here for a provisional recognition of all three previously described species: *C. goossensiae* with small, ellipsoid spores, and *C. longisporus* and *C. cyanoxanthus* with larger, more elongated spores that tend to be slightly wider (more inflated) in the case of *C. cyanoxanthus*. The latter species has apparently also wider hyphal terminations in the pileipellis and a cap that is more irregular, reaching a larger diameter compared to both other species. Apart from *C. subcyanoxanthus*, we refrained from describing new species and we opted for the introduction of new subspecies for the “*longisporus*” – related collections from Madagascar mainly because of ecological and morphological differences with the Central African type material. Notwithstanding the importance differences in field aspect between the two newly described subspecies, their quasi identical microscopy prevents us from considering them as different species awaiting molecular data for a more precise evaluation of their exact taxonomic status.

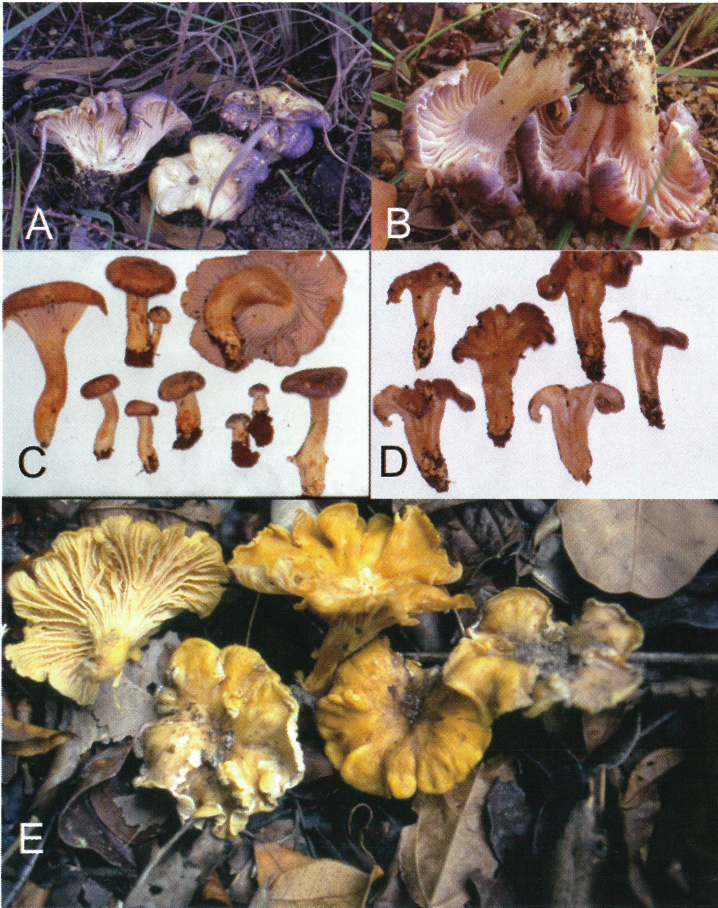


Fig. 22. **a-d.** *C. subcyanoxanthus* (**a.** BB 00.1173, **b, d.** BB 99.126, **c.** BB 4747); **e.** *C. aff. subcyanoxanthus* (BB 98.014). Photo's: B. Buyck (a, c-e), G. Eyssartier (b).

Fig. 23. **a-b.** *C. longisporus* subsp. *isaloensis* (holotype), **c-d.** *C. longisporus* subsp. *littoralis* in situ (holotype). Photo's: B. Buyck (b), G. Eyssartier (a), E. Randrianjohany (c, d).

Nevertheless, preliminary sequence data (Buyck & Hofstetter unpubl.) for some of the Malagasy collections suggest already that these taxa are not closely related to the European *C. cibarius* or *C. amethysteus*. Instead, these tropical taxa appear to be closer to a group of small *Cantharellus* such as the North American *C. cinnabarinus* and allies (see Buyck *et al.* 2010, 2011).

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