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## A new bioluminescent agaric from São Paulo, Brazil

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A new species, *Gerronema viridilucens*, collected from the bark of living *Eugenia fluminensis* trees in the Atlantic Forest region of São Paulo, Brazil is described, illustrated, and compared with phenetically similar taxa. It represents the only known *Gerronema* species with bioluminescent properties and may represent an independent evolution of this trait amongst euagarics.

**Key words:** euagarics, fungal bioluminescence, fungal taxonomy, *Gerronema*, systematics.

### Introduction

Described herein is a new species of *Gerronema* collected from the bark of living *Eugenia fluminensis* O. Berg. trees in the Atlantic Forest region of São Paulo, Brazil. An unusual feature of this new species is that the lamellae emit bright yellowish-green light at a maximum wavelength of 530 nm (Fig. 1; often appearing bluish to the naked eye), such that basidiomes can be seen easily in the forest at night. This is the only known species of *Gerronema* reported to be bioluminescent and may represent an independent origin of luminescence within the euagarics.

A review of recent molecular phylogenetic data on the euagarics (Moncalvo *et al.*, 2002) indicates that bioluminescent agaricoid fungi occur in four distinct clades: i) *Omphalotus* spp., *Lampteromyces* spp., and possibly *Neonothopanus* in the /omphalotoid clade in /omphalotaceae; ii) mycelium of *Armillaria* spp. in the /armillaria clade in /physalacriaceae; iii) an unidentified bioluminescent agaric allied with *Mycena adonis* in the /adonis clade (distantly related to other *Mycena* species); and iv) *Dictyopanus* (= *Panellus*) spp., *Poromyцена manipularis* (Berk.) R. Heim, and *Mycena* species [e.g. *M. chlorophos* (Berk. & M.A. Curtis) Sacc., *M. illuminans* Henn., *M. lux-coeli*

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Corner, *M. noctilucens* Corner, *M. sublucens* Corner] in the /mycenaceae clade. Assuming that *G. viridilucens* sp. nov. (described below) is phylogenetically allied with other *Gerronema* species and belongs in the /hydropoid clade, then it is distinct from other bioluminescent euagaric lineages and may represent an independent origin of this trait. For further information on luminous fungi and bioluminescent properties refer to the following short list of papers: Buller, 1924; Corner, 1950, 1954; Harvey, 1952; Calleja and Reynolds, 1970; Endo *et al.*, 1970; Herring, 1978, 1994; Wassink, 1978, 1979; Kamzolkina, 1982; O'Kane *et al.*, 1990.

Observations and measurements reported for micromorphological features were obtained from dried material rehydrated in 100% ethanol followed by distilled water, 3% KOH or Melzer's reagent. Basidiospore statistics include:  $\bar{x}$ , the arithmetic mean of the basidiospore length by basidiospore width ( $\pm$ SD) for n basidiospores measured; Q, the quotient of basidiospore length and basidiospore width in any one basidiospore, indicated as a range of variation in n basidiospores measured;  $Q_m$ , the mean of Q-values.

***Gerronema viridilucens* Desjardin, Capelari et Stevani, sp. nov.** (Figs. 1-6)

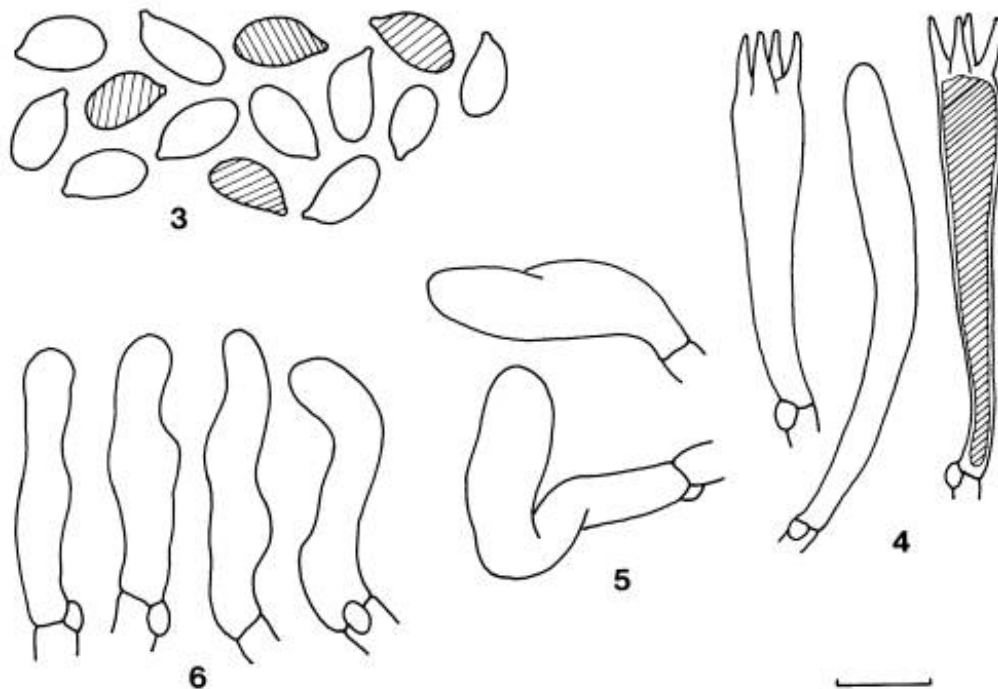
*Pileus* 5-20 mm latus, convexus dein planoconvexus, papillatus, centro depresso vel subumbilicato, marginem translucens striatus vel sulcatus, glabrus, hygrophanus, apicaliter rubrobrunneus, pallidior vel aurantiobrunneus marginem versus. *Caro* 3% KOH ope haud rubescens vel virescens. *Lamellae* subdecurrentes vel decurrentes, distantes, latae, pallide rubrobrunneae, viridae luminosae. *Stipes* 5-15  $\times$  2-3 mm, cylindricus, aequalis, fistulosus, haud insititius, glabrus ad apicem, pruinosis ad basim, pileo concolor. *Basidiosporae* 7-9.5  $\times$  4.5-5.5  $\mu$ m, ellipsoideae, leves, inamyloideae, hyalinae vel pallide luteae, contentae hyalinae vel vitellinae. *Basidia* 40-65  $\times$  6-8  $\mu$ m, subclavata, 4-spora. *Pleurocystidia* nulla. *Cheilocystidia* nulla. *Pileipellis* ex hyphis cylindraceis levibus hyalinis vel luteus inamyloideis cutem formantibus, 3-12  $\mu$ m diam., in 3% KOH hyalinis; cellulae terminalia clavatae, 30-42  $\times$  8-9.5  $\mu$ m. *Caulocystidia* 25-50  $\times$  3-8  $\mu$ m, cylindrica vel subclavata, hyalina, inamyloidea, tenuitunicata. *Fibulae* praesentes. Ad corticem Eugenia.

**Holotypus hic designatus:** São Paulo State, Brazil, Sept. 2003, C.V. Stevani, SP307883 (SP).

*Basidiomes* (Figs. 1-2) bioluminescent. *Pileus* 5-20 mm diam., convex to broadly convex, papillate, appanate and centrally depressed to subumbilicate in age, pellucid-striate to rugulo-striate or sulcate; surface glabrous, hygrophanus; disc reddish brown, margin pale reddish brown to orangish brown, becoming paler with moisture loss; 3% KOH negative on surface and context. *Context* thin, tough, pale concolorous with surface. *Odor* and *taste* not recorded. *Lamellae* subdecurrent to decurrent, distant with 2 series of lamellulae, relative thick, moderately broad (1-2 mm), pinkish-beige to pale concolorous with the pileus surface. *Stipe* 5-15  $\times$  2-3 mm, central, cylindrical,  $\pm$ equal above a slightly swollen base, hollow, pliant, non-insititious, glabrous above with a pruinose base, hygrophanus, concolorous with the pileus



**Figs. 1-2.** Basidiomes of *Gerronema viridilucens*. **1.** Basidiomes in the dark showing bioluminescence. Photo taken with Fuji Superia ASA 400 film at f11 with 50 min. exposure. The pileus surface appears weakly luminescent as a result of light transmitted through the pileus context from the lamellar source. **2.** Basidiomes in daylight. Basidiome at left in the bottom row of Fig. 2 is not present in Fig. 1. Bar = 10 mm.



**Figs. 3-6.** Micromorphological features of *Gerronema viridilucens* (from holotype). **3.** Basidiospores. **4.** Basidia and basidiole. **5.** Pileocystidia. **6.** Caulocystidia. Hatch marks in Figs. 3-4 indicate golden, resinous contents. Bar = 10  $\mu\text{m}$ .

surface, becoming beige with moisture loss, base white or buff-colored. *Basidiospores* (Fig. 3)  $7-9.5 \times 4.5-5.5 \mu\text{m}$  [ $\bar{x} = 8.7 \pm 0.9 \times 5 \pm 0.5 \mu\text{m}$ ,  $Q = 1.6-2$ ,  $Q_m = 1.7 \pm 0.12$ ,  $n = 25$  spores], ellipsoid to broadly ellipsoid, inequilateral in profile, smooth, hyaline to pale yellow, a few spores with golden, resinous contents, inamyloid, non-dextrinoid, thin-walled. *Basidia* (Fig. 4)  $40-65 \times 6-8 \mu\text{m}$ , subclavate, 4-spored, with sterigmata up to  $5 \mu\text{m}$  long, hyaline when young, mature basidia with yellowish tawny, resinous and refractive contents, thin-walled, basally clamped. *Basidioles* (Fig. 4) subclavate to narrowly clavate, obtuse, hyaline, not refractive. *Pleurocystidia* and *cheilocystidia* absent; lamellar edge fertile. *Pileipellis* a cutis with scattered pileocystidia; hyphae  $3-12 \mu\text{m}$  diam., cylindrical to slightly inflated, agglutinated, smooth, non-incrusted, hyaline to pale yellow, inamyloid, thin-walled; *pileocystidia* (Fig. 5)  $30-42 \times 8-9.5 \mu\text{m}$ , clavate, scattered, repent to erect, hyaline, thin-walled; pileus margin composed of filamentous to flexuous hyphae, terminal cells  $30-45 \times 3-5 \mu\text{m}$ , obtuse, hyaline, thin-walled. *Pileus trama* of loosely interwoven hyphae  $4-12(-18) \mu\text{m}$  diam., cylindrical, smooth, hyaline, inamyloid, thin-walled; with scattered oleiferous hyphae with golden,

refractive, resinous contents. *Stipe tissue* monomitic; cortical and medullary hyphae similar, 3-10  $\mu\text{m}$  diam., cylindrical, parallel, smooth, non-incrusted, hyaline to pale yellow, inamyloid, thin-walled, septa mostly unclamped. *Stipitipellis* composed of numerous caulocystidia: *caulocystidia* (Fig. 6) 25-50  $\times$  3-8  $\mu\text{m}$ , irregularly cylindrical to subclavate or irregular in outline, scattered on stipe apex, clustered on stipe base, erect, hyaline, inamyloid, thin-walled. *Clamp connections* present in all tissues.

In culture, hyphae white, becoming reddish brown like the pileus in age; young cultures green luminescent. Growth rate slow, 30-40 days to cover 90 mm Petri plate at 25°C.

*Habit, habitat, and distribution:* Solitary to scattered, common on bark of living *Eugenia fluminensis* (Myrtaceae) in Atlantic Forest of São Paulo State, Brazil; abundant during Sept. thru April when relative humidity is 85-90% and temperatures vary from 20-30°C.

*Specimens examined:* BRAZIL, São Paulo State, municipality of Iporanga, Parque Estadual Turístico do Alto Ribeira (PETAR), S24°16-38', W48°29-44', September 2003, C.V. Stevani, SP307883 (**holotype designated here**, SP; isotype, SFSU); same locality, 13 December 2002, C.V. Stevani, SP307922; same locality, 27 February 2003, R. Braga Neto, SP307923; same locality, 11 December 2002, C.V. Stevani & M. Capelari, SP307924; same locality, April 2004, C.V. Stevani, SP307925. All specimens are deposited in SP except where noted otherwise.

*Notes:* *Gerronema viridilucens* is characterized by the following features: small, reddish brown basidiomes with decurrent, distant lamellae and growth on living myrtaceous trees; a negative KOH reaction on pileus surface; the absence of hymenial cystidia; the presence of clamp connections; and an intense green luminescence. Pigmentation and basidiome shape are reminiscent of a *Xeromphalina* species, but the inamyloid basidiospores, lack of a KOH reaction (i.e., tissues not rubescent), and white stipe basal mycelium remove *Xeromphalina* from consideration. An atypical, although not unique, feature of *G. viridilucens* is that the basidiospores, basidia and oleiferous hyphae have golden, resinous contents. Only a few other *Gerronema* species have been reported with this characteristic [viz., *G. macrosporum* (Singer) Singer, *G. laccarioides* Singer, *G. cyathiforme* (Berk & M.A. Curtis) Singer, *G. bryogeton* Singer] and a comparison with these species is presented below.

*Gerronema macrosporum*, a species described from the bark of dicotyledonous trees in Tucuman, Argentina, differs from *G. viridilucens* in forming orange-ferruginous basidiomes with larger basidiospores (8.8-11.7  $\times$  5.5-6.2  $\mu\text{m}$ ) and lacks clamp connections (*fide* Singer, 1970). *Gerronema laccarioides*, a rose-colored species from Amazonas, Brazil, differs in forming smaller basidiomes (pilei 6-9 mm diam) with larger basidiospores (9.5-11.2  $\times$  4.8-6.7  $\mu\text{m}$ ), has filamentous cheilocystidia, and a terrestrial habit (*fide* Singer, 1989). The absence of bright yellow and orange pigments in *G. viridilucens*

suggests that it is allied with members of subgen. *Romagnesia*, sect. *Cyathiformia*, such as *G. cyathiforme* (known from the West Indies south to northern Argentina) and *G. bryogeton* (known from Bolivia). However, both of the latter species form olive-yellow to fuscous-olive basidiomes with pigment-incrusted oleiferous hyphae, and both have tissues that turn mahogany or reddish chestnut in KOH (*vide* Singer, 1970).

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