

Fungi Rickiani: the Brazilian clavarioid collection at PACA and BPI herbaria

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ABSTRACT

Seventy-two clavarioid specimens from Johannes Rick's collection at PACA and BPI were revised. Eleven taxa are presented. Illustrations of the microstructures are provided for nine taxa. The description of *Scytinopogon robustus* includes information from recently collected specimens and SEM photographs of the basidiospores. A new combination, *Clavulina ridleyi*, is proposed.

Key words: Clavariaceae; fungal taxonomy; morphology.

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Introduction

Johannes Rick (1869–1946) was an Austrian Jesuit who first came to Brazil in 1903 to finish his studies as a Jesuit priest and in parallel to study the mycobiota from Rio Grande do Sul (Rabuske & Rambo 2004). One year after his arrival he published the first paper on Brazilian fungi (Fidalgo 1968, but no figures were provided and the descriptions were incomplete for an adequate taxonomic identification (Rick 1928, 1931, 1959). Most of Rick's collections can be found at PACA (Brazil), BPI, FH (USA), K (England) and S (Sweden) herbaria (Rick 1928; Fidalgo 1962).

The family Clavariaceae Chevall. accommodates mostly club to coral-like fungi that were previously placed in *Clavaria* Vaill. ex. L. (Burt 1922; Coker 1923, 1947) and the major diversity is believed to be in tropical and subtropical regions (Corner 1950). Currently, Clavariaceae includes 125 species distributed in seven genera, of which five are clavarioid — *Clavaria*, *Clavulinopsis* Overeem, *Mucronella* Fr., *Ramariopsis* (Donk) Corner (Kirk et al. 2008; Kautmanová et al. 2012; Birkebak et al. 2016)— and three are agaricoid genera — *Camarophyllopsis* Herink, *Hodophilus* R. Heim. ex R. Heim and *Lamelloclavaria* Birkebak & Adamcík — that have been added to the family based on phylogenetic analysis in recent years (Birkebak et al. 2016).

Rick's clavarioid collection at PACA and BPI combined consists of 108 exsiccates. Many of the species names used by Rick in the identifications have been observed to be misidentifications. He frequently used measurements or characteristics of European specimens to determine Brazilian collections. Even though Rick was a particularly careful and attentive mycologist, it has been noted by some recent authors that his spore measurements were not entirely reliable, due to the low quality of the equipment used at the time (Dennis 1960; Corner 1950, 1970), therefore almost all simple club-shaped, yellow taxa of Clavariaceae were mixed due to insufficient microscopic observation (Petersen 1965).

The Herbarium Anchieta - PACA, considered one of the largest in the state, very well-represented in Brazil and housing the largest collection made by Rick, was founded in 1932 in Porto Alegre. Currently, the collection may be found at Instituto Anchietano de Pesquisas/Unisinos, in São Leopoldo, Brazil. The data of the collections are all computerized, and all images of nomenclatural types are available at <http://www.anchietano.unisinos.br>, at Specieslink (<http://www.splink.org.br>) and through INCT Herbário Virtual da Flora e Fungos do Brasil (<http://inct.florabrasil.net/>). The herbarium maintains exchanges with other national and international herbaria through loans, exchanges and donations integrated with research. But mainly, the herbarium receives visits from researchers from different educational and research institutions.

Considering that Rick's collections are some of the most important records of clavarioid fungi from Brazil and their revisions are important to better know the diversity from Southern Brazil, the aim of this work was to review the clavarioid fungi collected and studied by Rick, including the type collections deposited at PACA and BPI.

Material and Methods

Seventy-two specimens collected and identified by Rick and deposited at PACA and BPI were analyzed. *Scytinopogon robustus* Rick was recently collected in

Florianópolis, Santa Catarina, Brazil and the new collections were used to complement the study of this species. Eleven taxa are summarized. Specimens from INPA, JPB, K, MB, RBGE and URM herbaria were also studied as reference material, and are listed under ADDITIONAL MATERIAL(S) EXAMINED. A summary is provided in TABLE 1.

TABLE 1. Clavariaceae species reported by Rick from Brazil.

TAXA	REFERENCES	COMMENTS
" <i>Clavaria</i> sp."	Unpublished	<i>Clavulinopsis amoena</i>
" <i>Clavaria inaequalis</i> "	Rick 1931	<i>Clavulinopsis laeticolor</i>
" <i>Clavaria guarapiensis</i> "	Rick 1931	<i>Ramariopsis crocea</i>
" <i>Lachnocladium cartilagineum</i> "	Rick 1959	<i>Ramariopsis kunzei</i>
" <i>Clavaria alba</i> "	Rick 1959	<i>Ramariopsis</i> sp.
" <i>Clavaria pteruloides</i> "	Rick 1959	<i>Scytinopogon angulisporus</i>
" <i>Lachnocladium dubiosum</i> "	Rick 1928	<i>Scytinopogon dealbatus</i>
" <i>Clavaria robusta</i> "*	Rick 1931	<i>Scytinopogon robustus</i>
" <i>Clavaria ridleyi</i> "	Rick 1931	<i>Clavulina ridleyi</i>
" <i>Clavaria paludicola</i> "	Rick 1931	<i>Sulzbacheromyces caatingae</i>
" <i>Clavaria albipes</i> "	Rick 1931	<i>Ramaria stricta</i>
" <i>Clavaria parallela</i> "*	Rick 1931	Not found (<i>nomen dubium</i>)

*= type locality in Brazil.

Micromorphological analyses were conducted at herbarium PACA (Instituto Anchietano de Pesquisas, RS) and at Laboratório de Micologia – Micolab (Universidade Federal de Santa Catarina, SC) following traditional methods used for basidiomycetes (Largent 1986; Largent et al. 1977). Color codes (e.g., 2B19) were based on Kornerup & Wanscher (1978).

For the microscopical analysis, portions of the basidiomes were mounted in Melzer and 5% KOH solution and were observed with Olympus CX21 microscope using immersion oil lens at 1000× magnification. The use of descriptive terms followed Corner (1947), Largent et al. (1977) and Vellinga & Noordeloos (2001). The spore measurements excluded the ornamentation (Corner 1947). Twenty-five of each microstructures studied were measured for each collection. Q refers to the quotient average length/width ration range of basidiospores (Largent et al. 1977). All microscopic illustrations were traced with the aid of digital photographs.

The scanning electronic microscopy (SEM) was conducted at Laboratório Central de Microscopia Eletrônica (LCME/UFSC). Fragments of the hymenophore were removed from dried basidiomes, mounted directly on aluminum stubs using carbon adhesive tabs, and coated with 30 nm of gold. The fragments were examined with an SEM operating at 10 keV.

Voucher material of recent collections was deposited at herbarium FLOR at Universidade Federal de Santa Catarina.

In the following notes the species are described in alphabetical order by family and within family by genus. For each taxon the original diagnosis written by Rick (1959) is presented. Nomenclature of the fungi was updated according to CABI and CBS databases. The herbaria acronyms follow Thiers (2015).

Results

Many of the clavarioid specimens from the *Fungi Rickiani* collection could not be found or traced. Several of the packets do not contain the specimens that correspond to the description provided in the literature, and in others the hymenium was completely eaten by insects or covered by mold. Eleven taxa were associated with all collections recovered. Of the two Brazilian types presented, one was not found in any herbarium consulted, and now we regard it as *nomen dubium* (TABLE 1). Rick's classification for Clavariaceae included two genera: *Clavaria* and *Lachnocladium*.

Taxonomy

Clavaria alba Baumgarten (1790: 652)
= *Ramariopsis* (Donk) Corner (1950: 636)

Ad terram (Rick 1928).

Basidiospores $4.0\text{--}4.5 \times 3.0\text{--}4.0 \mu\text{m}$ ($Q=1.25$), hyaline, minutely echinulate, broadly ellipsoid, hilar appendage up to $1.0 \mu\text{m}$, slightly dextrinoid. Hymenium stratified, up to $100 \mu\text{m}$ thick, distinctly thickening upwards. Subhymenium up to $62.5 \mu\text{m}$ thick, short, tortuous, clamped. Trama parallel, with clamped hyphae.

Material examined:—BRAZIL. Rio Grande do Sul: Pareí Novo, 1918, *J.E. Rick* (BPI 297655, BPI 297617, as *Clavaria alba*).

Remarks:—Even without having access to the macro description, Rick (1928) probably identified these collections as *Clavaria alba* Baumg. due to the extremely white color of the basidiomes. Considering the branching pattern and the basidiospore morphology, this is a species of *Ramariopsis*. Inside de packet, there is a note from Petersen who reviewed these collections in 1986 and named it *Ramariopsis rickii*, however the name was never published. The specimens are well-preserved on the outside, but the ultrastructure is quite deteriorated. The lack of morphological data prevents the identification of the material to the specific level, and the validation of the name *R. rickii*. Therefore, we should regard it only at generic level for now.

Clavaria albipes Montagne (1842: 244)
= *Ramaria stricta* (Persoon) Quéllet (1888: 464)

Ramosissima, 3–7 mm alta, 1–4 cm lata, ramis tenuibus, repetite dichotomis, subvelutina, apicibus acutis, multipartitis, tota ferrugineo-brunnea, apicibus pallidioribus; stipite nitide distincto, carnosolento, albo-tecto, e mycelio albo orto. Sporibus $5 \times 3 \mu\text{m}$, coloratis, echinatis. Hanc speciem olim ad Lachnocladium furcellatum duxerum, a quo tamen forma robustiore sporisque maioribus recedit. cf. C. stricta Fr. In silvis non rara (Rick 1931).

BASIDIOSPORES (Fig. 1a) $7.0\text{--}10 \times 3.5\text{--}4.5 \mu\text{m}$ ($Q=1.66$), light yellow ochraceous, roughed, narrowly ellipsoid, uniguttulate. **BASIDIA** (Fig. 1b) $25\text{--}44 \times 4.5\text{--}7.0 \mu\text{m}$, mostly tetraspored, $6.0\text{--}7.0 \mu\text{m}$ long, multiguttulate, clamped. **CYSTIDIA** absent. **HYMENIUM** gradually thickening to $120 \mu\text{m}$, absent from the axils and the upperside of the main branches. **SUBHYMENIUM** interwoven, $2.0\text{--}3.5 \mu\text{m}$ wide hyphae. **TRAMA** (Fig. 1c) composed by thick-walled hyphae, clamped. Mycelial hyphae $2.5\text{--}5 \mu\text{m}$ wide, with slightly thickened walls interwoven with many narrow, thick-walled, unbranched, skeletal hyphae, $1.5\text{--}3.0 \mu\text{m}$ wide (walls $0.5\text{--}1.0 \mu\text{m}$ thick).

Habitat and distribution:—Growing on dead wood, on branches of coniferous trees. Brazil (Corner, 1970; Rick 1959), Malaysia, Guatemala (Corner, 1970), India (Thind 1961), Europe, Japan (Corner 1950) and USA (Petersen 1967).

Materials examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1907, *J.E. Rick* (PACA 12440, 12456, 17231, 17238, 19617, as *Clavaria albipes*), *ibid.*, *J.E. Rick* (PACA 17252).

Additional materials examined:—MALAYSIA. Sabah: Kinabalu, 11 Jun 1964, *E.J.H. Corner* (BPI 295906); ENGLAND. Ringwood: Hants, 1924, 516, *E.J.H. Corner* (BPI 295899); USA. Kansas: Rooks County, Jul 1896, *E. Bartholomell* (BPI 333231); CANADA. Ontario: University of Toronto, 18 Sep 1964, *R.F. Cain* (BPI 295914).

Remarks:—The reason why Rick (1931) identified these collections as *Clavaria albipes* Mont. is unknown, once Rick's collections are completely different from *C. albipes* especially when it is considered the color of the basidiomes and the spore morphology (smooth in *C. albipes*).

Based on Rick's description and the data results from our microscopic analysis these collections refer to *Ramaria stricta*. This species has straight and ascending branches, dull yellowish buff with yellow tips, and the surface of the basidiomes discolor to purplish brown when damaged (Petersen 1975). The thick-walled hyphae, clamped and indistinctly roughened basidiospores are diagnostic characters (Thind 1961; Petersen 1975). The yellowish color of the hymenium and the subhymenium is caused by the guttula of the basidia (Corner 1950).

Considering the sampling location, it is believed that *Ramaria stricta* was probably introduced to Brazil with *Pinus* species. The collection is macroscopically well preserved, but part of the hyphal system is collapsed.

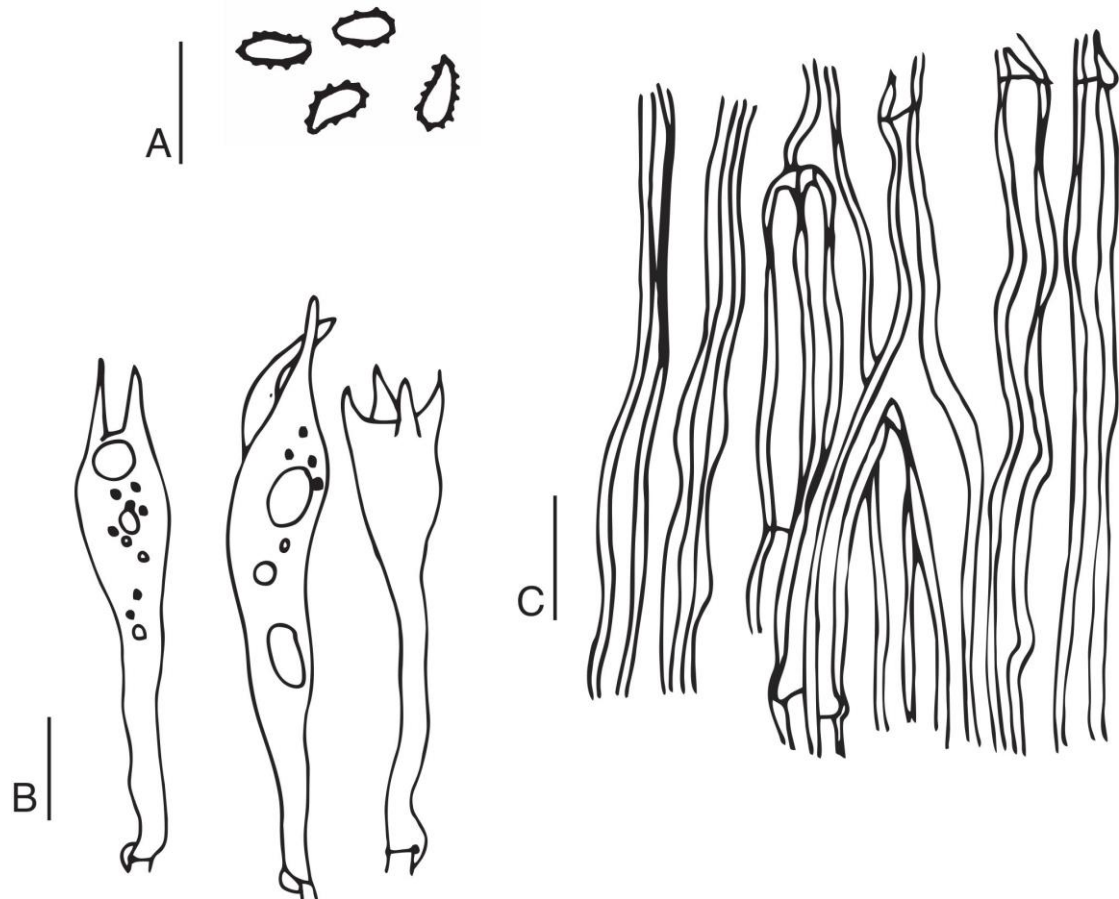


FIGURE 1. *Ramaria stricta* (PACA 17252). **A.** Microcharacteres of basidiospores. **B.** Basidia and **C.** Context hyphae of the basidiomes with, on the right, the skeletal hyphae from the basal mycelium. Bar = 10 μ m.

Clavaria guarapiensis Spegazzini (1884: 81)
= *Ramariopsis kunzei* (Fr.) Corner (1950: 638)

In vivo alba, in sicco cinerascens, glabra, laevissima, vix inferne, ob granulos arenae in epidermide inclusos sparse verruculosa, intus farcta, alba; stipite mycelioque albo, dense fibroso-floccoso, subgossypino, frustula ad humum late arcteque adnato-obvolvante, saepius solitario, fere a basi 3–4-partito; ramis primariis longiusculis 2 cm longis, 3 mm crassis, apice 4–13-partitis; ramis sencundariis mediocribus, 1–1.5 cm longis, 1.5–2 mm crassis, erectiusculis, apice 2-partitis, longiusculis ac pro ratione vertice integris vel saepe breviter bilobis, laciniis divarictis, 1–1.5 mm longis, 0.8 mm crassis, apicibus abrupte rotundato-aculatis, minutissime mucronulatis. Ad ligna (Rick 1931).

BASIDIOSPORES (Fig. 2a) 4.0–4.5 \times 3.0–3.5 μ m (Q=1.25), hyaline, echinulate, spiny scattered, broadly ellipsoid, sometimes uniguttulate, slightly dextrinoid; hilar appendage up to 1.0 μ m. **BASIDIA** (Fig. 2b) 15–23 \times 4.0–6.0 μ m, bi- or tetraspored, mostly tetraspored, clamped. **CYSTIDIA** absent. **HYMENIUM** distinctly thickening upwards. **SUBHYMENIUM** up to 20 μ m wide, coralloid, pseudoparenchymatic, composed of short-celled hyphae, 4.0–10 μ m wide. **TRAMA** parallel, inflated and short-celled next to subhymenium, becoming broad in the middle, 6.0–23 μ m wide.

Clamps present in all tissues.

Habitat and distribution:—Growing on the ground among grass in the forest. Bolivia, Australia, Japan (Corner 1970), Canada (Coker 1923) and USA (Coker, 1923; Corner 1970; Petersen 1964).

Material examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1931, *J.E. Rick* (BPI 294900, as *Clavaria guarapiensis*).

Additional materials examined:—SLOVAKIA. Lysá, 26 Sep 2005, *S. Adamčík* (SAV F-1250, neotype of *Ramariopsis crocea*), *ibid.*, 2007, *V. Kautman* (K 158309); INDIA. Khadralla: Mahasu: Himachal Pradesh, 25 Aug 1971, *I.P.S. Khurana* (BPI 294899), *ibid.*, 25 Aug 1971, *I.P. Khurana* (BPI 294927, *Ramariopsis pulchella*); ENGLAND. 2006, *A.W. Ainsworth* (K 145197); USA. Missouri: Saint Louis, *J. Monell* (BPI 0294901, as *Clavulinopsis corniculata*).

Remarks:—Rick (1931) published this collection as *Clavaria guarapiensis* Speg. based on the macroscopical description published in the protologue, but with no microstrutural comparison. The material consists of three basidiomes in good conditions macro and microscopically. Superficially it looks like a small and delicate *Clavulinopsis corniculata* (Schaeff.) Corner, but it has basidiospores echinulate like the ones found in *Ramariopsis crocea*.

The only other species that could be mistaken with *R. crocea* is *R. pulchella* (Boud.) Corner, but *R. crocea* is white, while *R. pulchella* has bright violet basidiomes (Corner 1950, 1970).

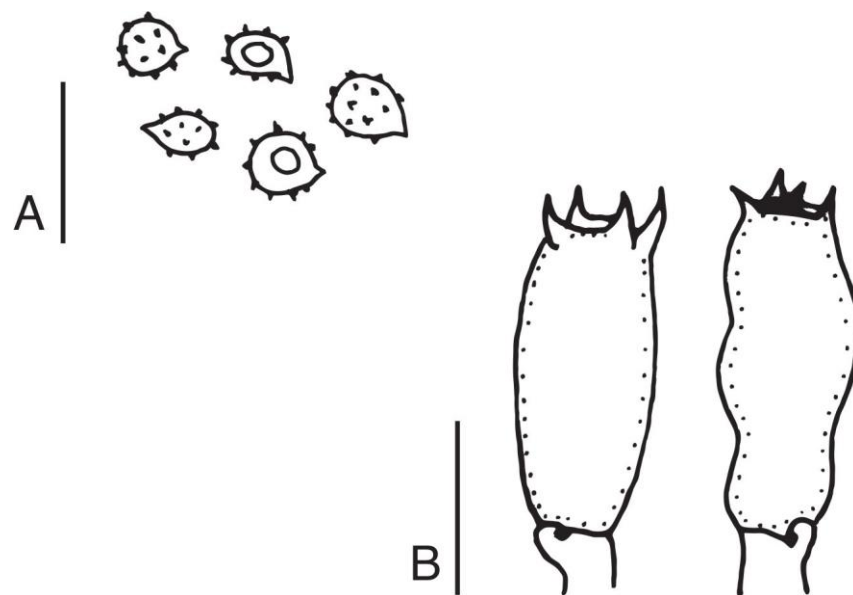


FIGURE 2. *Ramariopsis kunzei* (BPI 294900). **A.** Microcharacteres of basidiospores and **B.** Basidia. Bar = 10 μ m.

Clavaria inaequalis O.F. Müller (1780: 8)

= *Clavulinopsis laeticolor* (Berk. & M.A. Curtis) R.H. Petersen (1965: 522)

Gregaria, *subfasciculata*, *fragilis*, *farcta*, *lutea*; *clavis variis*, *simplicibus furcatisve*, *deorsum contiguis*, *concoloribus*, 1–10 cm altis, 3–5 mm latis, *simplicibus sulcatisve*, *sine stipite*. *Inter gramina* (Rick 1931).

BASIDIOSPORES $6.0\text{--}8.0 \times 3.5\text{--}5.0 \mu\text{m}$ ($Q=1.53$), ellipsoid to pip-shaped, hyaline, smooth, uniguttulate, inamyloid; hilar appendage up to $1.5 \mu\text{m}$, often sublateral. BASIDIA bi- or tetraspored, mostly tetraspored, clamped. CYSTIDIA absent. HYMENIUM $75 \mu\text{m}$ thick, thickening upwards, pale yellow (1A2), covering the upper part of the basidiomes. SUBHYMENIUM up to $30 \mu\text{m}$ thick, coralloid, tortuous, producing basidia in clusters. TRAMA subparallel, with hyphae of two different widths, the wider up to $10 \mu\text{m}$ wide, slightly inflated, and the narrower up to $3 \mu\text{m}$ wide, interweaving with the wider hyphae and arising from them, both clamped.

Habitat and distribution:—Growing on grassy fields or on the ground in the forest. Brazil (Rick 1928, Corner 1970), Argentina, Austria, Bolivia, Chile, Costa Rica, Jamaica, Panama, Peru, Sweden and Malaysia (Corner 1970, as *Clavulinopsis pulchra*), USA (Petersen 1968), (Corner 1970), India (Thind & Rattan 1967, as *Clavulinopsis pulchra*).

Material examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1906, *J.E. Rick* (PACA 12443, as *Clavaria inaequalis*).

Additonal materials examined:—SLOVAKIA. Lysá, 2005, *V. Kautman* (K 158310); INDIA. Dhanaulti, Mussoorie, Uttar Pradesh, 31 Aug 1968, *S.S. Rattan* (BPI 294884); BRAZIL. Amazonas: Manaus, Campus do INPA, 20 May 1977, *E.H. Freire* (INPA 69936, *Clavulinopsis fusiformis*), *ibid.*, 21 Jun 1977, *E.H. Freire* (INPA 79021) *ibid.*, 22 May 1978, *R. Singer* (INPA 79015, *Clavulinopsis fusiformis*), *ibid.*, Reserva Florestal Ducke, 20 Jul 1978, *R. Singer* (INPA 80977).

Remarks:—It is possible that the macroscopic aspect of the basidiome led Rick to identify the specimen PACA 12443 as *Clavaria inaequalis* O.F. Müll. However, *C. inaequalis* can be distinguished by the subglobose to broadly ellipsoid basidiospores, sharply angular to echinulate-warted (Corner 1966a), $5.5\text{--}7.2 \times 4.5\text{--}5.7 \mu\text{m}$ (Petersen 1968). The specimen collected by Rick is actually *C. laeticolor*, a species diagnosed by the color change from chrome yellow to deep green in ferrous salts (presence of pistillarin) (Petersen 1968), gregarious to fasciculate basidiomes, and a distinct stipe that becomes finely subtomentose when dried (Petersen 1965). Although some microstructures are collapsed, the hyphae of the context and the basidiospores confirm the redetermination as *C. laeticolor*.

Clavulinopsis laeticolor can be compared with *C. fusiformis* (Sowerby) Corner, a taxon widely distributed (Corner 1970). They differ by the densely fasciculate to caespitose habit, indistinct stipe and globose to subglobose basidiospores in *C. fusiformis* (Corner 1950).

Clavaria paludicola Libert (1837: 322)

= *Sulzbacheromyces caatingae* (Sulzbacher & Lücking) B.P. Hodk. & Lücking (2014: 176)

Pusilla, simplex, leviter compressa, rugulosa, lutea, sicca aurantiaca; clava brevi, obtusa, 1–2 cm alta, 4 mm lata. Sporis $8 \times 5 \mu\text{m}$, obtuse, piriformibus. Ad terram (Rick 1931).

BASIDIOSPORES (Fig. 3a) $5.5\text{--}8.5 \times 3.0\text{--}4.5 \mu\text{m}$ ($Q=1.86$), hyaline, smooth, ellipsoid, slightly curved, hilar appendage up to $1.0 \mu\text{m}$, aguttulate, inamyloid. BASIDIA (Fig. 3b) $18\text{--}35 \times 4.0\text{--}8.0 \mu\text{m}$, bi- to tetraspored, $3.0\text{--}5.0 \mu\text{m}$ long, clampless. CYSTIDIA absent. SUBHYMENIUM composed by thin-walled hyphae, coralloid, parallel to the trama hyphae. TRAMA parallel, loosely arranged, short-

celled, hyphae slightly thick-walled, clamped.

Habitat and distribution:—Growing on roadside soil banks and on termite nests. The species is known only from Brazil (Sulzbacher et al. 2012).

Material examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1929, *J.E. Rick* (PACA 12438, as *Clavaria paludicola*).

Additional materials examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1907, *J.E. Rick* (PACA 12459, *Multiclavula clara*), *ibid.*, 1929, *Braun* (PACA 12444); SINGAPORE. Singapore Botanic Garden, 30 Oct 1919, *T.F. Chipp* (BPI 332400, *Clavaria helicoides*), *ibid.*, 1934, *E.J.H. Corner* (K 77772, type of *Multiclavula fossicola*); MALAYSIA, 1985, *B.M. Spooner* (K 77773); USA, *H.W. Ravenel* (K 137452).

Remarks:—Rick (1931) published this collection as *Clavaria paludicola* Lib. based on the morphology and yellowish orange color of the basidiomes and probably he did not notice the presence of a green symbiont at the substrate. The specimen collected by Rick is a lichenized clavarioid fungus, *Sulzbacheromyces caatingae*. *Sulzbacheromyces* B.P. Hodk. & Lücking is a recently erected genus in Lepidostromales with a tropical distribution, with an entirely crustose, undifferentiated thallus lacking cortex and medullary structures (Sulzbacher et al. 2015). Despite *S. caatingae* being originally described from the Caatinga biome in Brazil (Sulzbacher et al. 2012, as *Lepidostroma*), the species has had its distribution expanded in several other localities that belong to different biomes, such as the Atlantic Forest (Sulzbacher et al. 2016).

Sulzbacheromyces and *Multiclavula* R.H. Petersen, another genus of lichenized fungi, exhibit strong morphological similarities even though they belong to distantly related clades within the subclass Agaricomycetidae (Hodkinson et al. 2014). The number of sterigmata and characteristics from the thallus can possibly partially separate both genera, although there are some exceptions and not all species of *Multiclavula* have been well-documented regarding thallus morphology.

Two tropical species, such as *M. clara* (Berk. & M.A. Curtis) R.H. Petersen, so far known from Cuba (Fischer et al. 2007), and *Multiclavula fossicola* (Corner) R.H. Petersen, described from Malaysia (Corner 1950), differ due to the ellipsoid basidiospores of different size ($6.5\text{--}8.0 \times 3.5\text{--}4.5 \mu\text{m}$ in *M. clara* and $5.0\text{--}6.5 \times 2.0\text{--}2.7 \mu\text{m}$ in *M. fossicola*).

Clavaria helicoides Pat. & Demange shares the yellow-pale orange-pink color of the basidiomes, but differs by the absence of a phycobiont, the ellipsoid basidiospores, and larger basidia (Voitk & Ohenoja 2011).

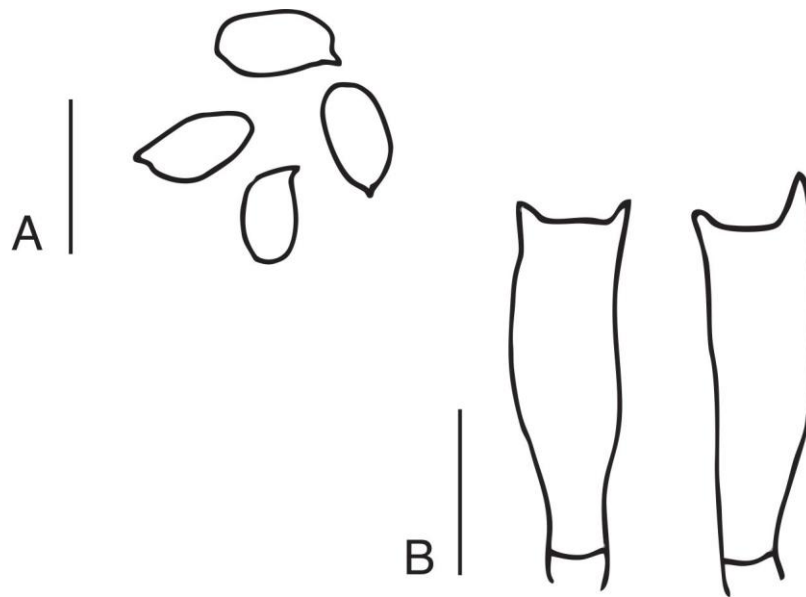


FIGURE 3. *Sulzbacheromyces caatingae* (PACA 12438). **A.** Microcharacteres of basidiospores and **B.** Basidia. Bar = 10 μ m.

Clavaria pteruloides Patouillard & Gallard (1888: 41)
= *Scytinopogon pallescens* (Bres.) Singer (1945: 139)

Dense caespitosa, confluens, subpulvinata, erecta, pallide ochracea, setosa, 2–4 cm alta; stipitibus ramosis, fastigiatis, ramis repetitive dichotomis vel fasciculatis, axillis late compressis, strictis, divergentibus, tenacellis; ramulis apice subulatis, fastigiatis vel cristatis. Sporis subellipsoides, laevibus, fuscidulis, 5–6 \times 3.5–4.5 μ m. Mycelio albo, membranaceo. Ad folia putrida. Clavaria potius quam Lachnocladium. Hennings specimen siccum prae se habens setosum dixit, equae tamen nota ad specimen vegetum non applicatur (Rick 1959).

BASIDIOSPORES (Fig. 4a) 3.5–4.5 \times 3.0–4.0 μ m (Q=1.15), hyaline, subglobose, echinulate, hilar appendage up to 1.0 μ m long, inamyloid. **BASIDIA** (Fig. 4b) 25–38 \times 4.0–7.0 μ m, clavate, short, bi- or tetraspored, 4.0–5.0 μ m long, clamped. **CYSTIDIA** absent. **HYMENIUM** 52.5 μ m thick at first, thickening upwards to 120 μ m, covering the whole basidiomes except the sterile stipe. **SUBHYMENIUM** well developed, coralloid, composed of narrow hyphae, 5.0 μ m wide, closely interwoven. **TRAMA** subparallel, smooth, with thin-walled hyphae 12–15 μ m wide, clamped. Surface of sterile base covered by loosely interwoven hyphae, up to 2.0–4.0 μ m wide, smooth, thin-walled, clamped.

Habitat and distribution:—Growing on the ground of the forest, perhaps also lignicolous. Brazil (Corner 1953, 1966b; Meijer 2006), Malaysia, Mauritius, Uganda, USA (Corner 1950, 1966b), Africa, Burma, Camaroons, Congo, Cuba, Japan, Java, Madagascar, Nigeria, Panama, Sumatra (Corner 1966, 1970), India (Dutta et al. 2012), Borneo, Phillipines and Solomon Islands (Corner 1970).

Materials examined:—BRAZIL. Rio Grande do Sul, 1925, *J.E. Rick* (BPI 295379, 333159, 333160, 333162, 333164, 723389, as *Clavaria pteruloides*); *ibid.*, 1907, *J.E. Rick* (PACA 17243).

Additional materials examined:—Pernambuco: Recife, 13 Ago 1954, *O.S.*

Silva (URM 876); MALAYSIA. Malaya: Pahang, 25 Nov 1930, *E.J.H. Corner* (BPI 295368).

Remarks:—The basidiospore characteristics described by Rick were not observed in the collections identified by him as *Clavaria pteruloides*. The basidiospores in these specimens are echinulate and smaller than any of the species known in *Clavaria*.

These specimens correspond instead to *Scytinopogon pallescens*. Corner (1970) lists many Brazilian collections under the name *Scytinopogon angulisporus* (Pat.) Corner, including several specimens from Rio Grande do Sul and also the type of *Lachnocladium chartaceum* Pat.. The epithet *angulisporus* has been removed from *Scytinopogon* since its type represents a *Clavulina* J. Schröt. species (Petersen 1988). Thus, the genus is left with the original type pointed out by Singer (1945), *Scytinopogon pallescens*.

The uninflated not mucilaginous hyphae, the flattened branches, and the hyaline, ellipsoid, angular-echinulate basidiospores observed in the specimens are diagnostic characteristics of *S. pallescens* (Corner 1950). In some of the collections the angles of the basidiospores are very subtle and could have been interpreted by Rick as ellipsoid only. In addition, the specimens have a chalk-white basal mycelium divided palmately before reaching the surface, exclusive of this species.

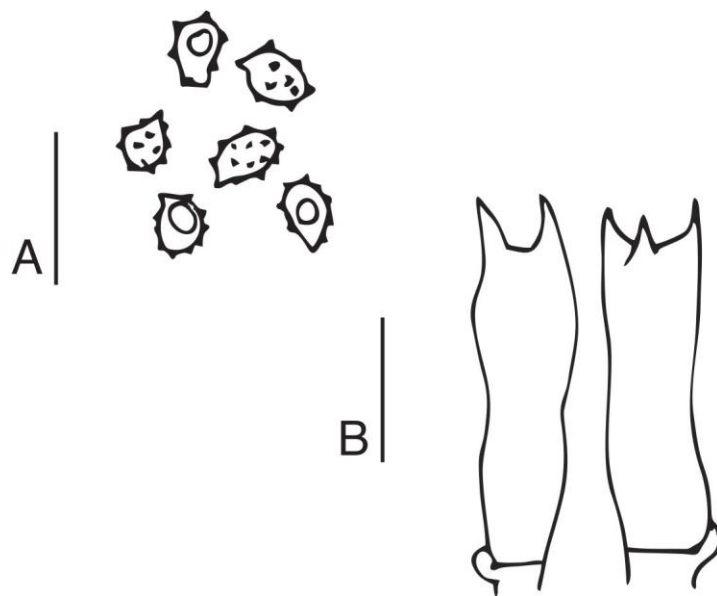


FIGURE 4. *Scytinopogon pallescens* (PACA 17243). **A.** Microcharacteres of basidiospores and **B.** Basidia. Bar = 10 µm.

Clavaria ridleyi Massee (1899: 172)

≡ *Clavulina ridleyi* (Massee) A.N.M. Furtado & M.A. Neves, *comb. nov.* (MycoBank MB 832675)

Trunco crasso, brevi, 1 cm diametro, umbrino, solido, ramis subconfertis, teretibus, laevibus, dichotomo-ramulosis, umbrino-rufescentibus, apicibus lunulato-furcatis, carne alba. Sporibus subglobois, laevibus, hyalinis, 7–8 my. Basidiis clavatis, 35 × 12 my. Ad terram. Rara sed gregaria (Rick 1931).

BASIDIOSPORES (Fig. 5a) 7.0–8.0 × 6.0–8.0 µm (Q=1.09), hyaline, smooth,

globose to subglobose, inamyloid; hilar appendage up to 1.0 μm . BASIDIA (Fig. 5b) 31–36 \times 9.0–12 μm , clavate, secondarily septate, bispored, incurved and short, 3.0–4.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 58–63 μm thick, covering the whole basidiomes except the sterile stipe. SUBHYMENIUM up to 20 μm thick, coralloid, composed of short-celled hyphae, slightly inflated. TRAMA (Fig. 5c) subparallel, with two different widths; the wider hyphae 15–21 μm wide, strongly inflated, the narrower hyphae 6.0–11 μm wide, interweaving with the wider hyphae, thin-walled, finely incrustated on the inner wall of some hyphae, clamped.

Habitat and distribution:—Growing on soil. Brazil (Rick 1959) and Malaysia (Massee 1899).

Material examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1930, *J.E. Rick* (PACA 12439, 12463, as *Clavaria ridlei*).

Additional materials examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, *J.E. Rick* (BPI 293798); Pareí Novo, 1918, *J.E. Rick* (BPI 293791, 332721); Pernambuco: Igarassu, 25 May 2010, *F. Wartchow* (URM 82947, holotype of *Clavulina incarnata*); MALAYSIA. Perak, *Ridley* 19 (KEW 176287, holotype of *Clavaria ridlei*).

Remarks:—Lloyd (1923) identified some of Rick's collections as *Clavulina cinerea*, and even though Rick (1959) recognized the similarity he pointed out the grayish color of the basidiomes of *C. cinerea*. Furthermore, *C. cinerea* has blunt tips; basidiospores ranging from 6.5–11 \times 6.0–10 μm ; bigger basidia (40–70 μm long) with a fuscous cytoplasm that corresponds to the gray color of the basidiome (Olariaga et al. 2009) that is not observed in the specimen collected by Rick.

The characteristics observed in Rick's collections at PACA and the type of *Clavaria ridlei* include ramifications with cristate tips, basidia bispored and secondarily septate with one or more septa after spore-discharge and subglobose basidiospores. This combination places the specimens in *Clavulina* J. Schröt, and therefore we are proposing the new combination.

Clavulina ridlei has the same incrustated hyphae of *C. incrustata* Wartchow described from Pernambuco, Brazil (Wartchow 2012). The species differ by the less inflated hyphae (11–13 μm wide), the almost clampless hyphae context and colorful incrustations observed in *C. incrustata*. Also, the incrustations of *C. incrustata* partly dissolve in 3% KOH and that does not happen to *C. ridlei* incrustations.

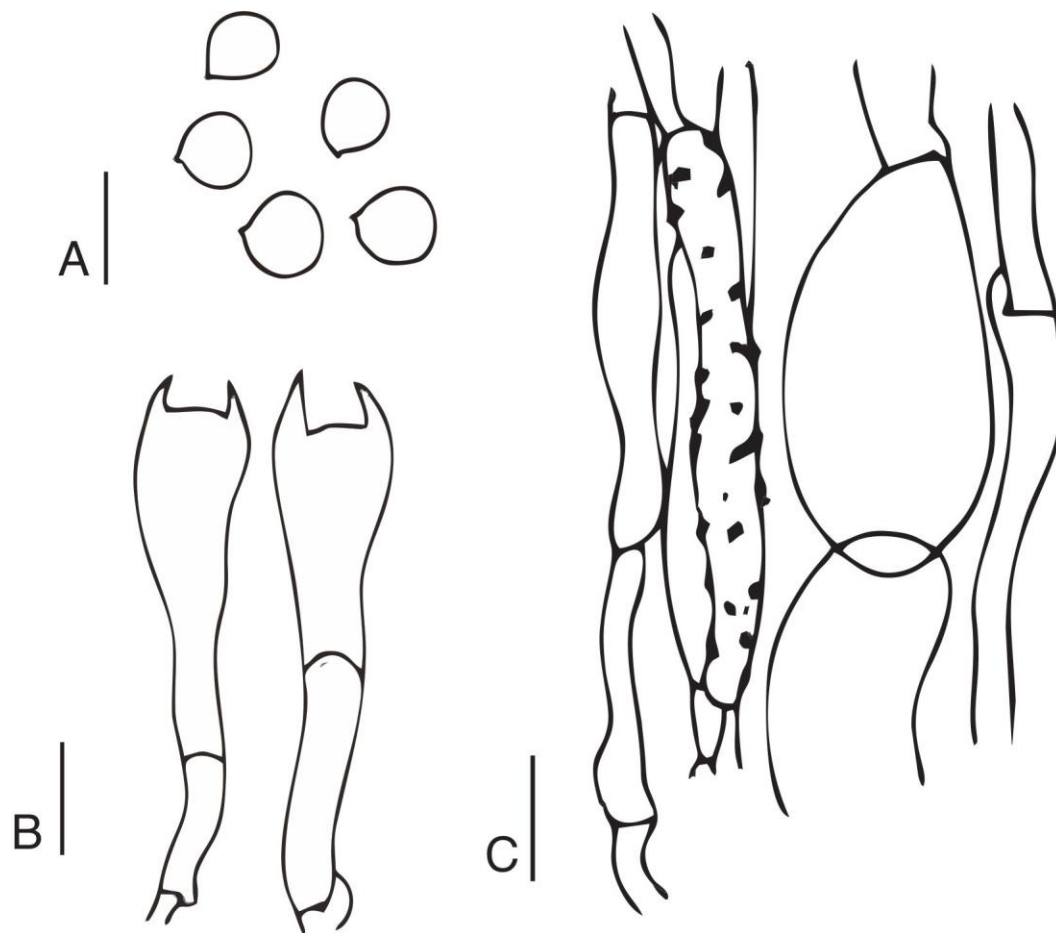


FIGURE 5. *Clavulina ridleyi* (PACA 12439). **A.** Microcharacteres of basidiospores. **B.** Basidia and **C.** Hyphae with inscrustations on the inner wall. Bar = 10 μ m.

Clavaria robusta Rick (1931: 120)

= *Scytinopogon robustus* (Rick) Corner (1970: 91) (Fig. 6a)

Spectabilis, usque 10 cm alta lataque, multiramosa, in ramos solidos, breves, applanatos abiens, colore griseo-violaceo; status iuvenili in violaceum vergente; gregaria, vix velutina, apicibus palmatis, brevibus, applanatis, incis; consistentia carnosa. Ad terram in silvis. Sporis 4–5 \times 3.4 μ m, echinatis, subcoloratis (Rick 1931).

BASIDIOSPORES (Fig. 6b, 6c) 6.0–7.0(–8.0) \times 3.5–4.0(–5.0) μ m (Q=1.58), hyaline, angular-ellipsoid, diverticulate to more or less echinulate, inamyloid; hilar appendage obscured by basidiospore ornamentation. **BASIDIA** (Fig. 6d) 22–31 \times 7.0–10 μ m, clavate, short, bi- or tetraspored, mostly tetraspored, 3.0–5.0 μ m long, clamped. **CYSTIDIA** absent. **HYMENIUM** 30 μ m thick, covering the whole basidiomes except the sterile stipe. Subhymenium up to 20 μ m thick, coralloid, composed of short-celled hyphae, slightly inflated. **TRAMA** (Fig. 6e) composed of subparallel hyphae, 6.0–23 μ m wide, clamped, thin-walled, slightly constricted at the septa. Surface of sterile base covered by repent hyphae, smooth, hyaline, clamped; medullary hyphae 12–15 μ m wide, cortical hyphae up to 3.0 μ m wide.

Habitat and distribution:—Growing on soil, in shady areas, in the Atlantic forest. In Brazil it is known from the states of Paraná (Meijer 2008), Rio de Janeiro,

Rio Grande do Sul (Rick 1931) and Santa Catarina (present study). It is also known from Porto Rico (Corner 1970) and Mexico (García-Sandoval et al. 2004).

Material examined:—BRAZIL. Rio Grande do Sul: Parecí Novo, 1935, *J.E. Rick* (PACA 12457, holotype of *Clavaria robusta*).

Additional materials examined:—BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, 27°59'43"S, 49°47'83"W, 23 Jan 2013, *A.N.M. Furtado* 422 (FLOR); Florianópolis, Costão do Santinho, Morro das Aranhas, 27°47'66"S, 48°38'18"W, 27 Jan 2014, *A.N.M. Furtado* 431 (FLOR); Rio Grande do Sul: São Leopoldo, 1925, *J.E. Rick* (BPI 295379, 333159, 333160, 333162, 333164, 723389, *Scytinopogon angulisporus*); Rio de Janeiro: Niterói, 7 Mar 1948, *E.J.H. Corner* 948 (MB); BELIZE, 2002, *P.J. Roberts* (K 109202, 109203, 109237).

Remarks:—Some of the basidiomes in Rick's collections are fragmented, but overall the collection is well preserved and both macro and microscopic characters agrees with the diagnosis of *Scytinopogon robustus*. Rick named the taxon based on the larger basidiospores dimension when compared to those observed in the species previously described for the genus. TABLE 2 shows a comparison between the spore dimensions of the holotype designated by Rick and other collections observed.

TABLE 2. Comparison between the spore dimensions of *Scytinopogon robustus*.

Author	Size in µm	Locality	Collection
Rick (1959)	4.0–5.0 × 3.4	Brazil (Parecí Novo, RS)	PACA12457
Corner (1970)	5.0–7.0 × 3.5–5.0	Brazil (Niterói, RJ)	Corner 948
Furtado & Neves	6.0–7.0(–8.0) × 3.5–4.0(–5.0)	Brazil (Parecí Novo, RS)	PACA12457
Furtado & Neves	6.0–6.5 × 3.5–4.0	Brazil (Florianópolis, SC)	ANMF 422

It is possible to observe the spore size variation between the spore measurements made by Corner and the ones presented in this study and those made by Rick. This discrepancy could be explained if Rick measured basidiospores from young basidiomes or due to the low quality of the equipment used by Rick.

Scytinopogon angulisporus is a widespread species that has similar basidiomes, but differs by the spore size, (4.5–) 5.5–7.0 × (2.5–) 3.5–4.0 (–4.5) µm, and the uninflated hyphae (up to 10 µm wide, occasionally) (Corner 1950, 1970; García-Sandoval et al. 2004).

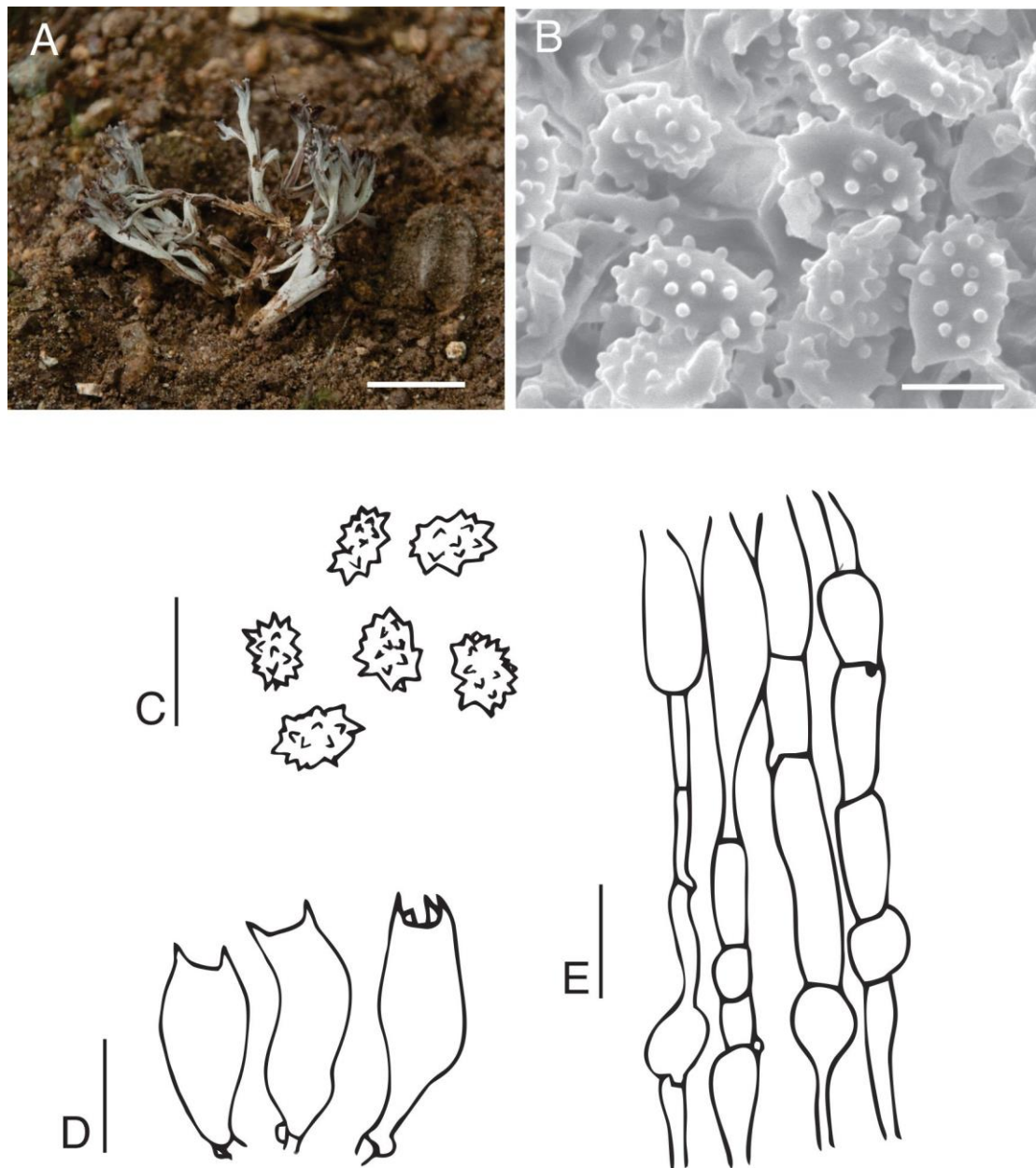


FIGURE 6. *Scytinopogon robustus* (PACA 12457; ANMF 422). **A.** Photographs of basidiomes in the field. **B.** SEM photographs of the basidiospores. **C.** Microcharacteres of basidiospores. **D.** Basidia and **E.** Context hyphae of the basidiomes with narrower and inflated hyphae. Bar (A) = 1.0 cm, (B) = 5.0 μm and (C–E) = 10 μm .

Clavaria Vaill. ex Linnaeus (1753: 1182)
= *Clavulinopsis amoena* (Zoll. & Moritzi) Corner (1950: 352)

Clava simplex, flavida. Ad terram (Rick on herbarium specimen label).

BASIDIOSPORES (Fig. 7a) 7.0–9.0 \times 7.0–8.5 μm (Q=1.04), hyaline or pale yellowish, smooth, globose, with a large guttula, inamyloid; hilar appendage up to 1.0 μm . **BASIDIA** (Fig. 7b) 46–93 \times 8.0–11 μm , longer in old hymenia, clavate-elongated, bi- or tetraspored, mostly tetraspored, 9.0–12 μm long, clamped.

CYSTIDIA absent. HYMENIUM 40–70 μm thick, thickening upwards up to 280 μm , not covering the stipe. SUBHYMENIUM composed at first of narrow short-celled hyphae, 2.0–3.5 μm wide, gradually inflating, 6.0–16 μm wide. TRAMA subparallel, thin-walled, pale orange walls in the context hyphae, inflated, 12–15 μm wide, interweaving with few, narrow, small inflated hyphae, 2.0–4.0 μm wide, shorter near the subhymenium, binding them together; clamps abundant.

Habitat and distribution:—Growing on the ground, in shady areas of the forest. Australia, Bolivia, Bonin Island, Brazil, Ceylon, Japan, Java, Malaysia, Panama, Peru (Corner 1950, 1970), China, Phillipines and Singapore (Petersen 1968).

Material examined:—BRAZIL. Rio Grande do Sul: Nova Petrópolis, 1923, J.E. Rick (BPI 294820, as *Clavaria* sp.).

Additional materials examined:—USA. Pennsylvania: Pocono, 1931, C.B. Stifler (BPI 293702, as *Clavaria aurantiocinnabarina* f. *amoena*); MALAYSIA. Sabah: Kota Kinabalu, 20 Apr 1964, E.J.H. Corner (BPI 294819), *ibid.*, 03 May 1964, E.J.H. Corner (BPI 294817); SOLOMON ISLAND. Guadalcanal: Popomanasia, 26 May 1965, E.J.H. Corner (BPI 294816).

Remarks:—Rick identified this collection as belonging to *Clavaria* due to its clavarioid unbranched basidiome. However, the evident presence of clamps in the basidia and in the context hyphae places this collection in *Clavulinopsis*.

Even though there is not a detailed macroscopic description for this specimen *Clavulinopsis amoena* can be easily identified by the short white-villous or strigose stipe (Corner 1950), the globose basidiospores with a guttula that becomes intense greenish-yellow at maturity (Corner 1967), and the small orange granules in the subhymenial hyphae that become green with iodine (Petersen 1968).

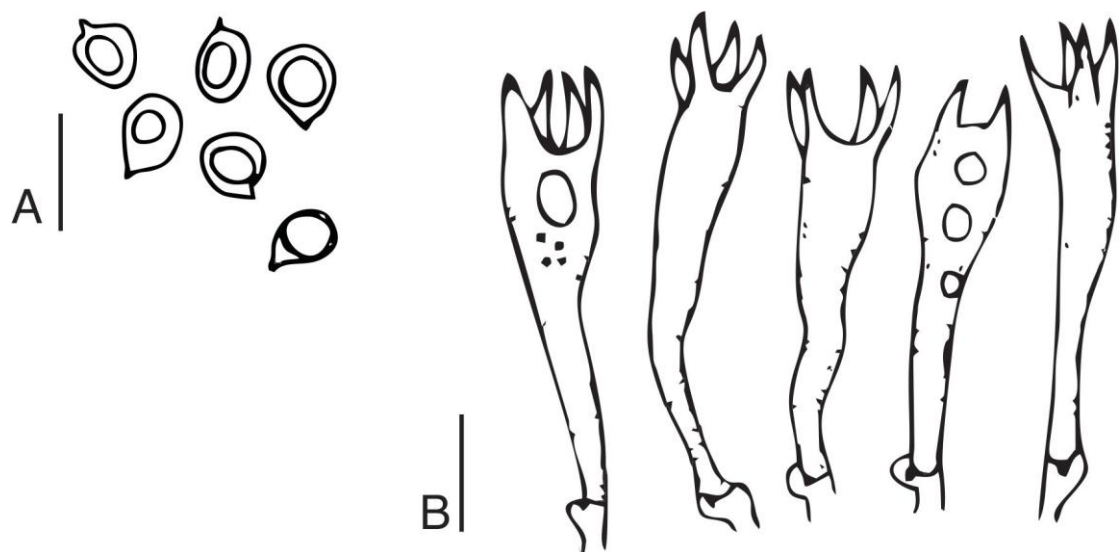


FIGURE 7. *Clavulinopsis amoena* (BPI 294820). **A.** Microcharacteres of basidiospores and **B.** Basidia. Bar = 10 μm .

Lachnocladium cartilagineum Berkeley & M.A. Curtis (1869: 330)
= *Ramariopsis kunzei* (Fr.) Corner (1950: 640)

Parvula, 2–5 cm alta, gracilis, alba; stipite pro rata longiusculo, 15 mm longo, 1 mm crasso, deorsum fuscescente, e basi incrassata usque 2 mm assurgente, applanato vel

canaliculato, abrupte in ramos 5–6 partito; ramis glaberrimis, simplicibus vel vix vertice parvissime ramosis, apicibus varie costatis. Sporis subglobosis, basi apiculate papilatis, 5–7 μ y, hyalinis. Ad terram (Rick 1959).

BASIDIOSPORES (Fig. 8a) $3.5\text{--}4.5 \times 3.0\text{--}4.0 \mu\text{m}$ ($Q=1.15$), hyaline, echinulate, subglobose, sometimes uniguttulate, inamyloid; hilar appendage up to $1.0 \mu\text{m}$. **BASIDIA** (Fig. 8b) $25\text{--}38 \times 4.0\text{--}7.0 \mu\text{m}$, bi- or tetraspored, mostly tetraspored, $4.0\text{--}5.0 \mu\text{m}$ long, clamped. **CYSTIDIA** absent. **HYMENIUM** $52.5 \mu\text{m}$ thick at first, thickening upwards to $120 \mu\text{m}$, absent on the stipe. **SUBHYMENIUM** well developed, coralloid, composed of narrow, closely interwoven hyphae up to $5.0 \mu\text{m}$ wide, not inflating,. **TRAMA** parallel, short-celled next to subhymenium, becoming broad in the middle, inflated, $12\text{--}15 \mu\text{m}$ wide.

Habitat and distribution:—Growing in forest and pastures, mostly terrestrial, occasionally on decayed wood. Brazil, Jamaica, Cuba (Corner 1950), Guadeloupe, Costa Rica, Panama, Colombia, Ceylon, Java, Borneo, Phillipines, New Zealand, Tibet, Solomons Island (Corner 1970).

Materials examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1927, *J.E. Rick* (BPI 332539, 332540; PACA 12460); *ibid.*, 1932, *J.E. Rick* (PACA 17221, 17225, 17235 as *Lachnocladium cartilagineum*).

Additional materials examined:—MALAYSIA. Sabah: Kinabalu, 21 Jan 1964, *E.J.H. Corner* (BPI 294906); SOLOMON ISLANDS. San Cristobal: Warahito River, 23 Jul 1965, *E.J.H. Corner* (BPI 294905).

Remarks:—Rick (1959) published these collections as *Lachnocladium cartilagineum* Berk & M.A. Curtis based on the whitish color of the basidiomes and on the spores dimensions. Even though the published description of this specimen and the description by Rick within the package have the dimensions of the basidiospores as being $5.0\text{--}7.0 \mu\text{m}$, the basidiospores from all collections are actually smaller ($3.5\text{--}4.5 \times 3.0\text{--}4.0 \mu\text{m}$), they are not smooth and apiculate as in *L. cartilagineum* and therefore the specimens were identified as *R. kunzei*. This species is very variable in size, shape and basidiospores size, however the stipe is always villous or tomentose and the dried basidiomes darken with potash (Corner 1950, 1970). *Ramariopsis kunzei* is widespread in tropical forests (Corner 1967).

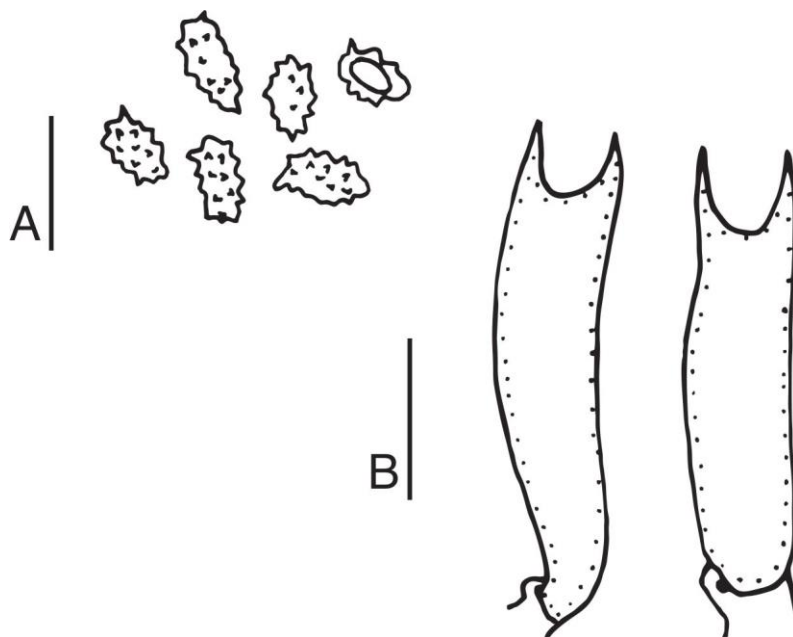


FIGURE 8. *Ramariopsis kunzei* (PACA 12460). **A.** Microcharacteres of basidiospores and **B.** Basidia. Bar = 10 μm .

Lachnocladium dubiosum Bresadola (1920: 50)
= *Scytinopogon dealbatus* (Berk.) Corner (1970: 89)

*Usque 4 cm altum latumque, plerumque depressum, ramis intricatis, undulantibus, hyalinis, incisis, cartilagineo-gelatinosis, varie curvulis divaricatisque, velutinis, compressis, siccis corneis. Sporis 4 \times 3 μm , echinatis, coloratis. Ad terram. A *L. cartilagineo* distinguitur quia magis gelatinosum, ramisque magis intricatis; forsano vero sunt identica (Rick 1931).*

BASIDIOSPORES (Fig. 9a) 4.0–4.5 \times 2.5–3.0 μm (Q=1.39), hyaline, echinulate, ellipsoid pip-shaped, inamyloid; hilar appendage up to 1.0 μm . **BASIDIA** (Fig. 9b) 21–29 \times 5.0–7.0 μm , clavate, bi- or tetraspored, 9.0–12 μm long, clamped. **CYSTIDIA** absent. **HYMENIUM** 40 μm thick at first, thickening upwards. **SUBHYMENIUM** up to 20 μm thick, short-celled, 4.0 μm wide. **TRAMA** parallel, 5.0–15 μm wide, slightly thick-walled, clamped, ampulliform hyphae present in the context, thin-walled, ampullate septa; agglutinating substance easily liberated when mounted in 5% KOH.

Habitat and distribution:—Growing on the ground of the forest. Brazil, Bolivia, Panama (Corner 1970), Venezuela (Petersen 1988).

Materials examined:—BRAZIL. Rio Grande do Sul: São Leopoldo, 1904, *J.E. Rick* (BPI 295129, PACA 17230, 17241, 17246, 17251, as *Lachnocladium dubiosum*), *ibid.*, 1907, *J.E. Rick* (BPI 295385, 333169, 333170, 333171) *ibid.*, 1932, *J.E. Rick* (BPI 295383).

Additional materials examined:—BRAZIL. Rio Grande do Sul: Panurê, São Jerônimo, 1873, *Spruce* (K 135803, 135804, holotype of *Clavaria dealbata*), *ibid.*, Mato Grosso: Chavantina, 01 Feb 1968, *E.J.H. Corner* (RBGE 101765); BRUNEI. 15 Feb 1959, *E.J.H. Corner* (K 69072, *Scytinopogon scaber*).

Remarks:—*Scytinopogon dealbatus* looks similar to a young basidiome of *Scytinopogon scaber* (Berk. & M.A. Curtis) D.A. Reid but it does not have the erect habit and the papillae on the branches (Petersen 1988).

Scytinopogon dealbatus can also be compared with *S. angulisporus* differing by the applanate branches, the presence of a mycelium at the base of the stipe and ellipsoid, angular-echinulate basidiospores, and the uninflated and the total absence of agglutination on the hyphae trama when mounted in 5% KOH present in *S. angulisporus* (Corner 1950).

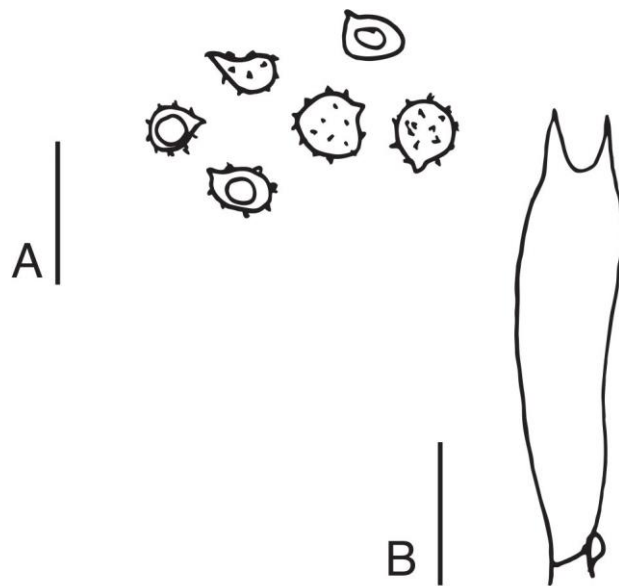


FIGURE 9. *Scytinopogon dealbatus* (PACA 17230). **A.** Microcharacteres of basidiospores and **B.** Basidia. Bar = 10 μ m.

Excluded species

Clavaria parallela Rick (1931: 118)

Clava tenuis, 2 cm alta, ramis parallelis, perpendicularibus, longis, paucis laxisque, albis, in sicco flavescentibus, glabris. Mycelio albofilamentoso, frustula amplexente. Ad terram. *Cl. epichnoe* et *C. candelabrum* Mass. affinis (Rick 1931).

Remarks:—The type is apparently lost and although the protologue has been published, there is no sampling location and collection cited. In the description, Rick wrote that his collection was near *Artomyces candelabrus* (Massee) Jülich (= *Clavaria candelabrum* Massee) and *Lentaria epichnoa* (Fr.) Corner (= *Clavaria epichnoa* Fr.), as they were identified under *Clavaria* Vaill. ex. L.. The specimen is not represented at Naturhistoriska Riksmuseet herbarium, in Bresadola, Rehm and Sydow collections, with whom Rick corresponded. For the present, therefore, it is necessary to regard them as lost.

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