

Ariadne Nóbrega Marinho Furtado

**DIVERSIDADE DE CLAVARIACEAE CHEVALLIER
(AGARICALES) NA MATA ATLÂNTICA BRASILEIRA**

Dissertação submetida ao Programa de Pós-graduação em Biologia de Fungos, Algas e Plantas da Universidade Federal de Santa Catarina para a obtenção do Grau de Mestre em Biologia de Fungos, Algas e Plantas.

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Clavulinopsis laeticolor (Berk. & M.A. Curtis) R.H. Petersen por Marisa di Paola

Clavaria

Do lado dado
nas encostas da terra
um coral sem oceano.
(Cauê Oliveira, 2014, não publicado)

RESUMO

Clavariaceae Chevallier contém aproximadamente 120 espécies descritas, e embora acredite-se que sua maior diversidade pode ser encontrada em regiões tropicais e subtropicais, os estudos com o táxon para essas áreas ainda são escassos. Com o objetivo de ampliar o conhecimento acerca da diversidade e distribuição de Clavariaceae, foi realizado um estudo taxonômico morfológico a partir de coletas realizadas na Mata Atlântica brasileira. Vinte e um táxons foram identificados em quatro gêneros: *Clavaria* (Ca.), *Clavulinopsis* (Cs.), *Ramariopsis* e *Scytinopogon*. *Clavaria fumosa*, *Clavaria gibbsiae* e *Clavulinopsis helvola* são registradas pela primeira vez para o Brasil. *Clavaria diverticulata*, *Clavulinopsis dimorphica*, *Clavulinopsis imperata*, *Scytinopogon caulocystidiatus* e *S. foetidus* são descritos como novos táxons para a ciência. Para todos os táxons são apresentadas fotografias dos basidiomas em campo, descrições macro e micromorfológicas completas, com ilustrações e fotos de microscopia eletrônica de varredura (MEV) dos basidiósporos ornamentados. Os clavarioides da coleção *Fungi Rickiani* do herbário PACA, e as coleções do Pe. Johannes Rick do BPI foram revisados e onze táxons são apresentados e ilustrados. A partir dos resultados obtidos nesse estudo, pode-se afirmar que a diversidade de Clavariaceae ainda é subestimada na Mata Atlântica brasileira. A ampliação dos estudos morfológicos integrados com dados ecológicos e filogenéticos possibilitarão uma melhor compreensão das relações inter e infragenéricas dentro da família.

Palavras-chave: Agaricomycetes. Taxonomia. Região subtropical.

ABSTRACT

Clavariaceae Chevallier encompasses nearly 120 species, and although it is believed that the greatest diversity can be found in tropical and subtropical regions, there are few studies with the taxon for these areas. In order to increase the knowledge of Clavariaceae diversity and distribution, a taxonomic study from collections from the Brazilian Atlantic Forest was made. Twenty-one taxa were identified in four genera: *Clavaria* (*Ca.*), *Clavulinopsis* (*Cs.*), *Ramariopsis* and *Scytinopogon*. *Clavaria fumosa*, *Ca. gibbsiae* and *Clavulinopsis helvola* are recorded for the first time from Brazil. *Clavaria diverticulata*, *Clavulinopsis dimorphica*, *Cs. imperata*, *Scytinopogon caulocystidiatus* and *S. foetidus* are described as new taxa for science. Images of the basidiomes in the field, illustrations of the microscopic characters, scanning electron microscopy (SEM) of ornamented basidiospores and full descriptions are presented for all the taxa. The *Fungi Rickiani* collection at PACA and Johannes Rick's collections at BPI were reviewed and eleven taxa are presented and illustrated. From the results obtained in this study, we can assert that the diversity of Clavariaceae in the Brazilian Atlantic Forest is underestimated. The expansion of morphological studies, integrated with ecological and phylogenetic data will allow a better understanding of inter and infrageneric relationships within Clavariaceae.

Keywords: Agaricomycetes. Taxonomy. Subtropical region.

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1 INTRODUÇÃO

1.1 CARACTERIZAÇÃO DE CLAVARIACEAE

Clavariaceae Chevallier inclui espécies com basidiomas cilíndricos, clavados, coraloides, hidnoides-pendentes, ressupinados, estipitado-lamelares, com himenóforo liso e completamente exposto, lamelar ou poroide (Hibbett & Thorn 2001; Birkebak et al. 2013). Quando comparada a outras famílias de Agaricales, Clavariaceae apresenta poucos caracteres diagnósticos que auxiliam na delimitação da família. Porém, esta a família é tradicionalmente definida por características morfológicas, tais como: morfologia do basidioma, disposição do himênio no mesmo, reações de coloração dos basidiomas quando lesionados ou em resposta a produtos químicos [p. ex. hidróxido de potássio (KOH) e sulfato ferroso (FeSO₄)], estrutura do sistema hifal, presença de fibulas, coloração e morfologia dos esporos (Corner 1970; Bononi 1979).

Considerando os representantes clavarioides da família, estes podem apresentar os basidiomas eretos, ramificados ou simples, solitários, gregários ou cespitosos, de coloração desde branca ou creme até cores mais vibrantes como vermelho, laranja ou roxo (Dentinger & McLaughlin 2006). Os esporos podem ser globosos, subglobosos, oblongos, elipsoides ou alongados, hialinos ou com conteúdo amarelado ou rosa-claro, não amiloides, geralmente gutulados, lisos ou equinulados (Corner 1950).

Clavaria Vaill. ex. L está subdividida em dois subgêneros, *Clavaria* subg. *Clavaria* Corner que inclui espécies afibuladas, e *Clavaria* subg. *Holocoryne* Corner, no qual as fibulas estão ausentes na trama hifal, mas presentes na base dos basídios, conferindo um aspecto bifurcado. *Clavulinopsis* Overeem é caracterizado principalmente pela presença de fibulas, tanto nos basídios quanto na trama hifal (Petersen 1978), e está subdividido em três subgêneros: *Clavulinopsis* subg. *Acularia* Corner, que inclui espécies com esporos ornamentados; *Clavulinopsis* subg. *Clavulinopsis* Corner, que inclui espécies com esporos globosos a subglobosos, com apêndice hilar curto (0.5–1.0 µm de comprimento) e, se elipsoides, com apêndice hilar proeminente (1.0–2.0 µm de comprimento); e *Clavulinopsis* subg. *Paraclavaria* Corner com espécies de esporos elipsoides e também apêndice hilar curto (0.3–1.0 µm de comprimento) (Petersen 1969).

Ramariopsis (Donk) Corner e *Scytinopogon* Singer são limitados a espécies com basidiomas ramificados, com hifas fibuladas, e esporos equinulados (Pegler & Young 1985; Corner 1950). *Scytinopogon* diferencia-se por apresentar basidiomas teleforoides, com himenóforo frequentemente unilateral e esporos angulosos.

1.2 SISTEMÁTICA E CLASSIFICAÇÃO

Inicialmente, todos os fungos que apresentavam morfologia clavarióide, ou seja, espécies com basidiomas saprofíticos, terrestres, clavados ou ramificado e com himenóforo anfigeno foram inseridos no gênero *Clavaria* (Rea 1922), de posição taxonômica incerta. Em 1826 Chevallier propôs a criação de Clavariaceae, dentro da grande ordem polifilética Aphyllophorales Rea.

Corner (1950) realizou o trabalho mais significativo para a família, *A monograph of Clavaria and allied genera*, no qual foi estudado um total de 540 espécies distribuídas em 27 gêneros. Corner separou estes 27 gêneros em 6 séries e mais um gênero distinto, *Clavicornia* Doty, levando em conta caracteres hifais como a presença de hifas infladas, dichifídios e fíbulas.

Donk (1964), optando por uma classificação mais natural para a ordem Aphyllophorales, propôs 21 novas famílias com gêneros clavarióides, hidnóides, estereóides e poliporóides, e reconheceu 18 gêneros em Clavariaceae, subdividindo-a em duas subfamílias usando como critério o tipo do sistema hifal: *Clavarioidea* S.F. Gray acomodando os fungos com sistema hifal monomítico; e *Pteruloidea* Donk incluindo os fungos com sistema hifal dimítico.

No suplemento do trabalho de 1950, Corner (1970) adotou a classificação modificada de Donk para Aphyllophorales, reconhecendo 12 famílias com 38 gêneros clavarióides e Clavariaceae contendo apenas 4 gêneros: *Clavaria*, *Clavulinopsis*, *Ramariopsis* e *Scytinopogon* Singer, cuja diferenciação principal estava relacionada ao padrão de ramificação do basidioma, à presença de fíbulas e à ornamentação da parede dos esporos.

Petersen (1978), baseado em três caracteres – comprimento do apêndice hilar, presença de pigmentos carotenóides e reação do himênio a sais ferrosos – criou uma nova classificação para Clavariaceae, com a proposição de subgêneros para os gêneros já existentes porém, com a dissolução do gênero *Clavulinopsis* e redistribuição de seus

representantes entre os demais. Aquelas espécies de *Clavulinopsis* que apresentavam apêndice hilar curto, pigmentos carotenoides presentes e reação negativa aos sais ferrosos, passaram a ser classificadas dentro de *Clavaria*, subgênero *Clavulinopsis* (van Ovreem) Petersen. As espécies de *Clavulinopsis* com apêndice hilar longo, pigmentos carotenoides ausentes e reação positiva aos sais de ferro, passaram a ser classificadas dentro de *Ramariopsis*, subgênero *Donkella* (Doty) Petersen.

Várias análises moleculares têm demonstrado que a morfologia clavarioide constitui um caráter homoplásico (Pine et al. 1999; Moncalvo et al. 2002) e que existem transições frequentes entre as morfologias clavarioides, agaricoides (Hibbett 2004) e corticioides (Hibbett & Binder 2002; Larsson et al. 2004, Binder et al. 2005), de tal forma que representantes clavarioides podem ser encontrados distribuídos em 12 ordens distintas dentro de Agaricomycetes: Auriculariales J. Schröt, Sebaciniales M. Weiss, Selosse, Rexer, A. Urb. & Oberw., Cantharellales Gäum, Geastrales K. Hosaka & Castellano, Gomphales Jülich, Hysterangiales K. Hosaka & Castellano, Phallales E. Fisch., Hymenochaetales Oberw., Polyporales Gäum, Thelephorales Corner ex Oberw., Russulales Kreisel ex P.M. Kirk, P.F. Cannon & J.C. David e Agaricales Underw. (Hibbett et al. 2007).

Estudos moleculares recentes têm alterado a circunscrição da família Clavariaceae permitindo uma melhor resolução filogenética. Um dos trabalhos mais significativos sobre a filogenia molecular da família é o de Dentinger & McLaughlin (2006), que propõe uma reconstrução da filogenia de Clavariaceae baseada em análises da subunidade maior do DNA ribossomal rejeitando o trabalho de Petersen (1978) que propunha a exclusão do gênero *Clavulinopsis*.

Trabalhos posteriores (Matheny et al., 2006; Larsson, 2007) demonstraram que o gênero pileado-lamelar *Camarophylloopsis* Herink e o ressupinado *Hyphodontiella* Å Strid, pertencem a Clavariaceae ao invés de Hygrophoraceae Lotsy e Hyphodermataceae Jülich, respectivamente, como havia sido proposto por Arnolds (1986), Boertmann (2002) e Hesler & Smith (1963). Birkebak et al. (2013) fizeram uma abordagem filogenética, morfológica e ecológica da família discutindo a monofilia de Clavariaceae e incluindo os gêneros *Camarophylloopsis*, *Clavaria*, *Clavicornia*, *Clavulinopsis*, *Hyphodontiella*, *Mucronella* Fr. e *Ramariopsis*.

Atualmente Clavariaceae inclui 120 espécies distribuídas em sete gêneros: *Camarophylloopsis*, *Clavaria*, *Clavulinopsis*,

Hyphodontiella, *Mucronella*, *Ramariopsis* e *Scytinopogon* (Kirk et al. 2008).

1.3 ASPECTOS ECOLÓGICOS

Assim como outros fungos, os clavarioides atuam diretamente na dinâmica de comunidades, principalmente pelo seu papel na decomposição, mineralização e mobilização de nutrientes importantes para o ambiente (Blackwell et al. 2006).

Os fungos clavarioides apresentam ampla distribuição mundial e adotaram diversas formas nutricionais (Rinaldi et al. 2008; Tedersoo et al. 2010). Estudos feitos a partir de evidências sorológicas e morfológicas a respeito do modo de nutrição de Clavariaceae apontaram para uma possível associação simbiótica de *Clavaria* com espécies de Ericaceae (Seviour et al. 1973, Englander & Hull 1980, Tedersoo et al. 2010), porém essa hipótese ainda não foi confirmada.

Birkebak et al. (2013), a partir de uma análise combinada de isótopos estáveis com dados ambientais, sugeriram que a maioria das espécies não-lignícolas de Clavariaceae apresentam preferência pelo modo de nutrição biotrófico e que, juntamente com Hygrophoraceae, teriam diversificado este modo de nutrição a partir de um status nutricional prévio ainda desconhecido (Griffith et al. 2002; Tedersoo et al. 2010).

1.4 DISTRIBUIÇÃO DE CLAVARIACEAE

A maioria dos estudos morfológicos e filogenéticos de Clavariaceae está baseada em espécimes da América do Norte e regiões temperadas da Europa e da Ásia (Burt 1922; Coker 1923; Corner 1950, 1953, 1966a, 1966b, 1967a, 1967b, 1970; Thind 1961; Thind & Rattan 1967; Petersen 1965, 1967, 1968, 1975, 1988; García-Sandoval et al. 2004, 2005; Dentinger & McLaughlin 2006; Shiryayev 2009; Dutta et al. 2012; Kautmanová et al. 2012; Olariaga et al. 2014). Uma vez que se acredita na existência de maior diversidade da família nas regiões tropicais e subtropicais (Corner 1950), torna-se necessário um estudo aprofundado acerca grupo e a inclusão de exemplares dessas áreas nas abordagens moleculares e filogenéticas.

No Brasil, o estudo de Clavariaceae é bastante escasso em comparação a outros países do hemisfério norte. Os trabalhos mais

significativos para o país foram feitos para a Amazônia por Corner (1950) e Singer (1959), e para a Mata Atlântica por Rick (1959, no Rio Grande do Sul e Santa Catarina), Bononi (1979, em São Paulo) e de Meijer (2006, 2008, no Paraná).

Segundo a Lista de Espécies da Flora do Brasil (Capelari et al., 2013) e o levantamento bibliográfico realizado durante este trabalho, existem vinte e cinco táxons de Clavariaceae registrados para o país, distribuídos em cinco gêneros. (Tabela 1).

Tabela 1 – Táxons de Clavariaceae registrados para o Brasil.

Táxon	UF	Referências
<i>Ca. fragilis</i> Holmsk.	PR	Meijer (2006)
<i>Ca. helicoides</i> Pat. & Demange	RS	Bononi et al. (1981)
<i>Ca. lilacina</i> Jungh.	RS	Rick (1959)
<i>Ca. neofossicola</i> Corner	SP	Bononi et al. (1981);
	MT	Corner (1970)
<i>Ca. paralela</i> Rick*	RS	Rick (1959)
<i>Ca. subglobosa</i> (= <i>Ca. rosea</i> var. <i>subglobosa</i> Corner)	RJ	Corner (1967a)
<i>Ca. seminicola</i> Henn.	SC	Corner (1950)
<i>Ca. verpiformis</i> Berk. & Cooke	AM	Corner (1950)
<i>Ca. zollingeri</i> Lév.	PR	Meijer (2006);
	SP	Bononi et al. (1981)
<i>Clavulinopsis amoena</i> (Zoll. & Moritz) Corner	AM	Corner (1970);
	RS	Rick (1923);
<i>Cs. aurantiocinnabarina</i> (Schwein.) Corner	PR	Meijer (2006)
<i>Cs. carneola</i> Corner	SP	Corner (1970)
<i>Cs. corniculata</i> (Schaeff.) Corner	MT	Corner (1970);
	PR	Meijer (2006);
	RS	Rick (1959)
<i>Cs. depokensis</i> (Overeem) Corner	PR	Meijer (2006)
<i>Cs. laeticolor</i> (Berk. & M.A. Curtis) R.H. Petersen	RS	Rick (1959), como <i>Clavaria inaequalis</i> ; Corner (1950)
<i>Cs. spiralis</i> (Jungh.) Corner	PR	Meijer (2006)
<i>Mucronella calva</i> (Alb. & Schwein.) Fr.	AC e	Capelari & Maziero (1956);
	RO	
	SP	Bononi (1979)
<i>Ramariopsis crocea</i> (Pers.) Corner	RS	Rick (1959)
<i>R. kunzei</i> (Fr.) Corner	PR	Meijer (2006);
	RS	Rick (1959)
<i>R. pulchella</i> (Boud.) Corner	RJ	Corner (1970)

Tabela 1 – Continuação.

Táxon	UF	Referências
<i>Scytinopogon angulisporus</i> (Pat.) Corner	MT	Corner (1953);
	PA	Corner (1966b);
	PR	Meijer (2006);
	RJ	Corner (1970);
	RS	Rick (1959)
<i>S. chartaceum</i> (Pat.) R.H. Petersen	SP	Patouillard (1907)
<i>S. dealbatus</i> (Berk.) Corner	MT	Corner (1970);
	PR	Meijer (2006);
	RS	Rick (1959);
	SP	Petersen (1988)
<i>S. robustus</i> (Rick) Corner	PR	Meijer (2006);
	RJ	Corner (1970);
	RS	Rick (1959)
<i>S. scaber</i> (Berk. & M.A. Curtis) D.A. Reid	AM	Corner (1970)

* *Clavaria parallela* Rick apresenta registro apenas para a localidade tipo, e, embora o dado esteja publicado, o tipo não foi encontrado. Comentários adicionais são apresentados no Capítulo 2.

1.5 OBJETIVOS

O objetivo principal do presente trabalho foi ampliar o conhecimento da diversidade de Clavariaceae em áreas de Mata Atlântica brasileira através de uma abordagem morfológica, levantamento bibliográfico, estudo de materiais de herbários, novas coletas, identificação e registro de novas espécies.

Embora Clavariaceae seja uma família com basidiomas de diversas morfologias, como o táxon estipitado-pileado *Camarophyllopsis* e o cortícioide *Hyphodontiella*, este trabalho teve como objetivo abordar apenas os cinco gêneros com morfologia clavarióide: *Clavaria* (Ca.), *Clavulinopsis* (Cs.), *Mucronella*, *Ramariopsis* e *Scytinopogon*.

2 MÁTERIAL E MÉTODOS

2.1 CLASSIFICAÇÃO TAXONÔMICA ADOTADA

Embora Birkebak et al. (2013) tenham apresentado dados que comprovem a monofilia de Clavariaceae com a inclusão de *Clavicornona* e exclusão de *Scytinopogon*, a classificação adotada neste trabalho segue Corner (1950, 1970), García-Sandoval et al. (2004, 2005), Kirk et al. (2008) e Kautmanová et al. (2012). Estes autores excluem *Clavicornona* da circunscrição da família devido à combinação de caracteres que o diferencia dos demais táxons de Clavariaceae: presença de pseudocistídios, ápices truncados e cristatos e a diferenciação do himênio a partir de uma superfície superior estéril. Por outro lado, *Scytinopogon* é incluído na família, pois as hipóteses filogenéticas apresentadas por Birkebak et al. (2013) não incluíram a espécie tipo, *S. pallescens* (Pat.) Singer, e utilizaram apenas uma sequência de *Scytinopogon angulisporus* (Pat.) Singer para a construção da árvore filogenética.

2.2 COLETAS E ÁREA DE COLETA

Durante as coletas foram feitos registros fotográficos do hábito e de detalhes dos basidiomas, além de anotações de dados ecológicos, como hábito (solitário, gregário, cespitoso), substrato (solo, madeira, húmus, serrapilheira), bem como as coordenadas geográficas através do *Global Position System* (GPS). As coletas foram realizadas de acordo com os métodos modificados de Muller et al. (2004). A amostragem foi feita a partir de coletas aleatórias pelas trilhas que apresentaram condições favoráveis ao desenvolvimento dos basidiomas.

Depois de descritos macroscopicamente, os espécimes foram desidratados em uma secadora de frutas (Total Chef TCFD-05 Deluxe), que permite a circulação do ar a uma temperatura de aproximadamente 40°C, onde permaneceram cerca de 24 horas, ou até sua completa desidratação. Depois de desidratados, os espécimes foram acondicionados com etiquetas contendo dados do coletor e coleta, e foram levados ao freezer, onde ficaram por um período de sete dias para a eliminação de eventuais larvas e ovos de insetos que possam ter resistido à desidratação, ou algum mofo.

As coletas foram realizadas em áreas de Mata Atlântica, entre

os períodos de mar./2011 e ago./2014, nos estados do Espírito Santo, Minas Gerais, Paraíba, Paraná, Rio Grande do Sul, Santa Catarina e São Paulo (Tabela 2). As coletas foram apoiadas pelo Laboratório de Micologia (MICOLAB/UFSC) ou foram realizadas por colegas, incluindo Altielys Casale Magnago, Celeste Heisecke, Eduardo Perez Fazolino, Jaime Duque, Larissa Trierweiler-Pereira e Raquel Friedrich.

Tabela 2 – Localidade das coletas.

UF	Cidade	Localidade
ES	Alfredo Chaves	Morro da Caixa d'Água
ES	Santa Tereza	Reserva Biológica Augusto Ruschi
MG	Virginópolis	Fazenda da Canga
MG	Santa Bárbara	RPPN do Caraça
PB	João Pessoa	Universidade Federal da Paraíba
PR	Piraquara	Piraquara
PR	Matinhos	-
RS	Porto Alegre	Universidade Federal do Rio Grande do Sul, Campus do Vale
RS	São Francisco de Paula	Floresta Nacional de São Francisco de Paula
SC	Águas Mornas	Sítio Portal
SC	Anitápolis	Sítio Passargada
SC	Concordia	Parque Estadual Fritz Plaumann
SC	Corupá	RPPN Emília Fiorentino Battistella
SC	Florianópolis	Costão do Santinho; Ilha do Campeche; Morro da Lagoa; Parque Municipal da Lagoa do Peri; Parque Municipal das Dunas da Lagoa da Conceição; Unidade de Conservação Ambiental Desterro; Universidade Federal de Santa Catarina/USFC - <i>Campus</i> da Trindade; Trilha para Lagoinha do Leste; Trilha para Naufragados
SC	Joinville	Vale do Pirai
SC	Itapoá	Reserva Volta Velha
SC	Santo Amaro da Imperatriz	Hotel Plaza Caldas da Imperatriz; Trilha da Cachoeira; Trilha da Pousada
SC	São Francisco do Sul	Parque Estadual do Acaraí
SC	Urubici	Parque Nacional de São Joaquim/PARNA-SJ
SP	São Paulo	Parque de Água Branca

2.3 ANÁLISE MORFOLÓGICA

As descrições macro e micromorfológicas dos basidiomas seguiram os métodos e nomenclatura de Corner (1947), Largent et al. (1977) e Vellinga & Noordeloos (2001). As descrições macroscópicas foram realizadas a partir do material fresco logo após as coletas. Os códigos de cores (p.ex., 2B19) seguiram Kornerup & Wanscher (1978).

Para as descrições microscópicas foram realizados cortes longitudinais, à mão livre, dos basidiomas, com auxílio de lâminas de aço de barbear descartáveis sob estereomicroscópio. Os cortes foram montados em lâminas contendo os seguintes compostos: água, hidróxido de potássio (KOH) 3%, reagente de Melzer, ou vermelho Congo, para observação de diferentes características morfológicas e possíveis reações. As estruturas microscópicas foram observadas e medidas ao microscópio óptico (OLYMPUS CX21), com auxílio de uma régua micrométrica acoplada a ocular, na objetiva de imersão (100×), alcançando o aumento total de 1000 vezes. As medidas foram realizadas em uma solução de vermelho Congo e KOH 3%. Para cada microestrutura foram realizadas 25 medições. Para os basidiósporos, foi calculado o quociente comprimento/largura, indicado por Q nas descrições (Largent et al. 1977).

As análises de Microscopia Eletrônica de Varredura (MEV) foram realizadas no Laboratório Central de Microscopia Eletrônica da UFSC (LCME-UFSC). Foram retirados fragmentos do himenóforo e montados sobre uma fita adesiva de carbono em *stubs* de alumínio e banhados por uma camada de 30 nm de ouro, e observados em Microscópio Eletrônico de Varredura a 10KeV.

Os desenhos de microscopia foram realizados à mão livre a partir de imagens digitais dos materiais em estudo.

Os espécimes identificados foram depositados no herbário FLOR (Departamento de Botânica, Universidade Federal de Santa Catarina, SC).

2.4 ESTUDO DE MATERIAIS DE HERBÁRIOS

Foram realizadas visitas e pedidos de empréstimo de materiais dos seguintes herbários: BPI, FLOR, INPA, JPB, K, MBM, PACA, RGBE e URM. Quando as exsicatas não puderam ser emprestadas, a análise comparativa foi realizada, quando possível, a partir dos dados

disponíveis no banco de dados dos herbários.

A análise dos materiais seguiu as normas e procedimentos estabelecidos pela instituição fornecedora do empréstimo e com base nos métodos descritos na seção anterior. Os acrônimos dos herbários estão de acordo com Thiers (atualizado continuamente).

3 RESULTADOS

Foram coletados 192 espécimes, dos quais cinquenta e cinco correspondem a representantes de Clavariaceae, distribuídos em quatro gêneros: *Clavaria* (6 spp.), *Clavulinopsis* (7 spp.), *Ramariopsis* (1 sp.), *Scytinopogon* (7 spp.) (Tabela 3). Dos vinte e um táxons identificados, três táxons são novos registros para Brasil e onze para o estado de Santa Catarina. Cinco táxons são descritos pela primeira vez para a ciência.

Tabela 3 – Táxons de Clavariaceae identificados durante a realização deste trabalho.

Táxons	Nº de Coletor	UF
<i>Clavaria diverticulata</i> sp. nov.	ACM 1044	RS
<i>Ca. fragilis</i>	ACM 1041	RS
* <i>Ca. fumosa</i>	ACM 598	SC
* <i>Ca. gibbsiae</i>	ANMF 363, 458, 484	SC
	ACM 910	PR
<i>Ca. subglobosa</i> stat. nov.	MAN 732	SC
<i>Ca. zollingeri</i>	ANMF 365, 391, 499	SC
	ACM 1039, 1043	RS
<i>Clavulinopsis amoena</i>	KEL 21	SC
<i>Cs. aurantiocinnabarina</i>	ANMF 382	SC
<i>Cs. dimorphica</i> sp. nov.	ACM 1051	RS
* <i>Cs. helvola</i>	KEL 34	SC
<i>Cs. imperata</i> sp. nov.	ANMF 482	SC
<i>Cs. laeticolor</i>	ACM 911	PR
	ANMF 315, 316, 364, 385, 440, 494, 495; CHC 201; DS 1085; FMF 242; J.DUQUE 71; KEL 33	SC
	ACM 1052, 1054	RS
<i>Cs. spiralis</i>	ANMF 301; MAN 1077	SC
<i>Ramariopsis kunzei</i>	ACM 595, 596	SC
<i>Scytinopogon angulisporus</i>	ANMF 304, 441, 488; ACM 974; MAN 588	SC
<i>S. caulocystidiatus</i> sp. nov.	ANMF 460	SC
<i>S. chartaceum</i>	ANMF 504	SC
<i>S. dealbatus</i>	EPF 176, 177	RS
<i>S. foetida</i> sp. nov.	ANMF 423	SC
<i>S. robustus</i>	ANMF 422, 431	SC
<i>S. scaber</i>	ANMF 483	SC

*Novos registros para o Brasil

Os resultados deste trabalho estão apresentados em dois capítulos:

Capítulo I – *Fungi Rickiani: the Brazilian clavarioid collection at PACA and BPI herbaria*. Artigo a ser submetido para a Mycotaxon.

Capítulo II – *New records and distribution of Clavariaceae (Agaricales) from the Brazilian Atlantic forest*. Artigo a ser submetido para a Nova Hedwigia.

Capítulo I – Artigo

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

Ariadne N. M. Furtado & Maria Alice Neves

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

Ariadne N. M. Furtado & Maria Alice Neves

Abstract: Seventy-two clavarioid specimens from Johannes Rick's collection at PACA and BPI were revised. Eleven taxa are presented and illustrated. 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: Fungal taxonomy, morphology, Clavariaceae.

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), however, no figures were provided and the descriptions were incomplete for an adequate taxonomic identification.

Clavariaceae Chevall. accommodate 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 120 species distributed in seven genera, of which five are clavarioid: *Clavaria*, *Clavulinopsis*, *Mucronella*, *Ramariopsis* and *Scytinopogon* (Kirk et al. 2008; Kautmanová et al. 2012).

Many of the clavarioid fungi 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 on the literature, and in others the hymenium was completely eaten by insects or covered by mold. Most of Rick's collections can be found at PACA (Brazil), BPI, FH (USA), K (England) and S (Sweden) herbaria (Rick 1928; Fidalgo 1962).

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. Even though Rick was particularly careful and an 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).

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 herbaria 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 commented and illustrated. Specimens from INPA, JPB, K, MB, RBGE, URM herbaria were also studied as reference material.

Macro and micromorphological analyses were conducted at herbarium PACA (Instituto Anchieta 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. The spore measurements excluded the ornamentation (Corner 1947).

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 the recently collections were deposited at herbarium FLOR from the 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 taxa the original diagnosis written by Rick (1959) is presented. The nomenclature of the fungi was updated according the CABI and CBS databases. The herbaria acronyms follow Thiers (continuously updated).

Taxonomy

Clavariaceae Chevall. [as '*Clavariae*'], *Fl. gén. env. Paris* (Paris) 1: 102 (1826)

Clavulinopsis amoena (Zoll. & Moritzi) Corner, *Monograph of Clavaria and allied Genera (Annals of Botany Memoirs No. 1)*: 352 (1950)

(Fig 2AB)

Clava simplex, flavida. Ad terram.

BASIDIOSPORES 7.0–9.0 × 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 46–93 × 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. Stiffler* (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 – Even though there is not a detailed macroscopic description for this specimen the species 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).

Clavulinopsis laeticolor (Berk. & M.A. Curtis) R.H. Petersen, *Mycologia* 57(4): 522 (1965)

(Fig 2C)

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

BASIDIOSPORES 6.0–8.0 × 3.5–5.0 μm (Q=1.53), ellipsoid to pip-shaped, hyaline, smooth, uniguttulate, inamyloid; hilar appendage up to 1.5 μm, often sublateral. BASIDIA bi- or tetraspored, mostly tetraspored, clamped. CYSTIDIA absent. HYMENIUM 75 μm thick, thickening upwards, pale yellow (1A2), covering the upper part of the basidiomes. SUBHYMENIUM up to 30 μm thick, coralloid, tortuous, producing basidia in clusters. TRAMA subparallel, with hyphae of two different widths, the wider up to 10 μm wide, slightly inflated, and the narrower up to 3 μm 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 *Clavulinopsis helvola*).

Additional 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 Mai 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 has lead Rick to identify the specimen PACA 12443 as *Clavulinopsis helvola* (Pers.) Corner. However, *C. helvola* 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 deep orange, 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).

Ramariopsis crocea (Pers.) Corner, *Monograph of Clavaria and allied Genera (Annals of Botany Memoirs No. 1):* 638 (1950)

(Fig 2DE)

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 arctique adnato-obvolvente, saepius solitario, fere a basi 3–4-partito; ramis primariis longiusculis 2 cm longis, 3 mm crassis, apice 4–13-partitis; ramis secundariis 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 1906).

BASIDIOSPORES $4.0\text{--}4.5 \times 3.0\text{--}3.5 \mu\text{m}$ (Q=1.25), hyaline, echinulate, spiny scattered, broadly ellipsoid, sometimes uniguttulate, slightly dextrinoid; hilar appendage up to $1.0 \mu\text{m}$. BASIDIA $15\text{--}23 \times 4.0\text{--}6.0 \mu\text{m}$, bi- or tetraspored, mostly tetraspored, clamped. CYSTIDIA absent. HYMENIUM distinctly thickening upwards. SUBHYMENIUM up to

20 µm wide, coralloid, pseudoparenchymatic, composed of short-celled hyphae, 4.0–10 µm wide. TRAMA parallel, inflated and short-celled next to subhymenium, becoming broad in the middle, 6.0–23 µm 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 – 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 like the ones from *Ramariopsis pulchella* (Boud.) Corner, but *R. crocea* is white, while *R. pulchella* has bright violet basidiomes.

Ramariopsis kunzei (Fr.) Corner, *Monograph of Clavaria and allied Genera (Annals of Botany Memoirs No. 1)*: 640 (1950)

(Fig 2FG)

Parvula, 2–5 cm alta, gracilis, alba; stipite pro rata longiusculo, 15 mm longo, 1 mm crasso, deorsum fusciscente, e basi incrassata usque 2 mm assurgente, applanato vel canaliculato, abrupte in ramos 5–6 partito; ramis glaberrimis, simplicibus vel vix vertice parcissime ramosis, apicibus varie costatis. Sporis subglobosis, basi apiculate papilatis, 5–7 my, hyalinis. Ad terram (Rick 1959).

BASIDIOSPORES 3.5–4.5 × 3.0–4.0 µm (Q=1.15), hyaline, echinulate, subglobose, sometimes uniguttulate, inamyloid; hilar appendage up to 1.0 µm. BASIDIA 25–38 × 4.0–7.0 µm, bi- or tetraspored, mostly tetraspored, 4.0–5.0 µm long, clamped. CYSTIDIA absent. HYMENIUM 52.5 µm thick at first, thickening upwards to 120 µm, absent on the stipe. SUBHYMENIUM well developed, coralloid,

composed of narrow, closely interwoven hyphae up to 5.0 μm wide, not inflating. TRAMA parallel, short-celled next to subhymenium, becoming broad in the middle, inflated, 12–15 μm 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 *Clavulina cartilaginea*).

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 – Even though the published description of this specimen and the description by Rick within the package have the dimensions of the basidiospores as being 5.0–7.0 μm , the basidiospores are actually smaller (3.5–4.5 \times 3.0–4.0 μm) and therefore the specimen was identified as *R. kunzei*. This species is very variable in size, shape, color 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).

Ramariopsis (Donk) Corner, *Ann. Bot. Mem.* 1: 636, 700 (1950)

(Fig 2H)

Ad terram (Rick 1959).

BASIDIOSPORES 4.0–4.5 \times 3.0–4.0 μm (Q=1.25), hyaline, minutely echinulate, broadly ellipsoid, hilar appendage up to 1.0 μm , slightly dextrinoid. HYMENIUM stratified, 100 μm thick, distinctly thickening upwards. SUBHYMENIUM 62.5 μm thick, short, tortuous, clamped. TRAMA parallel, with clamped hyphae.

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

Remarks – Considering the branching pattern and the basidiospores morphology, this is a species of *Ramariopsis*. Petersen

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.

Scytinopogon angulisporus (Pat.) Corner, *Ann. Bot. Mem.* 1: 648 (1950)
(Fig 2IJ)

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

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

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 basidiospores 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 angulisporus*. The uninflated not mucilaginous hyphae, the flattened branches, and the hyaline, ellipsoid, angular-echinulate basidiospores observed in the specimens are diagnostic characteristics of *S. angulisporus* (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.

Scytinopogon dealbatus (Berk.) Corner, *Beih. Nova Hedwigia* 33: 89 (1970)

(Fig 2KL)

Usque 4 cm altum latumque, plerumque depressum, ramis intricatis, undulantibus, hyalinis, incis, cartilagineo-gelatinosis, varie curvulis divaricatisque, velutinis, compressis, siccis corneis. Sporis 4 × 3 my, echinatis, coloratis. Ad terram. A L. cartilagineo distinguitur quia magis gelatinosum, ramisque magis intricatis; forsan vero sunt identica (Rick 1906, 1924, 1928, 1931).

BASIDIOSPORES 4.0–4.5 × 2.5–3.0 μm (Q=1.39), hyaline, echinulate, ellipsoid pip-shaped, inamyloid; hilar appendage up to 1.0 μm. BASIDIA 21–29 × 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 as *Scytinopogon dubiosum*) *ibid.*, 1932, *J.E. Rick* (BPI 295383).

Additional materials examined – BRAZIL. Rio Grande do Sul: Panuré, 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 angular basidiospores, and the total absence of agglutination on the hyphae trama when mounted in 5% KOH (Corner 1950).

Scytinopogon robustus (Rick) Corner *Beih. Nova Hedwigia* 33: 91 (1970)

(Figs 1A, 3ABC)

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, incisus; consistentia carnosus. Ad terram in silvis. Sporis 4–5 × 3.4 my, echinatis, subcoloratis (Rick 1931).

BASIDIOSPORES 6.0–7.0(–8.0) × 3.5–4.0(–5.0) μm (Q=1.58), hyaline, angular-ellipsoid, diverticulate to more or less echinulate, inamyloid; hilar appendage obscured by basidiospore ornamentation. BASIDIA 22–31 × 7.0–10 μm, clavate, short, bi- or tetraspored, mostly tetraspored, 3.0–5.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 30 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 composed of subparallel hyphae, 6.0–23 μm wide, clamped, thin-walled, slightly constricted at

the septa. Surface of sterile base covered by repent hyphae, smooth, hyaline, clamped; medullary hyphae 12–15 µm wide, cortical hyphae up to 3.0 µm 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 1 shows a comparison between the spore dimensions of the holotype designated by Rick and other collections observed.

Table 1 – Comparison between the spore dimensions of *Scytinopogon robustus*.

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

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 basidiome, 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).

Clavulinaceae Donk, *Beih. Nova Hedwigia* 1(4): 407 (1970)

Clavulina ridleyi (Massee) Furtado & Neves, comb. nov.

Basionym: *Clavaria ridleyi* Massee, *Bull. Misc. Inf.*, Kew: 172 (1899)

(Fig 3DEF)

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

BASIDIOSPORES 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 31–36 × 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 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).

Additional materials examined – BRAZIL. Rio Grande do Sul: São Leopoldo, *J.E. Rick* (BPI 293798, as *Clavaria cinerea*); Parecí Novo, 1918, *J.E. Rick* (BPI 293791, 332721); Penambuco: Igarassu, 25 Mai 2010, *F. Wartchow* (URM 82947, holotype of *Clavulina*

incarnata); MALAYSIA. Perak, *Ridley* 19 (KEW 176287, holotype of *Clavaria ridleyi*).

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 × 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 ridleyi* 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 ridleyi 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. ridleyi* incrustations.

Multiclavula vernalis (Schwein.) R.H. Petersen, *Am. Midl. Nat.* 77: 216 (1967)

(Fig 3GH)

Pusilla, simplex, leviter compressa, rugulosa, lutea, sicca aurantiaca; clava brevi, obtusa, 1–2 cm alta, 4 mm lata. Sporis 8 × 5 my, obtuse, piriformibus. Ad terram (Rick 1931).

BASIDIOSPORES 8.0–11 × 2.0–3.0 µm (Q=3.8), hyaline, smooth, bacilliform, slightly curved, hilar appendage up to 1.0 µm, aguttulate, inamyloid. BASIDIA 18×35 × 4.0×8.0 µm, tetraspored, 3.0–5.0 µm long, clamped. 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 trail banc associated

with algae or mosses. Canada (Voitk & Ohenoja 2011), Estonia (Shiryayev 2009), Tasmania (Kantvilas 1995) and USA (Petersen 1966).

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* as *Clavaria flavella*), *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 – Petersen (1967) proposed that all species growing in association with algae should be placed in the new genus *Multiclavula* Petersen. This genus is no longer included in Clavariaceae (Petersen 1967).

The specimen collected by Rick is a lichenized clavarioid fungi, *M. vernalis*. *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).

Other 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*) and the bisporous basidia.

Gomphaceae Donk, *Persoonia* 1(4): 406 (1961)

Ramaria stricta (Pers.) Quél., *Fl. mycol. France* (Paris): 464 (1888)

(Fig 3IJK)

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. Sporis $5 \times 3 \mu\text{m}$, 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 7.0–10 × 3.5–4.5 μm (Q=1.66), light yellow ochraceous, roughed, narrowly ellipsoid, uniguttulate. BASIDIA 25–44 × 4.5–7.0 μm, mostly tetraspored, 6.0–7.0 μm long, multiguttulate, clamped. CYSTIDIA absent. HYMENIUM gradually thickening to 120 μm, absent from the axils and the upperside of the main branches. SUBHYMENIUM interwoven, 2.0–3.5 μm wide hyphae. TRAMA composed by thick-walled hyphae, clamped. Mycelial hyphae 2.5–5 μm wide, with slightly thickened walls interwoven with many narrow, thick-walled, unbranched, skeletal hyphae, 1.5–3.0 μm wide (walls 0.5–1.0 μm 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, as *Lachnocladium brasiliensis*).

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 – *Ramaria stricta* 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 roughed basidiospores are diagnostic characteristics (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 samplig 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.

Excluded species

Clavaria parallela Rick, *Egatea* 16: 118 (1931)

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

The type is apparently lost and although the protologue has been published, there are no sampling location and collection cited. It is said to be near *Artomyces candelabrus* (Masse) Jülich and *Lentaria epichnoa* (Fr.) Corner, 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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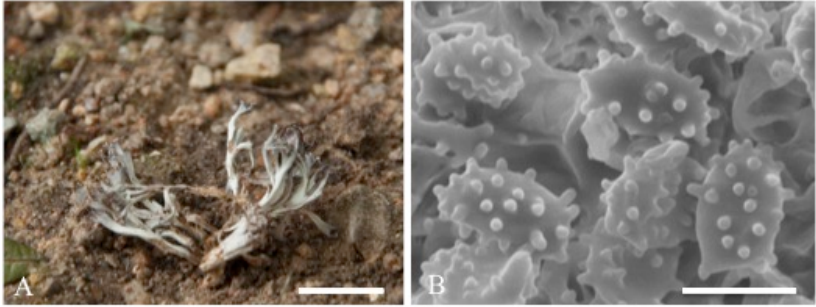


Figure 1 – Photographs of basidiomes in the field and SEM photographs of the basidiospores. **A–B.** *Scytinopogon robustus* (ANMF 422). Bar (A) = 1.0 cm (B) = 5.0 μm .

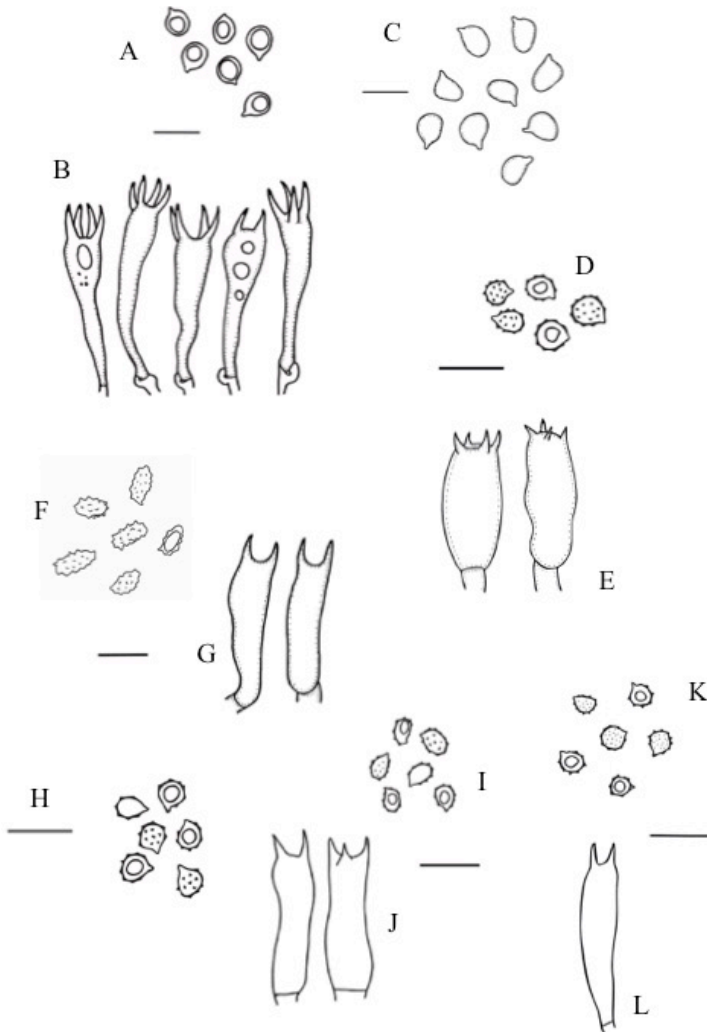


Figure 2 – Microcharacteres of *Clavulinopsis*, *Ramariopsis* and *Scytinopogon*. **A–B.** *Clavulinopsis amoena* (BPI 294820). **A.** Basidiospores; **B.** Basidia; **C.** *C. laeticolor* (PACA 12443). Basidiospores; **D–E.** *Ramariopsis crocea* (BPI 294900). **D.** Basidiospores; **E.** Basidia; **F–G.** *R. kunzei* (PACA 12460). **F.** Basidiospores; **G.** Basidia; **H.** *Ramariopsis* sp. (BPI 297655). Basidiospores; **I–J.** *Scytinopogon angulisporus* (PACA 17243). **I.** Basidiospores; **J.** Basidia; **K–L.** *S. dealbatus* (PACA 17230). **K.** Basidiospores; **L.** Basidia. Bar = 10 μm .

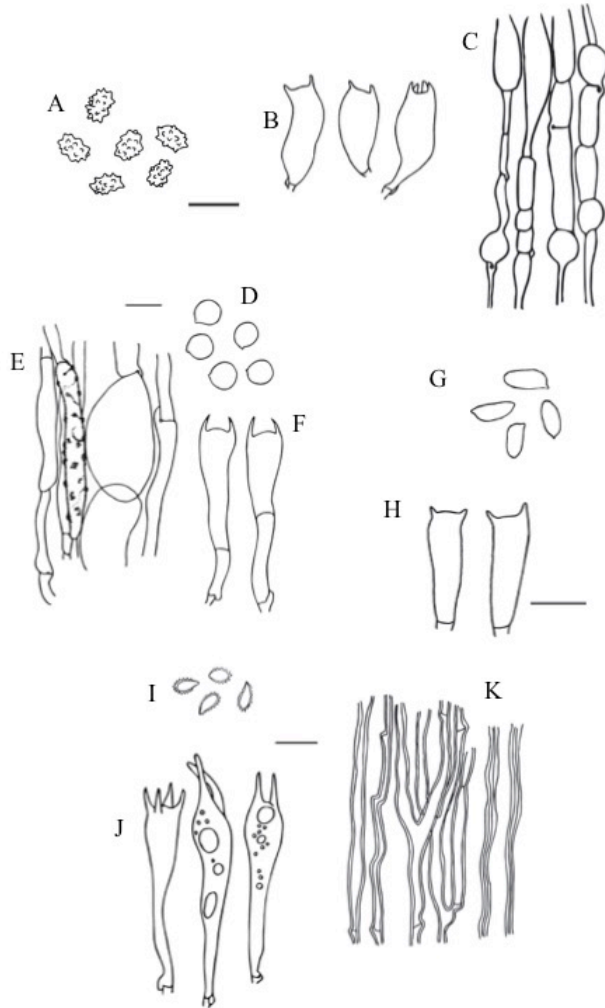


Figure 3 – Microcharacteres of *Scytinopogon*, *Clavulina*, *Multiclavula* and *Ramaria*. **A–C.** *Scytinopogon robustus* (PACA 12457). **A.** Basidiospores; **B.** Basidia; **C.** Context hyphae of the basidiomes with narrower and inflated hyphae; **D–F.** *Clavulina ridleii* (PACA 12439). **D.** Basidiospores; **E.** Basidia; **F.** Hyphae with inscrustations on the inner wall; **G–H.** *Multiclavula vernalis* (PACA 12438). **G.** Basidiospores; **H.** Basidia; **I–K.** *Ramaria stricta* (PACA 17252). **I.** Basidiospores; **J.** Basidia; **K.** Context hyphae of the basidiomes with, on the right, the skeletal hyphae from the basal mycelium. Bar = 10 µm.

**New records and distribution of Clavariaceae (Agaricales) from the
Brazilian Atlantic forest**

Ariadne N. M. Furtado & Maria Alice Neves

New records and distribution of Clavariaceae (Agaricales) from the Brazilian Atlantic forest

Ariadne N. M. Furtado
Maria Alice Neves

Abstract – To expand the knowledge of Clavariaceae from the Atlantic forest, we present here new records for the family from Brazil, presenting complete descriptions for the species recorded. Among the total of fifty-five collections twenty one species were identified within four genera in Clavariaceae: six *Clavaria*, seven *Clavulinopsis*, one *Ramariopsis* and seven *Scytinopogon*. *Clavaria gibbsiae*, *Ca. fumosa* and *Clavulinopsis helvola* are first reported from Brazil. *Clavaria diverticulata*, *Clavulinopsis dimorphica*, *Cs. imperata*, *Scytinopogon caulocystidiatus* and *S. foetidus* are proposed as new species to science. Illustrations of the basidiomes and the microstructures are provided for the twenty one taxa, as well as SEM images for the species with ornamented basidiospores: *Clavulinopsis helvola*, *Ramariopsis kunzei* and *Scytinopogon* species. A key to the taxa included in this work is also presented.

Key words: Taxonomy, morphology, clavarioid, Agaricales.

Introduction

Clavariaceae Chevall. (Agaricales) comprises species with a widely variety of basidiomes, including clavate, coralloid, resupinate, pendant-hydroid and hygrophoroid (Hibbett & Thorn 2001; Birkebak et al. 2013). The family was first proposed to accommodate mostly saprophytic, club to coral-like fungi that were previously placed in *Clavaria* Vaill. Ex. L., including the species currently accepted in other genera and families, such as *Clavulina* J.Schröt. (Clavulinaceae, Cantharellales) and *Ramaria* Fr. Ex. Bonord. (Gomphaceae, Gomphales) (Burt 1922; Coker 1923, 1947).

Since the family was defined by Chevallier (1826) its circumscription has been changed and the most significant genera accepted by several authors have been *Clavaria* Fr., *Clavulinopsis* v. Ov., *Ramariopsis* Donk and *Scytinopogon* Singer (Corner 1970; García-Sandoval et al. 2005; Dentinger & McLaughlin, 2006; Kautmanová et

al. 2012; Birkebak et al. 2013). *Scytinopogon* is the most distinct of these genera, allied to *Thelephora* Ehrh. ex Willd. and diagnosed by the clavarioid basidiomes with flattened branches and echinulate or verrucose angularly elliptic basidiospores (Corner 1950; Larsson et al. 2011; Birkebak et al. 2013). The other genera are known by their controversial morphological characters, especially regarding the hyphal system and the morphology of basidiospores (Corner 1970; Petersen 1978).

Clavariaceae encompasses ~120 species, mostly distributed in temperate regions of the northern hemisphere (Burt 1922; Coker 1923; Corner 1950, 1953, 1966a, 1966b, 1967a, 1967b, 1970; Thind 1961; Thind & Rattan 1967; Petersen 1965, 1967, 1968, 1975, 1988; Petersen 1999; García-Sandoval et al. 2004, 2005; Dentinger & McLaughlin 2006; Shiryayev 2009; Dutta et al. 2012; Kautmanová et al. 2012; Olariaga et al. 2014). There are few records and few collections from tropical and subtropical regions, although it is believed that the greater diversity of family is in these areas (Corner 1950).

In Brazil, the study of Clavariaceae is quite scarce compared to other countries from the northern hemisphere. The most significant studies for the country were made in Amazonas by Corner (1950) and Singer (1945), and in the Atlantic Forest by Rick (1959, in Rio Grande do Sul), Bononi (1979, in São Paulo), Corner (1970, in Rio de Janeiro) and Meijer (2006, 2008, Paraná). These studies account to twenty five species recorded for Brazil, most of them without a complete description presented. With the aim of expanding knowledge of clavarioid fungi for the Atlantic forest, we present twenty one new records of Clavariaceae from Brazil including complete descriptions for each species.

Material and Methods

The states of collections were conducted between March 2011 and August 2014 at Paraná, Rio Grande do Sul and Santa Catarina, mostly during the rainy seasons. Macromorphological characters were studied from fresh specimens whenever possible. Color codes (e.g., 2B19) were based on Korerup & Wanscher (1978). Micromorphological characters were observed from sections from dried basidiomes 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). All

microscopic structures were observed in water, Potassium hydroxide 3%, Melzer's solution, and Congo Red. Measurements were made in a solution of Congo Red and Potassium hydroxide 5%. The spore measurements excluded the ornamentation. Twenty-five of each microstructures studied were measured for each collection. Q refers to the quotient average length/width ration range from the basidiospores. The descriptions of species are based on all collections studied. 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 a SEM operating at 10 keV.

Voucher materials were deposited at FLOR herbarium. All specimen collected during this work are listed in the section "Specimens examined", except for the new species, which are listed in the section "Holotype". Additional specimens were requested as loan from BPI, FLOR, INPA, JPB, K, PACA, RBGE, URM herbaria and studied as reference materials. The nomenclature of the fungi was updated according the CABI and CBS databases. The herbaria acronyms follow Thiers (continuously updated).

Generic and infrageneric concepts followed Corner (1950, 1970) and are complemented by Petersen (1978). A key is provided for the twenty-one taxa described here.

Results

A total of fifty-five clavarioid fungi corresponding to Clavariaceae were collected and are distributed in four genera (the number in parenthesis corresponds to the number of species within the genus): *Clavaria* (*Ca.*) (6), *Clavulinopsis* (*Cs.*) (7), *Ramariopsis* (1) and *Scytinopogon* (7). *Clavaria fumosa* Pers., *Ca. gibbsiae* Ramsb and *Clavulinopsis helvola* (Pers.) Corner are first recorded from Brazil. *Clavaria divarticulata*, *Clavulinopsis dimorphica*, *Cs. imperata*, *Scytinopogon caulocystidiatus* and *S. foetidus* are described as new to science.

Taxonomy

Clavaria diverticulata Furtado & Neves, **sp. nov.** *ad int.*

(Figs 1A, 6ABCD, 13A)

DIAGNOSIS – Characterized by the presence of the diverticulate hyphae in the context of the branches and stipe and incrustations on the inner wall of medullary hyphae.

ETIMOLOGY – The name refers to the diverticulate hyphae present in the context of the branches and stipe.

HOLOTYPE – BRAZIL. Rio Grande do Sul: São Francisco de Paula, Floresta Nacional de São Francisco de Paula (FLONA), 29°22'58"S, 50°22'32"W, 12 Apr 2014, *A.C. Magnago 1044* (FLOR).

BASIDIOMES 4.0–6.5 cm high, solitary to caespitose, light yellow (1A4) to greenish yellow (1B8), drying pale yellow (4A3); branches 0.2–0.4 cm, smooth, cylindric, irregular, divided 2–4 times, polychotomous below, dichotomous above, internodes diminishing gradually, lunate axils, tips subacute to blunt; stipe 1.0–1.5 cm × 0.3–0.5 cm, finely subtomentose, concolorous with the branches, branched from the base. Context concolours, solid, rather tough; taste and smell absent. BASIDIOSPORES 6.0–8.0 × 3.0–5.0 μm (Q=1.73), narrowly ellipsoid, hyaline, smooth, thin-walled, uniguttulate, sometimes multiguttulate, inamyloid; hilar appendage up to 1.0 μm. BASIDIA 49–57 × 9.0–12 μm, clavate, becoming secundarily septate with one or more septa, tetraspored, 5.0–8.0 μm long, clampless. CYSTIDIA absent. HYMENIUM 65 μm thick, thickening upwards, covering the whole basidiome except the stipe. SUBHYMENIUM 87 μm thick, narrow hyphae, 6.5–8.0 μm wide, short-celled, loosely interwoven. TRAMA parallel, inflated, 7.0–12 μm wide, sometimes with oleaginous contents, with many, less inflated hyphae, 1.5–6.0 μm wide, secondarily septate, thin-walled to slightly thick-walled, with incrustations on the inner wall; diverticulate hyphae frequent.

HABITAT AND DISTRIBUTION – Growing on the ground among litter in the Atlantic forest, in *Araucaria angustifolia* moist forest, known only from the type locality.

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis corniculata*: BRAZIL. *J.E. Rick* (BPI 332515; 332517); *Ramariopsis crocea*: BRAZIL. Rio Grande do Sul: São Leopoldo, 1931, *J.E. Rick* (BPI 294900, as *Clavaria guarapiensis*); INDIA. Khadralla: Mahasu: Himachal Pradesh, 25 Aug 1971, *I.P.S. Khurana* (BPI 294899),

REMARKS – Considering the clampless basidia, *Ca.*

diverticulata is classified in subgenus *Clavaria* (Corner 1950, 1970).

Clavulinopsis corniculata (Shaeff.) Corner and *Ramariopsis crocea* (Pers.) Corner are related species, but *Ca. diverticulata* differs from both species by the presence of diverticulate hyphae in the context and the incrustations on the inner wall of medullary hyphae. Furthermore, the basidiospores in *Cs. corniculata* are globose, and in *R. crocea*, subglobose and nodulose (Corner 1950).

The presence of diverticulate hyphae has not been described in previously works on *Clavaria* (e.g. Burt 1922; Corner 1957, 1967; Petersen 1964; Kautmanová et al. 2012; Birkebar et al. 2013). This morphological feature could have a taxonomic significance in *Clavaria*, thus we suggest that related species should also be checked for this character. Therefore, we consider this a diagnostic character of *Clavaria diverticulata*.

Clavaria fragilis Holmsk., *Beata Ruris Otia FUNGIS DANICIS* 1: 7 (1790)

(Figs 1B, 6EF)

BASIDIOMES 1.0–5.0 cm high × 0.3–0.5 cm wide, simple, gregarious, in small fascicules of 3–4 to solitary, whitish (1A1), cylindric, becoming flattened and sulcate, often flexuous, acute then obtuse; stipe short, slightly narrow. Context white (1A5), first solid then hollow, very brittle; taste and smell absent. BASIDIOSPORES 4.5–5.5 × 2.0–3.5 μm (Q=1.57), ellipsoid, hyaline, smooth, thin-walled, uniguttulate, inamyloid; hilar appendage up to 1.0 μm. BASIDIA 31–39 × 6.0–8.0 μm, clavate, tetraspored, 4.0–5.0 μm long, clampless. CYSTIDIA absent. HYMENIUM 37.7 μm thick, covering the whole basidiome except the stipe. SUBHYMENIUM up to 30 μm thick, 1.5–4.0 μm wide, loosely interwoven. TRAMA parallel, 17–25 μm wide, shorter next to the subhymenium, secondarily septate, constricted at primary septa, thin-walled, compact.

HABITAT AND DISTRIBUTION – Growing on the ground with mosses, in the Atlantic forest. In Brazil it is known from Paraná (Meijer 2006) and Santa Catarina (present study). Also known from Bolivia (Corner 1970), Java, USA, Siberia (Corner 1950), Africa, Australia, Bonin Island, Ceylon, China, Japan and India (Thind 1961).

SPECIMENS EXAMINED – BRAZIL. Rio Grande do Sul: São Francisco de Paula, Floresta Nacional de São Francisco de Paula

(FLONA), 29°22'58.5"S, 50°22'32"W, 12 Apr 2014, *A.C. Magnago 1041* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavaria fragilis*: BRAZIL. Rio Grande do Sul, *J.E. Rick* (BPI 294648); Paraná: São José dos Pinhais, Roça Velha, 05 Feb 2001, *A.A.R. Meijer* (MBM 3964); USA. Ohio: Cincinnati, 03 Oct 1920, *C.G. Lloyd* (BPI 332898), *ibid.*, 05 Sep 1920, *C.G. Lloyd* (BPI 332897); *Ca. fumosa*: ENGLAND, 1923, *E.J.H. Corner* (K 161399); SOLOMON ISLANDS. Ysabel, 21 Sep 1965, *E.J.H. Corner* (BPI 264669, isotype); BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 09 Apr 2013, *A.C. Magnago 598* (FLOR).

REMARKS – This widespread and edible species is the type of the genus (*Corner* 1950). *Clavaria fragilis* is easily recognized by its white and brittle basidiomes (*Burt* 1922).

In *Corner's* classification (1950), our specimen is similar to *Ca. fragilis* var. *gracilis* due to the habit and the slightly smaller basidiospores ($5.0\text{--}7.0 \times 3.0\text{--}4.0 \mu\text{m}$ in *Ca. fragilis*), which also agrees with the specimens described by *Burt* from USA (*Burt* 1922). The North-American specimens described by *Coker* (1923) are taller than those recorded to other localities.

This common species can be mistaken as a less stout basidiomes of *Clavaria fumosa* Pers., that has smaller basidiospores ($5.0\text{--}7.0 \times 4.0\text{--}5.0 \mu\text{m}$ in *Ca. fumosa*) and a fuliginous basidiome (*Corner* 1967b).

Clavaria fumosa Pers., *Observ. Mycol.* (Lipsiae) 1: 31 (1796)

(Figs 1C, 6GH)

BASIDIOMES 1.5–7.5 cm high \times 0.2–0.7 cm wide, simple, densely caespitose, whitish to pale cream (5A1), light brown (5D5) at the apex, fuliginous, cylindric then subclavate, becoming compressed and slightly fusiform, acute then obtuse, slender, whitish towards the sterile base; stipe indistinct or absent. Context white (5A1), brittle; taste and smell absent. BASIDIOSPORES $5.0\text{--}8.0 \times 4.0\text{--}5.0 \mu\text{m}$ (Q=1.45), ellipsoid, hyaline, smooth, thin-walled, uniguttulate, inamyloid; hilar appendage up to $1.0 \mu\text{m}$. BASIDIA $55\text{--}63 \times 8.0\text{--}13 \mu\text{m}$, clavate, tetraspored, $5.0\text{--}8.0 \mu\text{m}$ long, clampless. CYSTIDIA absent. HYMENIUM $45.5\text{--}100 \mu\text{m}$ thick, covering the whole basidiome except the stipe. SUBHYMENIUM up to $50 \mu\text{m}$ thick, hyphae $2.0\text{--}4.0 \mu\text{m}$

wide, secondarily septate, loosely interwoven. TRAMA subparallel, hyphae secondarily septate, inflated, 5.0–28 µm wide, constricted at primary septa, thin-walled.

HABITAT AND DISTRIBUTION – Growing on bare soil in the Atlantic forest. In Brazil it is known only from Santa Catarina (present study), also known to Bolivia (Corner 1970), Europe, Java, USA and Siberia (Corner 1950).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 09 Apr 2013, *A.C. Magnago 598* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavaria fumosa*: ENGLAND, 1923, *E.J.H. Corner* (K 161399); SOLOMON ISLANDS. Ysabel, 21 Sep 1965, *E.J.H. Corner* (BPI 264669, isotype); *Ca. fragilis*: BRAZIL. Rio Grande do Sul, *J.E. Rick* (BPI 294648); Rio Grande do Sul: São Francisco de Paula, Floresta Nacional de São Francisco de Paula (FLONA), 12 Apr 2014, *A.C. Magnago 1041* (FLOR); Paraná: São José dos Pinhais, Roça Velha, 05 Feb 2001, *A.A.R. Meijer* (MBM 3964); USA. Ohio: Cincinnati, 03 Oct 1920, *C.G. Lloyd* (BPI 332898), *ibid.*, 05 Sep 1920, *C.G. Lloyd* (BPI 332897).

REMARKS – *Clavaria fumosa* is characterized by a whitish basidiome with the brown apex and no distinct stipe. When young, the pale basidiome has pinkish tips (Corner 1950, 1970).

Corner (1970) has stated that this species could be restricted to temperate regions, however, he recorded the occurrence of *Ca. fumosa* for Bolivia himself, from a collection made by Singer, and then for Java and Solomon Islands (Corner 1967a). The biggest difference observed between the temperate specimens and those collected in tropical or subtropical regions is the existence of fewer cystidia distributed in the hymenium in the temperate specimens (Kauffman 1928).

As previously discussed, *Ca. fumosa* seems to be a color-variety of *Ca. fragilis* that is cream and fuliginous and has smaller basidiospores (Corner 1967b).

Clavaria gibbsiae Ramsb., in Gibbs, *Contr. Phytogeogr. Arfak. Mount.*: 187 (1917)

(Figs 1D, 6IJK)

BASIDIOMES 2.0–6.5 cm high × 0.2–0.6 cm wide, simple or once furcate, densely caespitose, white (1A1) to pale cream with age

(5A1), subclavate, generally blunt, subacute; stipe 0.1–0.3 × 0.1–0.2 cm, distinct, smooth. Context solid, waxy, slightly brittle; taste and smell absent. BASIDIOSPORES 6.5–8.0 × 6.5–7.5 µm (Q=1.11), subglobose, hyaline, smooth, thin-walled, uniguttulate, inamyloid; hilar appendage up to 1.0 µm. BASIDIA 30–40 × 6.0–8.0 µm, clavate, bisporoid, 6.0–9.0 µm long, furcate at the base, clamped. CYSTIDIA absent. HYMENIUM 52–130 µm thick, covering the whole basidiome except the stipe. SUBHYMENIUM up to 45 µm thick, composed for densely interwoven, narrower hyphae, 1.5–4.0 µm wide. TRAMA parallel, much inflated, 12–23 µm wide, constricted at the septa, not secondarily septate, thin-walled, with incrustations on the inner wall, medullary loosely attached, and longitudinal narrow hyphae, 3.0–6.0 µm wide, not interweaving.

HABITAT AND DISTRIBUTION – Growing in soil, in shady places, in the Atlantic forest. In Brazil it is known only from Santa Catarina (present study). Africa, Malaysia, New Guinea (Corner 1950).

SPECIMENS EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 12 Nov 2013, *A.N.M. Furtado* 363 (FLOR); Santa Amaro da Imperatriz, Hotel Plaza Caldas da Imperatriz, Trilha da Cachoeira, 27°70'39"S, 48°80'37"W, 21 Mar 2014, *A.N.M. Furtado* 458 (FLOR), *ibid.*, 10 Abr 2014, *A.N.M. Furtado* 484 (FLOR); Paraná: Piraquara, Morro do Canal, 25°50'91"S, 48°97'75"W, 26 Jan 2014, *A.C. Magnago* 910 (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavaria gibbsiae*: MALAYSIA. Tembeling: Pahang, Malaya, 07 Nov 1930, *E.J.H. Corner* (BPI 294160); *Ca. fragillis*: BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 09 Apr 2013, *A.C. Magnago* 598 (FLOR); USA. Ohio: Cincinnati, 03 Oct 1920, *C.G. Lloyd* (BPI 332898), *ibid.*, 05 Sep 1920, *C.G. Lloyd* (BPI 332897).

REMARKS – According to Corner's infrageneric classification (1970), *Ca. gibbsiae* fits in subgenus *Holocoryne* (Fr.) Bonord. due to the presence of clamps at the base of the basidia.

This is probably a widespread and common tropical species (Corner 1950) that can be mistaken with *Ca. fragilis*, which shares the color of the basidiome, but differs by the shape and size of the basidiospores (ellipsoid and smaller, 4.5–5.5 × 2.0–3.5 µm, in *Ca. fragilis*), the number of sterigmata (basidia bisporoid in *Ca. fragilis*), and the absence of inner wall incrustations (Burt 1922).

Clavaria subglobosa (Corner) Furtado & Neves, **stat. nov. ad int.**

≅ *C. rosea* var. *grandispora* Corner, *Trans. Br. mycol. Soc.* 50(1): 41 (1967).

≅ *C. rosea* var. *subglobosa* Corner, *Annals of Botany Memoirs No. 1:* 691 (1950).

(Figs 1E, 7AB)

BASIDIOMES 2.5–9.5 cm high × 0.2–0.6 cm wide, simple, solitary, gregarious to caespitose, reddish orange (7B8) to brownish red (8C8) or vivid red (9A8), drying brownish orange (8C6), apex concolorous, flattened becoming cylindric upward, acute then fusiform and blunt, with a subtle groove; stipe really short, paler, fairly distinct, slightly strigose. Context brittle, pale orange (6A6), fistulose, first solid then hollow; taste and smell absent. BASIDIOSPORES 6.0–7.5 (–9.0) × 5.5–7.0 (–8.0) μm (Q=1.09), subglobose, hyaline, smooth, thin-walled, aguttulate, inamyloid; hilar appendage up to 1.0 μm. BASIDIA 82–94 × 7.0–10 μm, cylindric-elongate, bi- to tetraspored, mostly 4, 7.0–12 μm long, clampless. CYSTIDIA absent. HYMENIUM 70 μm thick, distinctly thickening upwards up to 110 μm, covering the whole basidiome except the stipe. SUBHYMENIUM 40–60 μm thick, coralloid, composed of narrow hyphae, 2.5–4.0 μm wide. TRAMA composed of parallel hyphae, 6.0–7.0 μm wide, cylindric, sparsely secondarily septate, sometimes constricted at primary septa, thin-walled, H-connexions frequent.

HABITAT AND DISTRIBUTION – Growing on soil among litter, under trees, in Atlantic forest. In Brazil it is known from Rio de Janeiro (Corner 1967b) and Santa Catarina (present study). Also known from the United States (Coker 1923), France, England, Sweden (Corner 1950), Jamaica, Java, Madagascar, Panama, Sierra Leone, Trinidad, West Pakistan (Corner 1967b), Singapore (Corner 1970), Estonia (Shiryaev 2009) and Thailand (Maneevun & Sanoamuang 2010).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 16 Mar 2011, *Neves, M.A.* 732 (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavaria rosea*: BRAZIL. *E.J.H. Corner* (BPI 294512); USA. Idaho, Priest River, Jul 1915; *J.R. Weir* (BPI 294510); SINGAPORE. Botanic Garden, 16 Dec 1931, *E.J.H. Corner* (BPI 294878);

REMARKS – *Clavaria subglobosa* (= *Ca. rosea* var.

subglobosa) is easily found in the field by its vivid color that contrasts with the litter.

The species varies much in color from a pale to vivid pink, reddish rose, reddish orange to brownish orange, and also has a range in basidiospore size which led Corner (1967b) to create four varieties for *Ca. rosea* (var. *grandispora*, var. *subglobosa*, var. *pallida* and var. *rosea*). The last two varieties have the typical basidiospore of *Ca. rosea*, ellipsoid slightly flattened adaxially, and inflated hyphae (up to 25 µm wide). *Clavaria rosea* var. *subglobosa* and *Clavaria rosea* var. *grandispora* have subglobose basidiospores not flattened, and narrow hyphae (up to 7.0 µm wide) which measures overlap (5.0–8.0 × 4.0–6.5 µm and 7.0–8.5 × 6.0–7.5 µm, respectively) (Corner 1950, 1970).

The only difference between these varieties of subglobose basidiospores is related to collection location and the color of the basidiome. *Clavaria rosea* var. *grandispora* from Brazil is reddish orange and *Clavaria rosea* var. *subglobosa* from India has pale red basidiome (Corner 1970). Thus we consider that both varieties represent a single taxon.

Considering that the hyphal system as well as the basidiospore morphology are important to delimitate a species (Corner 1950, 1970; Petersen 1967), we consider inappropriate the use of *Ca. rosea* var. *grandispora* and *Ca. rosea* var. *subglobosa*, therefore a new status is proposed. Since *Clavaria rosea* var. *subglobosa* is the earlier valid name, we propose *Clavaria subglobosa* stat. nov.

Clavaria zollingeri Lév., *Annls Sci. Nat., Bot.*, sér. 3 5: 155 (1846)
(Figs 1F, 7CDE)

BASIDIOMES 2.0–7.5 cm high, gregarious, caespitose, purple (15C7) or deep purple (15D8), varying grayish ruby (12E5), magenta (13D5), rose (12B6) or purplish red (14C7), drying pale yellow (4A3); branched 0.1–0.3 cm, cylindric, blunt or becoming subulate above, irregular, more or less fastigiate, axils rounded, divided 1–4 times, polychotomous below, tips concolorous with the branches; stipe 1.0–2.5 cm × 0.2–0.3 cm, often branched from the base. Context concolorous with the branches; taste and smell absent. BASIDIOSPORES 6.0–7.0 × 4.0–6.0 µm (Q=1.23), broadly ellipsoid, hyaline, smooth, thin-walled, uniguttulate, inamyloid; hilar appendage up to 1.0 µm, often sublateral. BASIDIA 38–60 × 9.0–13 µm, clavate, multiguttulate, tetraspored,

5.0–7.0 μm long, clampless. CYSTIDIA absent. HYMENIUM 40–100 μm thick, covering the whole basidiome except the stipe. SUBHYMENIUM up to 40 μm thick, coralloid, at first with narrow hyphae, 5.0 μm wide, gradually inflating up to 10 μm wide, short-celled hyphae. TRAMA subparallel, frequently secondarily septate, barrel-shaped, 5.0–22 μm wide, slightly constricted at primary septa, walls slightly thickened, smooth, H-connections frequent.

HABITAT AND DISTRIBUTION – Growing on soil, in shady areas, in the Atlantic forest. In Brazil it is known from Paraná (Meijer 2006), Santa Catarina, Rio Grande do Sul (present study) and São Paulo (Bononi et al. 1981), also known from Australia, Bonin Island, Canada, Ceylon, France, Gt. Britain, Italy, Java, Malaysia, USA (Corner 1950, 1970).

SPECIMENS EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 12 Nov 2013, *A.N.M. Furtado 365* (FLOR), *ibid.*, 03 Dec 2013, *A.N.M. Furtado 391* (FLOR); Florianópolis, Trilha para Lagoinha do Leste, 27°59'43"S, 49°47'83"W, 21 Mai 2014, *A.N.M. Furtado 499* (FLOR); Rio Grande do Sul: São Francisco de Paula, Floresta Nacional de São Francisco de Paula (FLONA), 29°22'58"S, 50°22'32"W, 12 Apr 2014, *A.C. Magnago 1039, 1043* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavaria zollingeri*: BRAZIL. Rio Grande do Sul, *J.E. Rick* (BPI 332489); Paraná: São José dos Pinhais, Roça Velha, 31 Mar 2001, *A.A.R. de Meijer* (MBM 4070); Amazonas: Manaus, Reserva Florestal Ducke, 15 Jun 1978, *E.M.H. Freire 202* (INPA 79050), *ibid.*, 21 Apr 1977, *R. Singer B9763* (INPA 69937), *ibid.*, 08 Jun 1978, *E.M.H. Freire 187* (INPA 79037); *Clavulina amethystina*: ENGLAND, 1977, *O.H. Frazer* (K 146709); USA. Washington: Bremerton, 21 Jan 1931, *J.B. Flett* (BPI 295409); *Ramariopsis pulchella*: INDIA. Narkanda. Mahasu: Himachal Pradesh, 17 Aug 1971, *I.P.S. Khurana* (BPI 294927).

REMARKS – *Clavaria zollingeri* is easily found in the forest for its vivid color. *Clavaria zollingeri* appears to be a cosmopolitan fungus with a great variability. It is one of the two branched species of *Clavaria s. str.* so far. The measures and shape of the basidiospores varies from author to author (Coker 1923; Corner 1967b; Gerault 2005; Shiryaev 2009). These differences combined with the variable shapes and colors of the basidiomes are determinant to identify this species (Corner 1950).

This species can be confused with the slightly brittle *Clavulina amethystina*, described for Europe (Olariaga et al. 2009), but it differs microscopically by the bisporous basidia and the non secondarily septated hyphae in the context of the basidiomes.

Ramariopsis pulchella also shares the purplish branched basidiome, but differs by its minutely verrucose basidiospores, clamps observed in the whole basidiome and the presence of crystals in the context of the base of the stipe (Petersen 1988).

Clavulinopsis amoena (Zoll. & Moritzi) Corner, *Annals of Botany Memoirs No. 1*: 352 (1950)

(Figs 2A, 8AB)

BASIDIOMES 2.5–5.0 cm high × 0.2–0.4 cm wide, simple, caespitose, light yellow (1A5) to greenish yellow (1A7), pale toward the whitish growing apex, cylindrical and blunt or subclavate, becoming longitudinally rugulose; stipe 0.5–1.5 cm high × 0.1–0.2 cm wide, slightly distinct, generally shortly white-villous or strigose at the base. Context waxy, solid becoming hollow; smell and taste unrecorded. BASIDIOSPORES 7.0–9.0 × 7.0–8.5 μm (Q=1.05), globose to subglobose, hyaline, smooth, thin-walled, uniguttulate, with a large guttula that becomes greenish-yellow at maturity, inamyloid; hilar appendage up to 1.0 μm. BASIDIA 46–93 × 8.0–10 μm, subclavate, longer in old hymenia, tetrasporous, 9.0–12 μm long, clamped. CYSTIDIA absent. HYMENIUM 40–70 μm thick at first, thickening upwards, covering the whole basidiome except the stipe. SUBHYMENIUM up to 50 μm thick, composed at first of narrow short-celled hyphae, 1.5–3.0 μm wide, gradually inflating up to 15 μm wide, with small orange granules that turn green with iodine. TRAMA parallel, inflated, 7.0–15 μm wide, thin-walled, with many, narrow, little inflated, longitudinal and interweaving hyphae, 2.0–7.0 μm wide, derived from the inflated hyphae and binding them together, abundant clamps.

HABITAT AND DISTRIBUTION – Growing on the ground among the litter, in the Atlantic forest, in *Araucaria angustifolia* moist forest. In Brazil it is known from Amazonas, Rio Grande do Sul (Corner 1970) and Santa Catarina (present study), also known to Bolivia, Colombia, Japan, Panama, Peru (Corner 1970), Solomon Island (Corner 1967a), Australia, Bonin Island, Ceylon, Java, Malaysia (Corner 1950),

India (Thind & Rattan 1967) and USA (Petersen 1979).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Urubici, Parque Nacional de São Joaquim (PNSJ), Trilha da Pedra, 28°08'40"S, 49°42'82"W, 17 Feb 2013, *R.C.S. Friedrich 21* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis amoena*: BRAZIL. Rio Grande do Sul: Nova Petrópolis, 1923, *J.E. Rick* (BPI 294820); USA. Pennsylvania: Pocono, 1931, *C.B. Stifler* (BPI 293702); MALAYSIA. Sabah: Kota Kinabalu, 20 Apr 1964, *E.J.H. Corner* (BPI 0294819), *ibid.*, 03 Mai 1964, *E.J.H. Corner* (BPI 0294817); SOLOMON ISLAND. Guadalcanal: Popomanasia, 26 Mai 1965, *E.J.H. Corner* (BPI 0294816); *Cs. fusiformis*: BRAZIL. Amazonas: Manaus, Campus do INPA, 20 Mai 1977, *E.M.H. Freire* (INPA 69936), *ibid.*, 21 Jun 1977, *E.M.H. Freire* (INPA 79021) *ibid.*, 22 Mai 1978, *R. Singer* (INPA 79015), *ibid.*, Reserva Florestal Ducke, 20 Jul 1978, *R. Singer* (INPA 80977); *Cs. spiralis*: MALAYSIA. Gunong Panti: Johore, 20 Apr 1930, *E.J.H. Corner* (BPI 294823); AUSTRALIA. Carnegie: Victoria, *J.T. Paul* (BPI 332533).

REMARKS – *Clavulinopsis amoena* is easily identified by the presence of a shortly white-villous or strigose stipe, globose to subglobose basidiospores, the guttula becoming intense greenish-yellow at maturity and small orange granules in the subhymenial hyphae becoming green with iodine (Petersen 1968).

Corner (1950) has discussed in detail the range variation of *Cs. amoena* and the differences from other allied species. The Brazilian collection fits within the range variation of the species. In the field, *Cs. amoena* can be mistaken with *Cs. spiralis* (Jungh.) Corner and with a bright yellow form of *Cs. fusiformis* (Sowerby) Corner. The basidiomes of these three species begin as tufts of slender, cylindric and filiform basidiomes with acute tips. They grow up through a fusiform stage to the clavate, as the hyphae inflate and the hymenium begins to thicken.

Clavulinopsis fusiformis differs by the brownish yellow basidiome at maturity, broadly ellipsoid to pip-shaped basidiospores, with a greater hilar appendage (1.0–2.0 µm long) (Corner 1966b) and *Clavulinopsis spiralis* differs from *Cs. amoena* only by the smaller basidiospores (5.5–7.0 × 4.5–6.5 µm) (Corner 1967a).

Clavulinopsis aurantiocinnabarina (Schwein.) Corner, *Annals of Botany Memoirs No. 1*: 358 (1950)

(Figs 2B, 8CDE)

BASIDIOMES 4.0–6.3 cm high \times 0.1–0.2 cm wide, simple, caespitose, sometimes gregarious, golden yellow (5B7) to deep orange (6A8), fading buffy orange (6A5), cylindric, subacute to blunt, flattened and rugulose; stipe indistinct. Context deep orange (6A8), not fading, slightly brittle; smell and taste unrecorded. BASIDIOSPORES 6.0–7.0 \times 6.0–6.5 μm (Q=1.07), subglobose, hyaline, sometimes pale yellow, smooth, thin-walled, uniguttulate, inamyloid; hilar appendage up to 1.0 μm . BASIDIA 43–51 \times 7.0–9.0 μm , cylindric-clavate, immersed in a parafisoid hymenium, tetraspored, 5.0–9.0 μm long, often with elongate abortive sterigmata, clamped. CYSTIDIA absent. HYMENIUM 70–130 μm thick, with many small crystals, covering the whole basidiome except the sterile base and the tips of the clubs. SUBHYMENIUM 50–75 μm thick, coralloid, composed of narrow hyphae, not inflated. TRAMA subparallel, with two different widths, wider hyphae up to 14 μm wide, slightly inflated, hyaline, and narrower up to 5.0 μm wide not inflated, next to subhymenium, thin-walled. Surface of sterile base in two layers, cortical layer up to 120 μm thick, perpendicular to medullary layer, with interwoven hyphae, 2.5–3.5 μm wide, loosely attached, cylindric, thick-walled, clamped. Medullary layer composed of slightly inflated hyphae, 7.0–12 μm wide, subparallel, interwoven with narrow hyphae, up to 5.0 μm wide, clamped.

HABITAT AND DISTRIBUTION – Growing among the litter, in shady areas, in Atlantic forest. In Brazil it is known from Paraná (Meijer 2006) and Santa Catarina (present study). Also known from Canada, China, Panama, Venezuela, Trinidad (Corner 1950, 1970), Tasmania (Maneevun & Sanouamuang 2010).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 03 Dec 2013, *A.N.M. Furtado* 382 (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis aurantiocinnabarina*: BRAZIL. Pernambuco: Recife, IPA, 14 Jun 1951, *J.N. Silva* (URM 499); Amazonas: Manaus, *Campus* do INPA, 26 Jan 1978, *H. Caldas de Souza & M.M.N. Braga* (INPA 72737); Itacoatiara, Reserva Florestal Ducke, 26 Mai 1978, *E.M.H. Freire* (INPA 79031); USA. Ohio: Maumee Valley, 1922, *W.R. Lowater* (BPI 295438); *L.D. von Schweinitz* (K 175527); *Cs. amoena*: BRAZIL. Santa Catarina: Urubici, Parque Nacional de São Joaquim (PNSJ), Trilha da Pedra, 17

Fev 2013, *R.C.S. Friedrich 21* (FLOR); MALAYSIA. Sabah: Kota Kinabalu, 20 Apr 1964, *E.J.H. Corner* (BPI 0294819), *ibid.*, 03 Mai 1964, *E.J.H. Corner* (BPI 0294817); SOLOMON ISLAND. Guadalcanal: Popomanasia, 26 Mai 1965, *E.J.H. Corner* (BPI 0294816).

REMARKS – *Clavulinopsis aurantiocinnabarina* is unmistakable in field by its vivid color and indistinct stipe. The stratified sterile surface is remarkable in the determination of this species (Corner 1950).

Corner (1970) commented that the rich orange and reddish pink states of *Cs. amoena* may be a pale *Cs. aurantiocinnabarina*. Microscopically, they share the subglobose basidiospores, slightly larger in *Cs. amoena*, and the inflated hyphae of the trama (Petersen 1968). *Clavulinopsis amoena* has a lighter color, distinct strigose stipe and indistinct sterile base (Maneevum & Sanoamuang 2010).

Clavulinopsis dimorphica Furtado & Neves, **sp. nov.** *ad int.*

(Figs 2C, 8FG)

DIAGNOSIS – Differs from *Cs. corniculata* by the basidiospores with two distinct morphologies and basidia with two different sizes and with both, one and four sterigmata.

ETIMOLOGY – The name refers to the dimorphism of the basidia and basidiospores size.

HOLOTYPE – BRAZIL. Rio Grande do Sul: São Francisco de Paula, Floresta Nacional de São Francisco de Paula (FLONA), 29°22'58"S, 50°22'32"W, 10 Apr 2014, *A.C. Magnago 1051* (FLOR).

BASIDIOMES 6.0 cm high, branched, solitary, yellow (3B7), orange yellow (4B8) to deep orange (5A8), drying pale yellow (2B4); branches 0.3–0.5 cm, subfastigate, smooth, viscid, subcylindric, firm, with blunt, divided 2–3 times, dichotomous upwards, internodes diminishing gradually, with wide lunate axils, bifid or somewhat subulate tips, tips concolorous with the branches; stipe 1.5 cm × 0.6 cm, smooth, slightly striated at the base, concolorous with the branches. Context concolorous with the branches, solid, rather tough; smell and taste absent. BASIDIOSPORES dimorphic, the majority 8.0–9.5 × 3.5–5.5 μm (Q= 1.91), narrowly ellipsoid to pip-shaped, the minority 6.5–7.5 × 4.0–6.0 μm (Q=1.29), subglobose to broadly ellipsoid, both hyaline, smooth, thin-walled, uniguttulate, inamyloid; hilar appendage 0.5 μm long, sublateral. BASIDIA 50–64 × 6.0–10 μm, clavate-

elongate, uni- to tetraspored, 21–32 μm long and 4.0–7.0 μm respectively, clamped. CYSTIDIA absent. HYMENIUM 75 μm , thickening upwards up to 160 μm , multiguttulate, covering the whole basidiome except the stipe. SUBHYMENIUM hardly differentiated. TRAMA subparallel, thin-walled hyphae, hyphae, 3.5–10 μm wide, with longitudinal and interweaving hyphae, clamped. Surface of sterile base covered by trichodermal hyphae, cylindrical, 2.0–5.0 μm wide, clampless.

HABITAT AND DISTRIBUTION – Growing on the ground among the litter, in the Atlantic forest, in *Araucaria angustifolia* moist forest, known only from the type locality.

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis corniculata*: BRAZIL. *J.E. Rick* (BPI 332515; 332517).

REMARKS – The size of the hilar appendage and basidiospores wall are important taxonomic characters to identify species of *Clavulinopsis* (Corner 1950).

The presence of a short hilar appendage is commonly associated to species of subg. *Paraclavaria* (Corner 1950, 1970; Petersen 1978), although only for ellipsoid basidiospores, and subg. *Clavulinopsis* for those subglobose to broadly ellipsoid basidiospores. The presence of dimorphism in the basidiospores of *Clavulinopsis dimorphica* does not let us follow the infrageneric classification by Corner (1970), and, how recently confirmed by Kautmanová et al. (2012), this character has evolved repeatedly during the diversification in the genus and probably should no longer be used to separate groups.

Clavulinopsis corniculata is morphologically similar to *Cs. dimorphyca* by the branched and yellowish basidiome, however *Cs. corniculata* has globose basidiospores (5.5–6.0 \times 5.0–5.5 μm) and only tetraspored basidia (Petersen 1979).

Clavulinopsis helvola (Pers.) Corner, *Annals of Botany Memoirs No. 1*: 372 (1950)

(Figs 3AB, 8HI)

BASIDIOMES 6.0 cm high \times 0.1–0.5 cm wide, simple, solitary, light yellow (2A5) to orange-yellow (4B7), fading buffy orange (6A5), subcylindric, blunt; stipe 1.0 cm high \times 0.1–0.2 cm wide, distinct as the narrower, basal part of basidiome, pale yellow. Context white to yellowish, solid, subfloccose, waxy; smell and taste absent.

BASIDIOSPORES 5.0–7.0 × 4.2–6.5 μm (Q=1.29), subglobose to broadly ellipsoid, hyaline, thin-walled, uniguttulate, sharply angular to tuberculous, inamyloid; hilar appendage indistinct. BASIDIA 38–59 × 7.0–11 μm, subclavate, bi- to tetraspored, 7.0–9.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 70–125 μm thick, covering the whole basidiome except the stipe. SUBHYMENIUM 25–50 μm thick, composed of closely interwoven hyphae, 3.0–4.0 μm wide, tortuous, producing basidia in clusters or bouquets. TRAMA subparallel, hyphae branching and anastomosing abundantly, hyaline, thin-walled, with two different widths, 5.0–10 μm wide, slightly constricted at the septa, and 2.5–3.0 μm wide, not inflated, both interweaving.

HABITAT AND DISTRIBUTION – Growing among the litter, in Atlantic forest. In Brazil it is known only from Santa Catarina (present study). Also known from Africa, Australia, Europe (common), Japan, USA (Corner 1950, 1970), Estonia (Shiryayev 2009), India (Thind & Rattan 1967) and France (Gerault 2005).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 01 Jul 2013, *R.C.S. Friedrich 34* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis helvola*: UGANDA. Kyetume: Kyagwe, Banana plantation, 1915, *R.A. Dummer* (BPI 294872, holotype); INDIA. Jabber Khet: Mussoorie, Uttar Pradesh, 07 Sep 1968, *S.S. Rattan* (BPI 294868); BRAZIL. Rio Grande do Sul: Parecí Novo, 1918, *J.E. Rick* (BPI 294557); *Cs. laeticolor*: SLOVAKIA. Lysá, 2005, *V. Kautman* (K 158310); INDIA. Dhanaulti, Mussoorie, Uttar Pradesh, 31 Aug 1968, *S.S. Rattan* (BPI 294884);

REMARKS – *Clavulinopsis helvola* is easily recognized by the simple club-shaped yellow basidiomes and spiny basidiospores (Petersen 1968). This is the only species of *Clavulinopsis* with spines basidiospores. Although very variable in size of basidiospores, the basidiospore measurements fall within the range of values published by several authors for this species (Corner 1950, Petersen 1968, Pegler & Young 1985, Adamčík 2009).

Petersen (1978) included *Cs. helvola* in a subgenus of *Ramariopsis* [= *Ramariopsis helvola* (Pers.) R.H. Petersen] based on the basidiospores with thick tuberculous ornamentation. In studying the structure of the basidiospore wall, Pegler & Young (1985) recognized several types of basidiospore ultrastructure and that all members of

Ramariopsis s. str. have warts formed by tunica. Spines of *Ramariopsis helvola* are formed from growth of the corium. Therefore, the species was accepted as a member of *Clavulinopsis*.

Clavulinopsis laeticolor (Berk. & M.A. Curtis) R.H. Petersen is similar to *Cs. helvola* by the color of the basidiome, however, the first species has smooth, ellipsoid pip-shaped basidiospores (Petersen 1968).

Clavulinopsis imperata Furtado & Neves, **sp. nov. ad int.**

(Figs 2D, 8JKL, 13B)

DIAGNOSIS – Characterized by the presence of irregularly thick-walled hyphae in the context.

ETIMOLOGY – The name refers to the type location, Santo Amaro da Imperatriz.

HOLOTYPE – BRAZIL. Santa Catarina: Santo Amaro da Imperatriz, Hotel Plaza Caldas da Imperatriz, Trilha da Pousada, 27°70'39"S, 48°80'37"W, 26 Jul 2013, *A.N.M. Furtado 482* (FLOR).

BASIDIOMES 5.5 cm high × 0.8 cm wide, simple, solitary, light yellow (2A5) to greenish yellow (2B8), spatulate flattened, subacute, strigose; stipe 1.0 cm high × 0.3 cm wide, fairly distinct, slightly strigose at the base. Context solid, becoming hollow, pale yellow (1A3); smell and taste unrecorded. BASIDIOSPORES 6.0–8.0 × 6.0–7.5 μm (Q=1.08), subglobose, hyaline, smooth, thin-walled, uniguttulate, with a large guttula which becomes greenish-yellow at maturity, inamyloid; hilar appendage up to 1.0 μm. BASIDIA 43–54 × 7.0–10 μm, subclavate, tri- or tetraspored, 6.0–12 (–20) μm long, clamped. CYSTIDIA absent. HYMENIUM 65.2–75 μm thick, covering the whole basidiome except the stipe. SUBHYMENIUM 25–37 μm thick, composed of inflated short-celled hyphae, 9.5–11 μm wide. TRAMA subparallel, inflated hyphae, 7.0–15 μm wide, thin-walled, with many irregularly thick-walled hyphae, hyaline, clamps scattered and diminished.

HABITAT AND DISTRIBUTION – Growing on soil between the litter, in the Atlantic forest, known only from the type locality.

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis amoena*: BRAZIL. Rio Grande do Sul: Nova Petrópolis, 1923, *J.E. Rick* (BPI 294820); MALAYSIA. Sabah: Kota Kinabalu, 20 Apr 1964, *E.J.H. Corner* (BPI 294819), *ibid.*, 03 Mai 1964, *E.J.H. Corner* (BPI 294817); *Cs. spiralis*: BRAZIL. Santa Catarina: Itapoá, Reserva Volta

Velha, 26°0850"S, 49°04'07"W, 18 Nov 2012, M.A. Neves 1077 (FLOR).

REMARKS – In the field *Cs. imperata* can be mistaken by *Cs. amoena* due to the morphology of basidiomes, especially for its greenish yellow color. However, *Cs. amoena* has typically thin-walled hyphae and small orange granules in the subhymenial hyphae that become green with iodine (Petersen 1968; Corner 1970).

Clavulinopsis spiralis is similar, but differs from *Cs. imperata* also for having smaller basidiospores ($5.5\text{--}7.0 \times 4.0\text{--}6.5 \mu\text{m}$) and by the absence of the irregularly thick-walled hyphae (e.g. Corner 1950; Petersen 1968, 1978).

The presence of irregularly thick-walled hyphae in the context has not been described in previously works on *Clavulinopsis* (Corner 1950, 1967a, 1967b, 1970; Petersen 1968, 1978, 1979). Thus we consider this a diagnostic character of *Clavulinopsis imperata* and this character should be checked in related species of the genus.

Clavulinopsis laeticolor (Berk. & M.A. Curtis) R.H. Petersen, *Mycologia* 57(4): 522 (1965)

(Figs 2E, 9ABC)

BASIDIOMES 1.5–9.5 cm high, solitary, gregarious, fasciculate in small tufts, yellowish orange (4B7) to deep orange (6A8) or reddish orange (7B8), tips discoloring to a brownish orange (6C7) in age, drying deep orange (6A8), cylindric and acute, often somewhat flattened, becoming blunt, compressed, sometimes rugulose; stipe 1.0–2.5 cm high \times 0.1–0.2 cm wide, distinct, drying finely subtomentose, often with a white mycelium at the base of basidiomes. Context pale, often hollow, floccose, not brittle; smell and taste absent. BASIDIOSPORES $5.5\text{--}8.0 \times 3.5\text{--}6.0 \mu\text{m}$ (Q=1.56), ellipsoid to pip-shaped, hyaline (old basidiospores stained yellow), smooth, slightly thick-walled, uniguttulate, inamyloid; with a prominent hilar appendage 1.0–2.0 μm long, often sublateral. BASIDIA $32\text{--}58 \times 4\text{--}10 \mu\text{m}$, clavate-elongate, uni- or tetraspored, mostly 4, 4.0–13 μm long (–17 μm on those unispored), clamped. CYSTIDIA absent. HYMENIUM 35–125 mm, covering the whole basidiome except the stipe. SUBHYMENIUM 45 μm thick, coralloid, tortuous, hyphae with 1.5–4.0 μm wide, producing basidia in clusters or bouquets. TRAMA parallel, hyphae with 3.0–13 μm wide, long-celled, not constricted at the

septa, incrustations on the inner wall of medullary hyphae, slightly thick-walled, clamped. Surface of sterile base covered by excrecent hyphae, up to 3.0 μ m wide, cylindrical, clamped.

HABITAT AND DISTRIBUTION – Growing between the litter, on road bank, on soil, in shady areas in Atlantic forest. In Brazil it is known from Rio Grande do Sul (Rick 1959, present study) and Santa Catarina (present study). The species is also known from China, Germany, Great Britain, Holland, Italy, USA (Corner 1950; Petersen 1965), Estonia (Shiryav 2009), France (Corner 1950; Gerault 2005), Spain (Tabarés & Rocabruna 1991), India (Corner 1970; Swapna et al 2008), Australia (Petersen 1979), Argentina, Austria, Bolivia, Chile, Costa Rica, Jamaica, Panama, New Zealand, Peru, Sweden (Corner 1970), Malaysia (Corner 1970; Petersen 1978, 1988) and Thailand (Maneevun & Sanoamuang 2010).

SPECIMENS EXAMINED – BRAZIL. Paran: Piraquara, Morro do Canal, 2550'91"S, 4897'75"W, 26 Jan 2014, *A.C. Magnago 911* (FLOR); Rio Grande do Sul: So Francisco de Paula, Floresta Nacional de So Francisco de Paula (FLONA), 2922'58"S, 5022'32"W, 13 Abr 2014, *A.C. Magnago 1052, 1054* (FLOR); Santa Catarina: Florianpolis, Morro da Lagoa, Trilha do Jipe, 2759'43"S, 4947'83"W, 12 Nov 2013, *A.N.M. Furtado 364* (FLOR), *ibid.*, 01 Jul 2013, *R.C.S. Friedrich 33* (FLOR), *ibid.*, 16 Jan 2014, *A.N.M. Furtado 385* (FLOR); Florianpolis, Trilha para Lagoinha do Leste, 2759'43"S, 4947'83"W, 21 Mai 2014, *A.N.M. Furtado 494, 495* (FLOR); Florianpolis, Ilha do Campeche, 2769'64"S, 4846'51"W, 06 Jul 2013, *E.R.Dreschler-Santos 1085* (FLOR); Florianpolis, Trilha para Naufragados, 16 Jan 2014, *A.N.M. Furtado 440* (FLOR); Santo Amaro da Imperatriz, Hotel Plaza Caldas da Imperatriz, Trilha da Pousada, 2770'39"S, 4880'37"W, 26 Jul 2013, *A.N.M. Furtado 315, 316* (FLOR); guas Mornas, Stio Portal, 17 Dez 2013, *C. Heisecke 201* (FLOR); So Francisco do Sul, Parque Estadual do Acara, 2631'22"S, 4855'68"W, 05 Ago 2014, *F.Mafalda-Freire 242* (FLOR), *ibid.*, 05 Ago 2014, *J.A. Duque 71, 79* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis laeticolor*: BRAZIL. Rio Grande do Sul: *J. Rick* (Lloyd Catalogue n. 30205, 57698); Amazonas: Manaus, Estrada para Caracara km 45, 22 Mai 1978, *R. Singer* (INPA 79015), *ibid.*, 21 Jun 1977, *E.M.H. Freire* (INPA 79021); INDIA. Dhanaulti, Mussoorie, Uttar Pradesh, 31 Aug 1968, S.S. Rattan (BPI 294884); USA. New York: Northville &

Chittenango Falls, *E.J.H. Corner* (BPI 284886, holotype); *Cs. fusiformis*: BRAZIL. Amazonas: Manaus, Campus do INPA, 20 Mai 1977, *E.M.H. Freire* (INPA 69936), *ibid.*, 21 Jun 1977, *E.M.H. Freire* (INPA 79021) *ibid.*, 22 Mai 1978, *R. Singer* (INPA 79015), *ibid.*, Reserva Florestal Ducke, 20 Jul 1978, *R. Singer* (INPA 80977); USA. Vermont: Town of Essex, Indian Brook Reservoir, 11 Sep 2011, *M. Sundue* (FLOR 40809); *Cs. helvola*: UGANDA. Kyetume: Kyagwe, Banana plantation, 1915, *R.A. Dummer* (BPI 294872, holotype); BRAZIL. Rio Grande do Sul: Parecí Novo, 1918, *J.E. Rick* (BPI 294557); Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 01 Jul 2013, *R.C.S. Friedrich 34* (FLOR).

REMARKS – *Clavulinopsis laeticolor* is easily noticed on the field due to its vibrant color that contrasts with the soil or leaf litter. The species is easily characterized by the gregarious to fasciculate basidiomes, with a distinct stipe, becoming finely subtomentose when dried (Petersen 1965). Although some characteristics can be very variable, such as the color of basidiomes and basidia size, the contextual details and basidiospores are constant for the species (Petersen 1979).

Clavulinopsis laeticolor can be compared with *Cs. fusiformis* (Sowerby) Corner, a taxon widely distributed (Corner 1970). *Clavulinopsis fusiformis* differs by the densely fasciculate to caespitose habit, indistinct stipe and globose to subglobose basidiospores (Corner 1950). As previously discussed, *Cs. helvola* shares some macromorphological characteristics with *Cs. laeticolor*, but *Cs. helvola* has subglobose to broadly ellipsoid basidiospores that are sharply angular to echinulate-warted, $5.5\text{--}7.2 \times 4.5\text{--}5.7 \mu\text{m}$ (Petersen 1968).

Although never described before, the presence of incrustations on the inner wall of the hyphae is not considered character to separate a new species and it might be attributed to environmental or chemical changes. These structures can only be visualized in a 3% KOH plus Congo Red.

Clavulinopsis spiralis (Jung.) Corner, *Annals of Botany Memoirs No. 1*: 388 (1950)

(Figs 2F, 9DEF)

BASIDIOMES 4.0–10 cm high \times 0.1–0.4 cm wide, simple, caespitose, rare, gregarious, white (1A1), the tips becoming light yellow (1A5) with age, finely wholly greenish yellow (1A7), cylindric or

subfusiform and acute, becoming blunt and often compressed, longitudinally rugulose, twisted and flexuous; stipe 0.2–1.5 cm high \times 0.1–0.2 cm wide, indistinct, slightly villous at the base. Context waxy, solid becoming hollow; smell and taste unrecorded. BASIDIOSPORES 5.5–7.0 \times 4.5–6.0 μm ($Q=1.04$), globose, hyaline, smooth, thin-walled, uniguttulate, with a large guttula, inamyloid; hilar appendage up to 1.0 μm . BASIDIA 35–62 \times 5.0–13 μm , clavate, tri- or tetraspored, mostly tetraspored, 6.0–11 μm long, clamped. CYSTIDIA absent. HYMENIUM 40–155 μm thick at first, covering the whole basidiome except the stipe. SUBHYMENIUM up to 42.5 μm thick, coralloid. TRAMA parallel, inflated, up to 13 μm wide, slightly thick-walled, with many, narrow, little inflated, longitudinal and interweaving hyphae, 2.0–7.0 μm wide, with incrustations on the inner walls, clamped.

HABITAT AND DISTRIBUTION – Growing on soil, in shady areas, in the Atlantic forest. In Brazil it is known only from Paraná (Meijer 2006) and Santa Catarina (present study), also known to Australia, Ceylon, Java, Malaysia and Trinidad (Corner 1950, 1970).

SPECIMENS EXAMINED – BRAZIL. Santa Catarina: Itapoá, Reserva Volta Velha, 26°08'50"S, 49°04'07"W, 18 Nov 2012, *M.A. Neves 1077* (FLOR); Florianópolis, Parque Municipal das Dunas da Lagoa da Conceição, 27°60'83"S, 48°45'58"W, 19 Mar 2013, *A.N.M. Furtado 301* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Clavulinopsis spiralis*, MALAYSIA. Gunong Panti: Johore, 20 Apr 1930, *E.J.H. Corner* (BPI 294893); BRASIL. Amazonas: Manaus, Estrada para Caracará Km 115, 22 Mai 1978, *R. Singer* (INPA 79016, 20 Jul 1978, *R. Singer* (INPA 80976); *Cs. amoena*. BRAZIL. Santa Catarina: Urubici, Parque Nacional de São Joaquim (PNSJ), Trilha da Pedra, 17 Fev 2013, *R.C.S. Friedrich 21* (FLOR); MALAYSIA. Sabah: Kota Kinabalu, 20 Apr 1964, *E.J.H. Corner* (BPI 0294819), *ibid.*, 03 May 1964, *E.J.H. Corner* (BPI 0294817).

REMARKS – Based on macroscopic characteristics only *Cs. spiralis* could be mistaken by a pale form of *Cs. amoena*. However *Cs. spiralis* lacks the small granules that become green with iodine present in the subhymenial hyphae of *Cs. amoena* (Corner 1967a), and *Cs. amoena* has larger subglobose basidiospores (7.0–9.0 \times 7.0–8.5 μm) (Corner 1950).

Meijer (2006) collected from Paraná that he called *Cs. aff. spiralis*. Unfortunately the four collections deposited at MBM

herbarium were not found and the descriptions are not accessible.

Ramariopsis kunzei (Fr.) Corner, *Annals of Botany Memoirs No. 1*: 640 (1950)

(Figs 3CD, 10AB)

BASIDIOMES 4.5–6.0 cm high, solitary to gregarious, white (1A1) or pale yellow (1A2), much branched; branched 0.1–0.3 cm thick, polychotomous below, becoming narrow and dichotomous above, erect, more or less parallel to the main axis, cylindric, axils rounded and narrow, tips acute to blunt, never cristate; stipe 0.5–2.5 cm × 0.2–0.6 cm, distinct, becoming pale yellow (1A2), shortly villose-tomentose. Context slightly brittle, toughening when dried; taste and smell unrecorded. BASIDIOSPORES 3.5–4.5 × 3.0–3.5 μm (Q=1.15), subglobose, hyaline, minutely echinulate to asperulate, uniguttulate, slightly dextrinoid; hilar appendage small. BASIDIA 25–38 × 4.0–7.0 μm, clavate, bispered, 4.0–5.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 40 μm thick at first, thickening upwards up to 150 μm, covering the whole basidiome except the sterile stipe. SUBHYMENIUM up to 28.5 μm thick, composed of loosely interwoven hyphae, short-celled hyphae, up to 5.0 μm wide, thin-walled. TRAMA subparallel, inflated hyphae, 12–15 μm wide, thin-walled, short-celled next to subhymenium, smooth. Surface of sterile base composed by loosely interwoven hyphae, 2.0–4.5 μm wide, smooth, thin-walled, clamped.

HABITAT AND DISTRIBUTION – Growing mostly on soil, occasionally on decayed wood, in Atlantic forest. In Brazil it is known from Paraná (Meijer 2006), Rio Grande do Sul (Rick 1959) and Santa Catarina (present study). Borneo, Ceylon, Colombia, Costa Rica, Cuba, Guadalupe, Jamaica, Java, Panama, Philippines, New Zealand, Solomon Islands, Tibet (Corner 1950, 1970), USA (Burt 1922), Canada (Coker 1923), India (Thind 1961) and Spain (Tabaré & Rocabrana 1991).

SPECIMENS EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 27°59'43"S, 49°47'83"W, 09 Apr 2013, *A.C. Magnago 595, 596* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Ramariopsis kunzei*: BRAZIL. Rio Grande do Sul: São Leopoldo, 1927, *J.E. Rick* (BPI 332539, 332540; PACA 12460, as *Clavaria kunzei*); *ibid.*, 1932, *J.E. Rick* (PACA 17221, 17225, 17235 as *Clavulina cartilaginea*);

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 – This species is very variable in size, shape, color and basidiospore dimensions, widespread in the tropical and subtropical forest (Corner 1967a), but in all cases the stipe is villous or tomentose and the dried basidiome darkens in potash (Corner 1950, 1970).

In all collections studied, it was possible to observe a large variation in basidiospore size ($3.0\text{--}3.5 \times 2.5\text{--}3.0 \mu\text{m}$ on Rick's collection; $5.0\text{--}6.5 \times 4.5\text{--}5.7 \mu\text{m}$ on Malaysia and Solomon Islands' collections). The Malaysia and Solomon Islands' collections are probably a distinct taxon. The Brazilian collections seem to have slightly smaller basidiospores than the collections from other localities. Some basidiomes are extremely white, as the typical state of *R. kunzei* described to Europe (Thind & Rattan 1967), but in subtropical collections, there are basidiomes that start white and turn yellowish, pink or even pale yellow (Thind 1961).

Ramariopsis kunzei was originally described from Europe as having tetraspored basidia (Cotton 1907). Thind (1961) described and reported a similar specimen with bispored basidia and clampless hyphae from Mussoorie, India. Olariaga & Salcedo (2012) elevated *R. bispora* to the species level based on the bispored basidia, absence of clamps, smaller basidiomes and lack of pinkish patches in older specimens. Despite the bispored basidia, the Brazilian collections studied have clamped hyphae in the whole basidiomes, including at the basal tomentum hyphae, and the basidiomes change color in age. We do not consider the number of sterigmata as a valid character to segregate species within *Ramariopsis*.

Scytinopogon angulisporus (Pat.) Corner, *Ann. Bot. Mem. 1*: 648 (1950)
(Figs 3EF, 11ABC, 13C)

BASIDIOMES 4.0–11 cm high, solitary, gregarious or densely caespitose, chalk-white (1A1) becoming pale yellow (1A2), drying concolour, the tips white, palmately branched from a flattened stipe immersed on the ground, branching in one plane but twisted, slightly rugulose; branches flattened and narrowly spatulate, the uppersides of the branches minutely subtomentose, 0.3–0.5 cm wide in the lower branches, tapering towards the apex, polychotomous below, becoming

dichotomous, internodes longer gradually, tips acute to blunt, subulate or subterete, narrowly ligulate; stipe 1.5–4.5 cm × 0.2–0.4 cm, sometimes branched from the base, dilated and flattened below the points of branching, arising from a compact mycelial strands in the soil. Context pale yellow (1A2), slightly coriaceous, tough at the base of the stipe; smell unpleasant; taste unrecorded. BASIDIOSPORES 6.0–7.5 × 3.0–4.5 μm (Q=1.96), narrowly ellipsoid, hyaline, angular-nodulose, finely verrucose, slightly thick-walled, inamyloid; hilar appendage small. BASIDIA 25–32 × 6.0–8.0 μm, clavate, bi- to tetraspored, 4.0–5.0 μm long, finely granular-vacuolate, clamped. CYSTIDIA absent. HYMENIUM 40 μm thick, thickening upwards up to 250 μm, covering the undersides of the branches. SUBHYMENIUM up to 28.5 μm thick, composed of loosely interwoven hyphae, short-celled hyphae, 2.5–5.0 μm wide, thin-walled. TRAMA parallel, compact, with 3.5–4.0 μm wide, slightly thick-walled, long-celled hyphae, cylindric, ampulliform segments, 5.0–6.0 μm wide, ampulled septa, clamped. Surface of sterile base composed by trichodermal hyphae, 1.5–3.0 μm wide, smooth, thin-walled, clamped. Crystals of calcium oxalate covering the context hyphae and the hyphae from basal mycelium.

HABITAT AND DISTRIBUTION – Growing on the ground in the forest, perhaps also lignicolous. In Brazil it is known from Mato Grosso, Pará, Paraná, Rio de Janeiro, Rio Grande do Sul (Corner 1953, 1966b, 1970; Meijer 2006) and Santa Catarina (present study). Malaysia, Mauritius, Uganda, USA (Corner 1950, 1966b), Africa, Burma, Cameroons, Congo, Cuba, Japan, Java, Madagascar, Nigeria, Panama, Sumatra (Corner 1966b, 1970), India (Thind 1961; Dutta et al. 2012), Borneo, Philippines and Solomon Islands (Corner 1970).

SPECIMENS EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Lagoa do Peri, Trilha da Cachoeira, 27°74'41"S, 48°52'04"W, 15 Feb 2014, *A.N.M. Furtado 441* (FLOR), *ibid.*, 19 Mar 2014, *A.C. Magnago 974* (FLOR); Florianópolis, Universidade Federal de Santa Catarina, *Campus* Trindade, Depto de Botânica, 27°60'17"S, 48°52'50"W, 26 Mar 2013, *A.N.M. Furtado 304* (FLOR), *ibid.*, 14 Apr 2014, *A.N.M. Furtado 488* (FLOR), *ibid.*, *M.A. Neves 588* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon angulisporus*: 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, as *Lachnocladium mölleri*); São Leopoldo, 1925, *J.E. Rick* (BPI 295379, 333159, 333160,

333162, 333164, 723389); Pernambuco: Recife, 13 Ago 1954, *O.S. Silva* (URM 876); MALAYSIA. Malaya: Pahang, 25 Nov 1930, *E.J.H. Corner* (BPI 295368).

REMARKS – *Scytinopogon angulisporus* is very variable in morphology and a common taxon in tropical and subtropical regions (Corner 1970).

Scytinopogon angulisporus is easily recognized macroscopically by its white-chalky basidiomes with flattened branches. Microscopically it has hyaline ellipsoid, angular-echinulate basidiospores, and uninflated not mucilaginous hyphae in the whole basidiome (Corner 1950). In some of the collections studied the angles of the basidiospores are very subtle, what could give them the appearance of ellipsoid basidiospores. In addition, the specimens have a chalk-white basal mycelium that divides palmately before reaching the surface of the substrate.

Scytinopogon chartaceum (Pat.) R.H. Petersen is quite similar to *S. angulisporus* by the color and morphology of the basidiome, but *S. chartaceum* has basidiospores with stronger echinulate ornamentations, a characteristic unusual for the basidiospores of most species of *Scytinopogon* that are normally nodulose-warted, with the warts often cushion-shaped, typical of theleporoid fungi (Corner 1966b).

Scytinopogon caulocystidiatus Furtado & Neves, **sp. nov.** *ad. int.*

(Fig 3GH, 11DEF)

DIAGNOSIS – Differs from *Scytinopogon dealbatus* by the presence of a cystidial stipitipellis.

ETIMOLOGY – The name refers to the cystidia-like hyphae that covers the surface of the stipe.

HOLOTYPE – BRAZIL. Santa Catarina: Florianópolis, Ilha do Campeche, Trilha do Morcego, 27°69'64"S, 48°46'51"W, 24 Mar 2014, *A.N.M. Furtado 460* (FLOR).

BASIDIOMES 3.5–7.0 cm high, solitary, gregarious to densely caespitose, whole white (1A1), drying yellowish white (4A2) with reddish brown (8D7) tips; branches subcylindric at first becoming flattened, twisted, slightly subpruinose, 0.3 cm wide in the lower branches, tapering towards the apex, polychotomous below, di- or trichotomous upwards, internodes diminutive gradually, tips subfusiform, acute, subterete, narrowly spathulate; stipe cylindric, short, 1.0–2.0 × 0.3–0.5 cm. Context reddish brown (8DF), tough at the base of the stipe; smell amoniac; taste

unrecorded. BASIDIOSPORES 3.5–4.5 × 3.0–3.5 μm (Q=1.06), subglobose, hyaline, uniguttulate, slightly angular, diminute spines, slightly thick-walled, inamyloid; hilar appendage up 0.5 μm. BASIDIA 20–29 × 4.5–6.0 μm, clavate, bi- to tetraspored, 3.5–5.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 62.5 μm thick, thickening upwards, amphigenous, stratified in three layers, older basidia tortuous to collapsed, covering the whole basidiome except the stipe. SUBHYMENIUM up to 40 μm thick, articulate, hyphae with 5.0 μm wide, thin-walled. TRAMA subparallel, narrower hyphae, cylindric, 4.0–6.0 μm wide, alternating with inflated hyphae, 10–12 μm wide, ampulliform segments rare, 6.0–7.0 μm wide, thin-walled, clamped. Surface of stipe composed by cystidial hyphae, smooth, thin-walled, clamped, narrowly utriform, capitate to spheropedunculate, 58–72 × 10–18 μm, peduncle when present 4.0 × 2.0 μm; medullary hyphae of the stipe colored pale yellow (1A2), irregularly inflated, 2.0–7.0 μm wide.

HABITAT AND DISTRIBUTION – Growing on sandy soil in *restinga*. It is known only from the type locality.

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon dealbatus*. BRAZIL. Rio Grande do Sul: Panuré, São Jerônimo, 1873, Spruce (K 135803, 135804, holotype of *Clavaria dealbata*); 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 as *Scytinopogon dubiosum*), *ibid.*, 1932, J.E. Rick (BPI 295383); Mato Grosso: Chavantina, 01 Feb 1968, E.J.H. Corner (RBGE 101765).

REMARKS – *Scytinopogon caulocystidiatus* is difficult to be found in the field due to the sandy color of the basidiomes that mixes with the whitish sandy substrate.

The macromorphology of *S. caulocystidiatus* is similar to *S. dealbatus* on the size, shape, color and consistency of the basidiomes. Also, they both have the amphigenous hymenium, unlike most *Scytinopogon* species. They differ by the basidiospores morphology, that is ellipsoid in *S. dealbatus* and subglobose in *S. caulocystidiatus*, and by the lack of caulocystidia in *S. dealbatus*.

The diagnostic characteristic of this species is the cystidial stipitipellis, never described before for *Scytinopogon* (Corner 1950, 1970; Petersen 1988; García-Sandoval et al. 2004).

Scytinopogon chartaceum (Pat.) R.H. Petersen, *Mycologia* 80(4): 574 (1988)

(Figs 4AB, 11GHI)

BASIDIOMES 3.0–6.5 × 2.5–4.7 cm, solitary to gregarious, chalk-white (1A1) becoming grayish white (1B1), drying pale yellow (3A4), the tips palmately branched from a flattened stipe immersed on the ground, branching in one plane, twisted; branches flattened and narrowly spatulate, 0.2–0.6 cm wide in the lower branches, tapering towards the apex, polychotomous below, becoming dichotomous, internodes diminishing gradually, axils rounded, tips acute to blunt, subterete, suede-like above, smooth below; stipe 1.5–3.0 × 0.7–1.5 cm, sometimes branched from the base, dilated and flattened below the points of branching, arising from a very scarce white mycelial strands on the soil. Context pale yellow (1A2), waxy, tough at the base of the stipe, drying cartilaginous; smell and taste unrecorded. BASIDIOSPORES 6.0–8.0 × 3.0–4.5 μm (Q=1.82), narrowly ellipsoid, hyaline, angular-echinulate, slightly thick-walled, inamyloid; hilar appendage obscured by spore ornamentation. BASIDIA 25–32 × 6.0–8.0 μm, clavate, barrel-shaped, uni- to bispored, 4.0–7.0 μm long, with contents homogeneous to minutely guttulate, clamped. CYSTIDIA absent. HYMENIUM thickening upwards up to 100 μm, covering the undersides of the branches. SUBHYMENIUM 30 μm thick, short-celled hyphae, 2.5–3.0 μm wide, thin-walled. TRAMA parallel, with 3.5–4.0 μm wide, slightly thick-walled, long-celled hyphae, cylindric, ampuliform segments, 5.5–8.0 μm wide, ampullate septa, clamped. Surface of sterile base composed by repent hyphae, 2.5–5.0 μm wide, smooth, thin-walled, clamped. Crystals of calcium oxalate covering the contextual hyphae and the hyphae from basal mycelium.

HABITAT AND DISTRIBUTION – Growing on soil, between the litter, in Atlantic forest. Known only from Brazil: São Paulo (Campinas, Patouillard 1907; São Paulo, Petersen 1988) and Santa Catarina (present study).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Trilha para Naufragados, 23 Mai 2014, *A.N.M. Furtado 504* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon angulisporus*: BRAZIL. Paraíba: Mataraca, 06 Jun 2011, *F. Wartchow* (JPB 45094); Florianópolis, Universidade Federal de Santa Catarina, *Campus* Trindade, Depto de Botânica, 27°60'17"S, 48°52'50"W, 26 Mar 2013, *A.N.M. Furtado 304* (FLOR), *ibid.*, 14 Apr 2014, *A.N.M. Furtado 488* (FLOR); 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, as *Lachnocladium mölleri*); São Leopoldo, 1925, *J.E. Rick* (BPI 295379, 333159, 333160, 333162, 333164, 723389); Pernambuco: Recife, 13 Ago 1954, *O.S. Silva* (URM 876); MALAYSIA. Malaya: Pahang, 25 Nov 1930, *E.J.H. Corner* (BPI 295368).

REMARKS – *Scytinopogon chartaceum* is a subtropical species, known from the type locality (Petersen 1984) and Santa Catarina state (present study).

The type specimen was not requested for loan due to the age of the specimen, first published as *Lachnocladium chartaceum* by Patouillard (1907). The identification of the Brazilian specimen was based on the protologue published by Patouillard (1907, as *Lachnocladium chartaceum*) and the description published by Petersen (1988) from a specimen collected by Dr. Leif Ryvarden and identified as *S. chartaceum*.

The only species that shares macro- and microcharacteristics with *S. chartaceum* is *S. angulisporus*, as previously discussed. Although hardly noticeable, they differ by their branching pattern, the surface of the basidiomes and the basal mycelium compaction (Petersen 1988). *Scytinopogon angulisporus* has larger internodes, rugulose and subtomentose basidiomes, and a very compact and abundant basal mycelium (Corner 1950, 1970). *Scytinopogon chartaceum* has smaller internodes, basidiomes with a smooth surface, and a scarce and loosely attached basal mycelium (Petersen 1984). Also, *S. angulisporus* has nodulose to verrucose basidiospores, and *S. chartaceum* has echinulate basidiospores with long spines (Petersen 1988).

Scytinopogon dealbatus (Berk.) Corner, *Beih. Nova Hedwigia* 33: 89 (1970)

(Figs 4CD, 11JK)

BASIDIOMES 5.5–7.5 cm high, solitary to gregarious, white (1A1), the hymenium becoming pale yellow (1B3), drying to reddish brown (5C4); branched 0.1–0.3 cm thick, flattened axils, tips concolorous with the branches; stipe 0.2–0.3 cm thick, slightly distinct, white (1A1), branches often polychotomous from the base, becoming dichotomous above, ligulate, smooth. Context tough; taste and smell unrecorded. BASIDIOSPORES 4.0–4.5 × 2.5–3.5 μm (Q=1.39),

ellipsoid, hyaline, echinulate, varying to almost spineless, uniguttulate, inamyloid; hilar appendage up to 1.0 μm , often sublateral. BASIDIA 21–29 \times 5.0–7.0 μm , clavate, tetraspored, 3.5–6.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 150 μm thick, thickening upwards, amphigenous, covering the whole basidiome except the stipe. SUBHYMENIUM up to 20 μm thick, composed of loosely interwoven hyphae, short-celled hyphae, up to 5.0 μm wide, thin-walled. TRAMA subparallel, hyphae with 5.0–6.5 μm wide, thin-walled, subgelatinous wall, ampuliform segments, 6.6–13 μm wide, ampullate septa, clamped, slightly agglutinated.

HABITAT AND DISTRIBUTION – Growing on the ground in Atlantic forest. In Brazil it is known from Mato Grosso (Corner 1970), Paraná (Meijer 2006), São Paulo (Petersen 1988) and Rio Grande do Sul (Rick 1959; present study). Bolivia, Panama (Corner 1970) and Venezuela (Petersen 1988).

SPECIMENS EXAMINED – BRAZIL. Rio Grande do Sul: Porto Alegre, Universidade Federal do Rio Grande do Sul, *Campus do Vale*, 01 Apr 2014, *E.P. Fazolino 176, 177* (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon dealbatus*. BRAZIL. Rio Grande do Sul: Panurê, São Jerônimo, 1873, *Spruce* (K 135803, 135804, holotype of *Clavaria dealbata*); 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 as *Scytinopogon dubiosum*), *ibid.*, 1932, *J.E. Rick* (BPI 295383); Mato Grosso: Chavantina, 01 Feb 1968, *E.J.H. Corner* (RBGE 101765); *Scytinopogon scaber*: BRUNEI, 15 Feb 1959, *E.J.H. Corner* (K 69072); *Scytinopogon angulisporus*: BRAZIL. Pernambuco: Recife, Parque Estadual de Dois Irmãos, 13 Ago 1954, *O.S. Silva* (URM 876); Vitória de Santo Antão, Itamatamirim, 17 Sep 1954, *S.J. Silva* (URM 1071); Rio Grande do Sul: São Leopoldo, 1925, *J.E. Rick* (BPI 295379, 333159, 333160, 333162, 333164, 723389); BELIZE, 2002, *P.J. Roberts* (K 109202, 109203, 109237).

REMARKS – *Scytinopogon dealbatus* is similar to young basidiomes of *Scytinopogon scaber* (Berk. & M.A. Curtis) D.A. Reid, but it lacks the erect habit and the papillae on the branches (Petersen 1988). Also, the hymenium is present on both sides of the branches, contrary to other *Scytinopogon* species in which the hymenium is unilateral.

Scytinopogon angulisporus could be mistaken for a robust form

of *S. dealbatus*. However *S. angulisporus* has flattened branches with hymenium on one side of the branches, mycelium at the base of stipe, angular-nodulose basidiospores, and lacks the agglutination on the hyphae trama (Corner 1950).

Petersen (1988) proposed to combine *S. dealbatus* in *Ramariopsis* based on the gelatinous consistency of the context of the basidiomes when fresh, a characteristic never reported for *Scytinopogon*. However, Petersen (1988) also studied a specimen from Venezuela collected by Halling and identified as *S. dealbatus*, agreeing that it shares more characteristics with *Scytinopogon* than with *Ramariopsis*, especially regarding the dextrinoid reaction on *Ramariopsis*.

Scytinopogon foetidus Furtado & Neves, **sp. nov. ad. int.**

(Figs 4EF, 11LM, 13D)

DIAGNOSIS – Differs from *Scytinopogon robustus* by the robust basidiomes, uninflated hyphae and the presence of crystals of calcium oxalate in the cortical layer.

ETIMOLOGY – The name refers to the strong, unpleasant smell of the basidiomes.

HOLOTYPE – BRAZIL. Santa Catarina: Florianópolis, Costão do Santinho, Morro das Aranhas, 27°47'66"S, 48°38'18"W, 27 Jan 2014, *A.N.M. Furtado 423* (FLOR);

BASIDIOMES 2.5–5.5 cm high, gregarious, pale grayish beige (4C2) becoming reddish brown (8E6) to deep brown (8F5) upwards, the tips pure white (1A1), palmately branched from a flattened stipe, branching in one plane, twisted sometimes, subpruinose; branches cylindric to flattened and narrowly spatulate, 0.3–0.4 cm wide in the lower branches, tapering towards the apex, polychotomous below, becoming dichotomous, internodes diminute gradually, tips blunt, subterete, narrowly ligulate; stipe 0.8–1.5 cm × 0.2–0.6 cm, rare branched from the base, flattened below the points of branching, pale grayish beige (4C2). Context pale yellow (1A2), slightly viscid, tough at the base of the stipe; smell unpleasant; taste unrecorded. BASIDIOSPORES 5.0–6.5 × 3.0–4.0 μm (Q=1.52), ellipsoid, the inner side slightly applanate to slightly concave, hyaline, finely verrucose, thin-walled, inamyloid; hilar appendage small. BASIDIA 23–28 × 7.0–9.0 μm, clavate, barrel-shaped, tetraspored, 3.0–5.0 μm long, clamped. CYSTIDIA absent. HYMENIUM 32.5 μm thick, covering the whole basidiome except the sterile stipe. SUBHYMENIUM up to 50 μm thick, ramulose-coralloid, short-celled hyphae, loosely interwoven, thin-

walled. TRAMA subparallel, hyphae with 3.5–8.0 µm wide, thin-walled, constricted at the septa, ampulaeform segments, inflated septa, 5.0–6.0 µm wide, clamped. Surface of sterile stipe composed by trichodermal hyphae, up to 3.0 µm wide, cylindric, slightly thick-walled, clamped. Crystals of calcium oxalate covering the cortical hyphae from the sterile stipe.

HABITAT AND DISTRIBUTION – Growing on the ground in the forest, perhaps also lignicolous. It is known only from the type locality.

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon robustus*: BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 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: Parecí Novo, 1935, J.E. Rick (PACA 12457, holotype).

REMARKS – Considering that the color of the basidiomes in most species from *Scytinopogon* is frequently white, the only species to compare to *S. foetidus* based on the color is the grayish purple *S. robustus*. *Scytinopogon robustus*, however, is more slender and dry, with flattened branches and an unilateral hymenium (Corner 1970), it has inflated hyphae and lacks crystals of calcium oxalate in the context.

Scytinopogon robustus (Rick) Corner, *Beih. Nova Hedwigia* 33: 91 (1970)

(Figs 4GH, 12AB)

BASIDIOMES 2.3–3.5 cm high, solitary or caespitose, pale grayish (19B2), drying pale yellow (3A4), subfragile, flattened; branches flattened to subcylindric, bifurcate with slightly compressed axils, subacute, mostly dichotomous, internodes irregular, diminishing gradually towards the apex, tips grayish violet (15E5), subulate, sometimes blunt, subcristate, subpalmate; stipe 0.9 × 0.2 cm, white to pale grayish (19B2), smooth, cylindric to flattened, coriaceus-fibrous. Context hollow; smell and taste absent. BASIDIOSPORES 6.0–6.5 × 3.5–4.0 µm (Q=1.53), ellipsoid, hyaline, angular-nodular, slightly echinulate, slightly thick-walled, inamyloid; hilar appendage obscured by spore ornamentation. BASIDIA 22–31 × 7.0–10 µm, clavate, barrel-shaped, bi- or tetraspored, mostly tetraspored, 3.0–5.0 µm long, with contents homogeneous to minutely guttulate, clamped. CYSTIDIA absent. HYMENIUM 37.5 µm thick, covering the undersides of the branches. SUBHYMENIUM 20 µm thick, coralloid, composed of short-celled hyphae, slightly inflated, clamped. TRAMA composed of

subparallel hyphae, inflated, 6.0–23 µm wide, thin-walled, slightly constricted at the septa, clamped. Surface of sterile base covered by repent hyphae, smooth, hyaline, clamped; medullary 12–15 µm wide, cortical hyphae up to 3.0 µm wide.

HABITAT AND DISTRIBUTION – Growing on soil, among the litter, in Atlantic forest. In Brazil it is known from Paraná (Meijer 2006), Rio de Janeiro (Corner 1970), Rio Grande do Sul (Rick 1959) and Santa Catarina (present study). Also known from Porto Rico (Corner 1970) and Mexico (García-Sandoval et al. 2004).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Florianópolis, Morro da Lagoa, Trilha do Jipe, 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);

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon robustus*: BRAZIL. Rio Grande do Sul: Parecí Novo, 1935, J.E. Rick (PACA 12457, holotype); *S. angulisporus*: BRAZIL. Rio Grande do Sul: São Leopoldo, 1925, *J.E. Rick* (BPI 295379, 333159, 333160, 333162, 333164, 723389); BELIZE, 2002, *P.J. Roberts* (K 109202, 109203, 109237); MALAYSIA. Malaya: Pahang, 25 Nov 1930, *E.J.H. Corner* (BPI 295368); *S. echinosporus*: SOLOMON ISLANDS. 1967. *E.J.H. Corner* (RBGE 101775); INDONESIA. 1996, *R.F. Ellen* (K 45815).

REMARKS – Despite of the name, *Scytinopogon robustus* is hard to find on the field due to its small size and fragile basidiomes with pale colors. The epithet refers to the size of the basidiospores that are bigger than that described for *Scytinopogon*.

Scytinopogon angulisporus, a widespread species, is similar to a pale form of *S. robustus*, however besides the different color, the basidiospores are slightly bigger (4.5–) 5.5–7.0 × (2.5–) 3.5–4.0 (–4.5) µm, and the hyphae are not inflated (occasionally up to 10 µm wide) (Corner 1950, 1970; García-Sandoval et al. 2004).

Among the known species of *Scytinopogon*, only *S. robustus* and *S. echinosporus* (Berk. & Broome) Corner have inflated hyphae (Corner 1970). *Scytinopogon echinosporus* has basidiomes with light brown tips and smaller basidiospores (4.5–5.5 × 3.5 µm, García-Sandoval et al. 2004).

Scytinopogon scaber (Berk. & M.A. Curtis) D.A. Reid, *Persoonia* 2(2):

BASIDIOMES 9.5 cm high, solitary to scattered, white (1A1), slightly translucent, branched; branches in one plane, becoming inclined and horizontal, flattened and narrowly spathulate, polychotomous below, becoming dichotomous, internodes distally, subterete, slightly expanded at the axils and becoming horizontal, the underside developing minutely spines or papillae at first scattered, then crowded and concrescent, entire or slightly dentate, irregular; stipe 3.5 cm × 0.7 cm, dilating 0.3 cm wide upwards, multifid. Context rather dry, firm; smell and taste absent. BASIDIOSPORES 3.0–4.0 × 2.5–3.5 μm (Q=1.26), broadly ellipsoid, hyaline, slightly angular, echinulate, inamyloid; hilar appendage obscured by spore ornamentation. BASIDIA 15–18 × 4.5–5.5 μm, clavate, tetraspored, 2.0–4.0 μm long, finely granular-vacuolate, clamped. CYSTIDIA absent. HYMENIUM 20 μm thick, thickening upwards, amphigenous, covering the undersides of the branches, sterile on the hypogeous region. SUBHYMENIUM 15 μm thick, coralloid, short-celled hyphae, 2.5–5.0 μm wide, thin-walled. TRAMA parallel, hyphae with 3.5–4.0 μm wide, slightly thick-walled, long-celled hyphae, cylindric, wide hyphae spread in the context, 8.0–12 μm wide, not inflated, clamped. Surface of sterile base covered by repent hyphae, 3.0 μm wide, cylindric, slightly thick-walled, disarticulated.

HABITAT AND DISTRIBUTION – Growing on the ground, in Atlantic forest. In Brazil it is known from Amazonas (Corner 1970) and Santa Catarina (present study). Also known from Fiji, Brunei (Corner 1970) and Mexico (Ramírez-Lopes et al. 2012).

SPECIMEN EXAMINED – BRAZIL. Santa Catarina: Santo Amaro da Imperatriz, Hotel Plaza Caldas da Imperatriz, Trilha da Pousada, 27°70'39"S, 48°80'37"W, 10 Apr 2014, *A.N.M. Furtado* 483 (FLOR).

ADDITIONAL SPECIMENS EXAMINED – *Scytinopogon scaber*: BRUNEI. 1959, *E.J.H. Corner* (K 69072), *ibid.*, 1992, *B.M. Spooner* (K 27130).

REMARKS – Originally described from Fiji, *Scytinopogon scaber* is diagnosed by its small, echinulate basidiospores and branched, clavarioid basidiomes that are distinctly papillate (Ramírez-Lopes et al. 2012).

The collection from Santa Catarina is quite similar to Corner's collection from Brunei, except for some hyphae in the context that are wider in the Brazilian specimen (2.0–3.5 (–4.0) μm wide on Corner's specimen).

Scytinopogon papillosus Corner is the only other species in the genus that has a papillate hymenophore (Corner 1970). *Scytinopogon papillosus* can be distinguished by the reddish color of the basidiomes, the very strongly inflated hyphae (3.0–25 (–30) μm wide), and the larger ellipsoid basidiospores (4.0–4.5 \times 2.7–3.5 μm) (Corner 1970).

Scytinopogon papillosus was only recorded from Bolivia, from Singer's collection by Corner (1970). As the type collection could not be tracked, the comparison was made based on the protologue published by Corner.

Key to Clavariaceae species from Brazil

1. Hyphae without clamps, often secondarily septate, or with a clamp at the base of the basidia 2 (*Clavaria*)
 Hyphae clamped, not secondarily septate 7
2. Simple basidiomes 3
 Branched basidiomes 6
3. Basidia with a wide loop-like clamp at the base *Ca. gibbsiae*
 Basidia without clamps 4
4. Basidiomes deep orange to red, typically caespitose *Ca. subglobosa*
 Basidiomes white to pale yellow, not caespitose 5
5. Basidiomes rather robust, fuliginous, becoming light brown when older, basidiospores 5.0–8.0 \times 4.0–5.0 μm *Ca. fumosa*
 Basidiomes fragile, white, smaller basidiospores 4.5–5.5 \times 2.0–3.5 μm *Ca. fragilis*
6. Basidiomes light yellow to greenish yellow, basidiospores narrowly ellipsoid, context hyphae diverticulate *Ca. diverticulata*
 Basidiomes purple to deep purple, basidiospores broadly ellipsoid,

- context hyphae smooth-walled *Ca. zollingeri*
7. Basidiospores smooth or sharply angular to tuberculous, in some species with simple basidiomes 8 (*Clavulinopsis*)
 Basidiospores regularly nodulose-verrucose or echinulate; branched basidiomes 14
8. Verrucose-angular basidiospores *Cs. helvola*
 Smooth basidiospores 9
9. Basidiomes orange, pinkish orange to deep orange 10
 Basidiomes white tinged yellow to yellow or greenish yellow 12
10. Basidiospores and basidia dimorphic *Cs. dimorphica*
 Basidiospores and basidia of the same size and shape 11
11. Basidiospores ellipsoid to pip-shaped, with a proeminent hilar appendage (1.5–2.0 μm long) *Cs. laeticolor*
 Basidiospores subglobose, with a short hilar appendage (0.5–1.0 μm long) *Cs. aurantiocinnabarina*
12. Growing solitary or in small groups; context hyphae irregularly thick-walled *Cs. imperata*
 Typically caespitose; context hyphae with walls regularly thickened 13
13. Subhymenium with small orange granules that become greenish with iodine; basidiospores 7.0–9.0 \times 7.0–8.5 μm *Cs. amoena*
 Subhymenium without orange granules; basidiospores slightly smaller 6.0–8.0 \times 6.0–7.5 μm *Cs. spiralis*
14. Basidiomes radially branched, hymenium amphigenous; basidiospores not angular *Ramariopsis kunzei*
 Basidiomes branching in one plane, mostly flat, hymenium often unilateral; basidiospores angular 15 (*Scytinopogon*)
15. Hymenophore becoming more or less minutely papillate or hydroid
S. scaber

Hymenophore smooth	16
16. Basidiomes light brown to reddish brown when fresh	17
Basidiomes pure white to pale yellow when fresh	18
17. Basidiomes slender and dry, with flattened branches; inflated hyphae on the context, 12–23 μm wide	<i>S. robustus</i>
Basidiomes robust and viscid, with inflated branches; hyphae on the context up to 8.0 μm wide	<i>S. foetidus</i>
18. Basidiomes subfragile, becoming reddish brown when dried; basal mycelium absent	19
Basidiomes more robust, becoming grayish yellow when dried; basal mycelium present	20
19. Subglobose basidiospores; cystidial stipitipellis present	<i>S. caulocystidiatus</i>
Ellipsoid basidiospores; cystidia stipitipellis absent	<i>S. dealbatus</i>
20. Basal mycelium very compact and abundant with crystals insoluble in KOH; basidiospores nodulose, finely verrucose	<i>S. angulisporus</i>
Basal mycelium scarce and loosely attached, without crystals; basidiospores truly echinulate	<i>S. chartaceum</i>

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Figure 1 – Photographs of basidiomes in the field. A. *Clavaria diverticulata*

(ACM 1044); **B.** *Ca. fragilis* (ACM 1041); **C.** *Ca. fumosa* (ACM 598); **D.** *Ca. gibbsiae* (ANMF 484); **E.** *Ca. subglobosa* (MAN 732); **F.** *Ca. zollingeri* (ANMF 365). Bars = 1.0 cm. Photographs by Altelys C. Magnago (A, B, C).



Figure 2 – Photographs of basidiomes in the field. **A.** *Clavulinopsis amoena* (KEL 21); **B.** *Cs. aurantiocinnabarina* (ANMF 382); **C.** *Cs. dimorphica* (ACM 1051); **D.** *Cs. imperata* (ANMF 482); **E.** *Cs. laeticolor* (ANMF 495); **F.** *Cs. spiralis* (MAN 1077). Bars = 1.0 cm. Photographs by Raquel Friedrich (A) and Altielys C. Magnago (C).



Figure 3 – Photographs of basidiomes in the field and Scanning Electron Microscopy of the basidiospores. **A–B.** *Clavulinopsis helvola* (KEL 34); **C–D.** *Ramariopsis kunzei* (ACM 596); **E–F.** *Scytinopogon angulisporus* (ANM 488); **G–H.** *S. caulocystidiatus* (ANMF 460). Bars (A, C, E, G) = 1.0 cm (B, D, F, H) = 2.0 μ m. Photography by Altelys C. Magnago (C).



Figure 4 – Photographs of basidiomes in the field and Scanning Electron Microscopy of the basidiospores. **A–B.** *Scytinopogon chartaceum* (ANMF 504); **C–D.** *S. dealbatus* (EPF 176); **E–F.** *S. foetidus* (ANMF 423); **G–H.** *S. robustus* (ANMF 422). Bars (A, C, E, G) = 1.0 cm (B, D, F, H) = 2.0 μ m. Photographs by Pablo P. Daniëls (A) and Eduardo Perez Fazolino (C).



Figure 5 – Photographs of basidiomes in the field and Scanning Electron Microscopy of the basidiospores. **A–B.** *Scytinopogon scaber* (ANMF 483). Bars (A) = 1.0 cm (B) = 2.0 μ m.

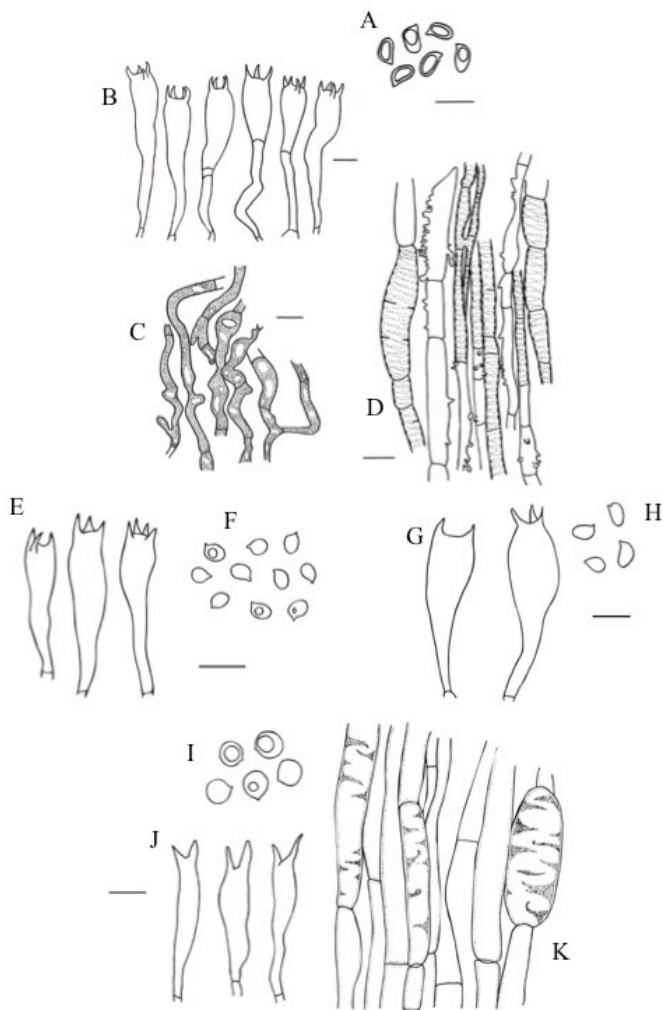


Figure 6 – Microcharacters of *Clavaria* species. **A–D.** *Ca. divarticulata* (ACM 1044). **A.** Basidiospores; **B.** Basidia; **C.** Hyphae with oleaginous contents; **D.** Hyphae from the context. Hyphae divarticulata with incrustations on the inner wall and secondarily septate. **E–F.** *Ca. fragilis* (ACM 1041). **E.** Basidia; **F.** Basidiospores; **G–H.** *Ca. fumosa* (ACM 598). **G.** Basidia; **H.** Basidiospores; **I–K.** *Ca. gibbsiae* (ANMF 484). **I.** Basidiospores; **J.** Basidia; **K.** Hyphae from

the context with incrustations on the inner wall. Bars = 10 μm .

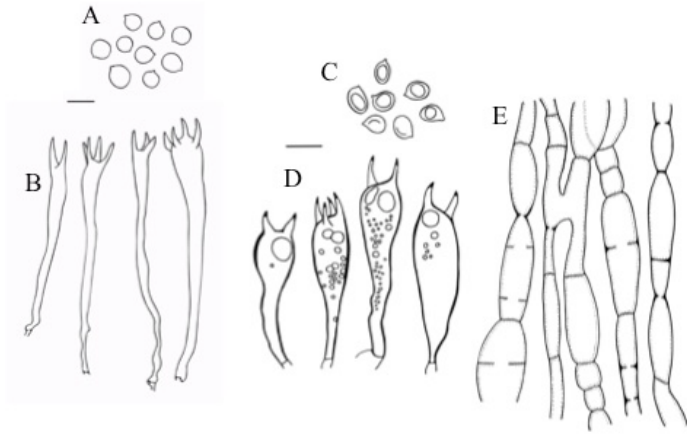


Figure 7 – Microcharacters of *Clavaria* species. **A–B.** *Ca. subglobosa* (MAN 732). **A.** Basidiospores; **B.** Basidia; **C–E.** *Ca. zollingeri* (ANMF 365). **C.** Basidiospores; **D.** Basidia; **E.** Hyphae secondarily septate. Bars = 10 µm.

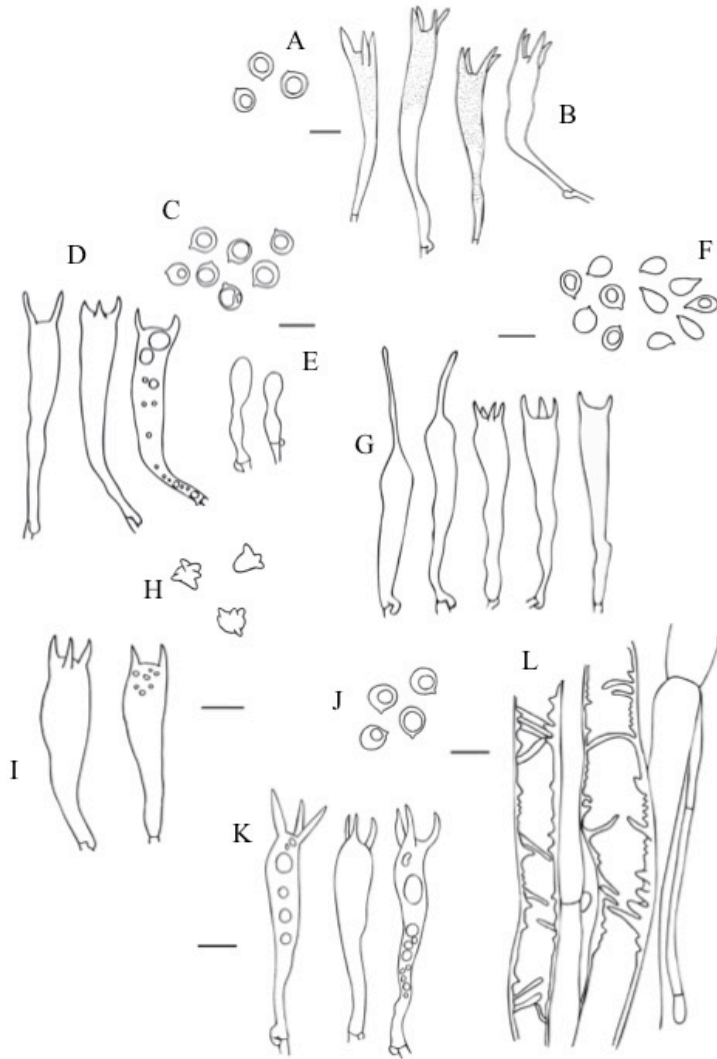


Figure 8 – Microcharacters of *Clavulinopsis* species. **A–B.** *Cs. amoena* (KEL 21). **A.** Basidiospores; **B.** Basidia; **C–E.** *Cs. aurantiocinnabarina* (ANMF 382). **C.** Basidiospores; **D–E.** Basidia; **F–G.** *Cs. dimorphica* (ACM 1051). **F.** Basidiospores; **G.** Basidia; **H–I.** *Cs. helvola* (KEL 34). **H.** Basidiospores; **I.** Basidia; **J–L.** *Cs. imperata* (ANMF 482). **J.** Basidiospores; **K.** Basidia; **L.** Hyphae with irregularly thickened wall. Bars = 10 μ m.

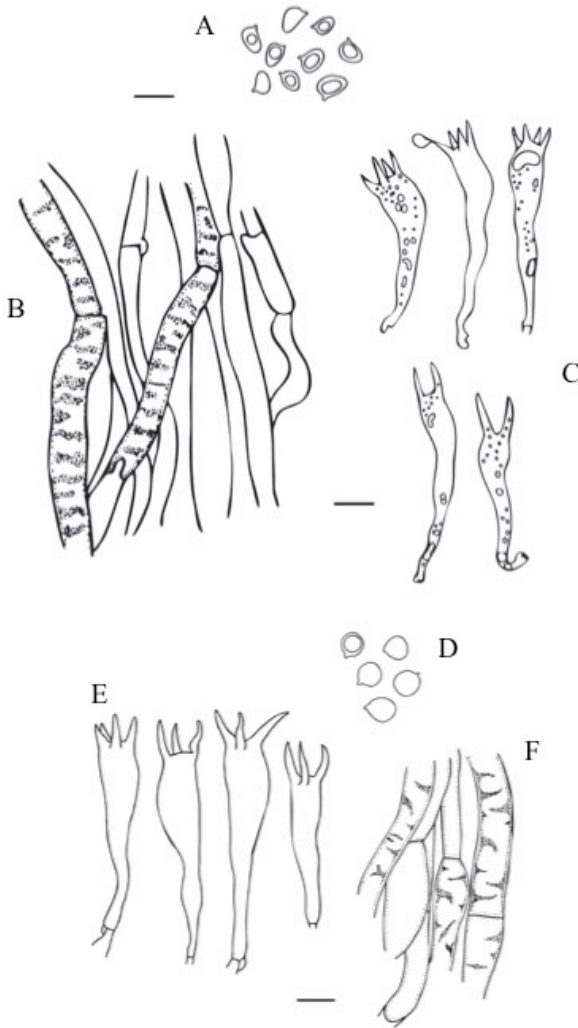


Figure 9 – Microcharacteres of *Clavulinopsis* species. **A–C.** *Cs. laeticolor* (ANMF 495). **A.** Basidiospores; **B.** Basidia; **C.** Hyphae with incrustations on the inner wall; **D–F.** *Cs. spiralis* (MAN 1077). **D.** Basidiospores; **E.** Basidia; **F.** Hyphae with incrustations on the inner walls. Bars = 10 µm.

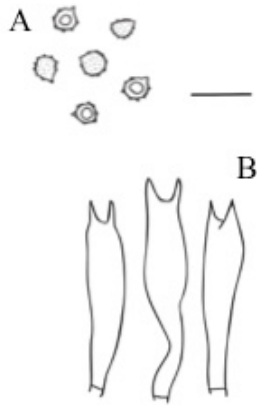


Figure 10 – Microcharacteres of *Ramariopsis* species. **A–B.** *R. kunzei* (ACM 596). **A.** Basidiospores; **B.** Basidia. Bar = 10 μ m.

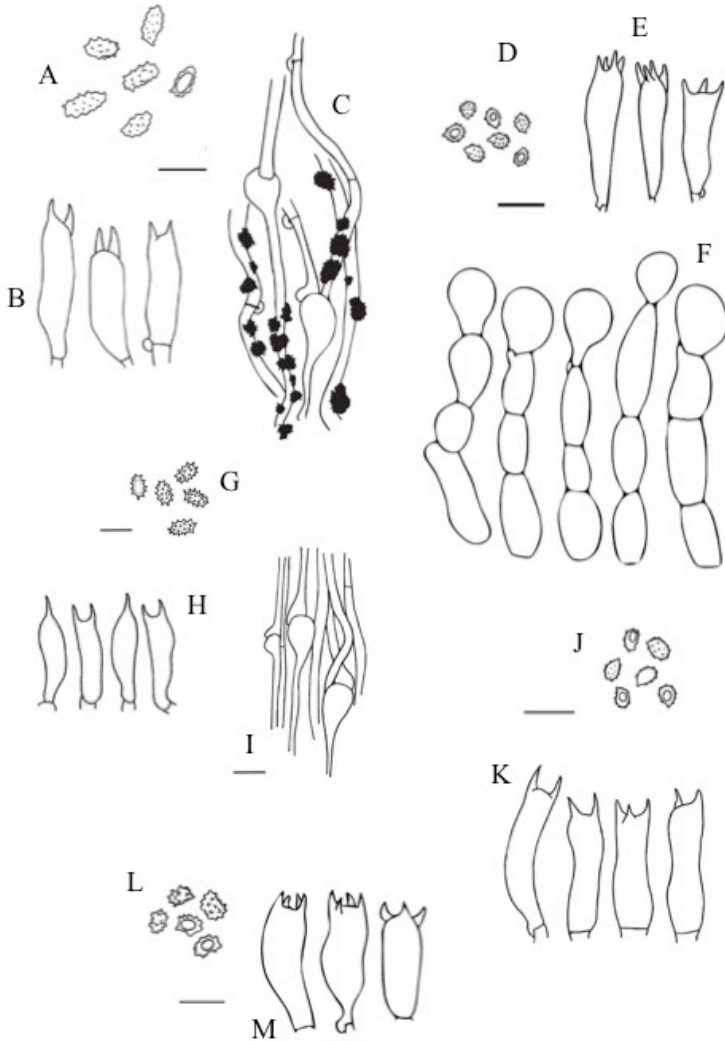


Figure 11 – Microcharacters of *Scytinopogon* species. **A–C.** *S. angulisporus* (ANMF 488). **A.** Basidiospores; **B.** Basidia; **C.** Context hyphae with crystals of calcium oxalate; **D–F.** *S. caulocystidiatus* (ANMF 460). **D.** Basidiospores; **E.** Basidia; **F.** Capitulate cystidia of the stipe; **G–I.** *S. chartaceum* (ANMF 504). **G.** Basidiospores; **H.** Basidia; **I.** Context hyphae with ampulaeform segments; **J–K.** *S. dealbatus* (EPF 176). **J.** Basidiospores; **K.** Basidia; **L–M.** *S. foetidus* (ANMF 423). **L.** Basidiospores; **M.** Basidia. Bars = 10 µm.

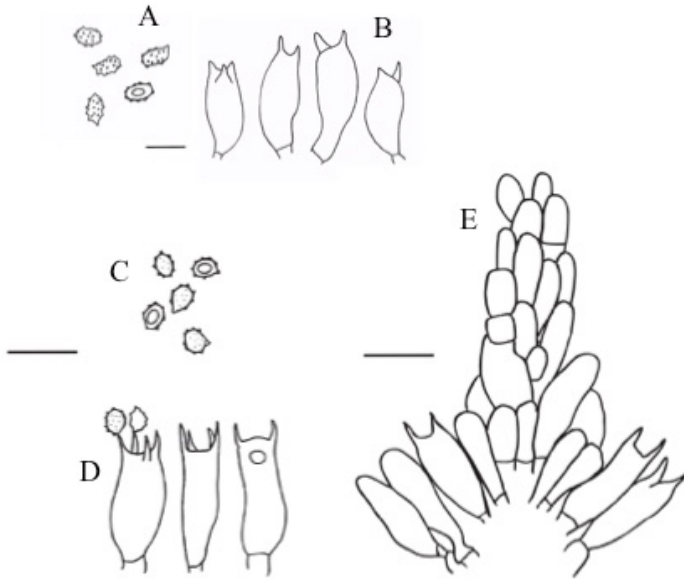


Figure 12 – Microcharacters of *Scytinopogon* species. **A–B.** *S. robustus* (ANMF 422). **A.** Basidiospores; **B.** Basidia; **C–E.** *S. scaber* (ANMF 483). **C.** Basidiospores; **D.** Basidia; **E.** Underside of the branches showing the papillate hymenium. Bars = 10 μ m.

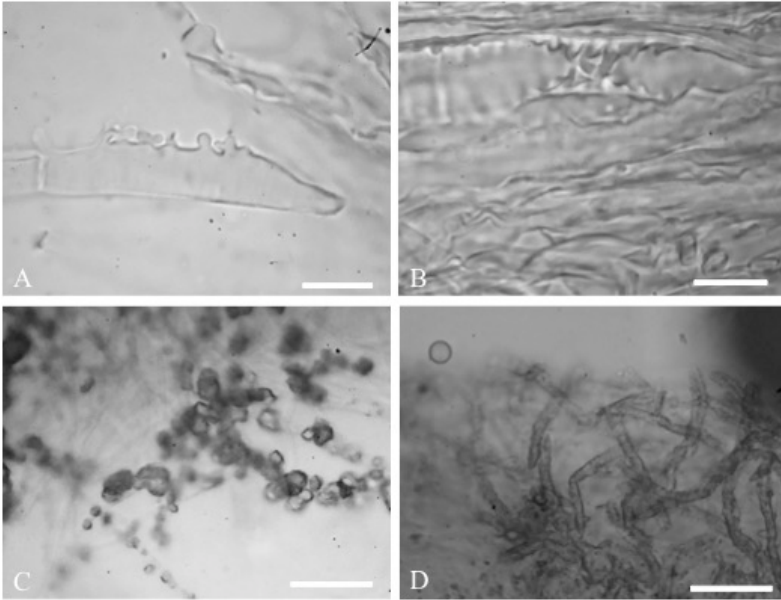


Figure 13 – Photographs of microcharacters. **A.** Diverticulate hyphae of *Clavaria diverticulata*; **B.** Hyphae with irregularly thickened walls of *Clavulinopsis imperata*; **C.** Context hyphae with crystal of calcium oxalate of *S. angulisporus*; **D.** Hyphae covered with crystals of calcium oxalate from the surface of sterile stipe of *S. foetidus*. Bars = 10 µm.

4 CONCLUSÃO

O presente trabalho amplia os estudos de Clavariaceae para o Brasil, reforçando informações sobre as espécies já registradas, além de fornecer novidades acerca da diversidade e distribuição da família.

Considerando a ampliação nos dados de distribuição das espécies de Clavariaceae para o país, além dos cinco novos táxons propostos neste trabalho, podemos reforçar as afirmativas de que existe uma grande diversidade da família nas regiões tropicais e subtropicais (Corner 1950, 1970; Petersen 1988; García-Sandoval et al. 2004, 2005; Birkebak et al. 2013). Torna-se necessário, porém, expandir os estudos de Clavariaceae no Brasil a partir da inclusão de novas áreas de amostragem, p.ex. o bioma Amazônia, e incrementação no número de expedições de coleta, de tal forma que novos dados de distribuição possam ser gerados e potenciais novos táxons sejam descritos.

A revisão dos fungos clavarioides da *Fungi Rickiani* foi de suma importância, pois demonstrou que apesar de existir uma grande diversidade de táxons da família registrados para o sul do país, alguns espécimes estavam com a descrição e identificação equivocadas ou incompletas. Desta forma, foi possível realizar a redeterminação de alguns exemplares, além de fornecer uma descrição micromorfológica mais completa, respeitando o estado de preservação das exsiccatas.

Os caracteres morfológicos que delimitam os táxons dentro de *Clavaria* e *Clavulinopsis* precisam ser melhor elucidados, visto que as características que definem as espécies ainda são dúbias. Além disso, deve-se ressaltar que as circunscrições propostas para os táxons já descritos são baseadas em espécimes de regiões temperadas.

Embora neste trabalho tenham sido apresentados resultados preliminares sobre as relações filogenéticas de Clavariaceae, principalmente no que diz respeito à posição de *Scytinopogon* na família, estas precisam ser revisadas e ampliadas, de tal forma que consideramos necessária uma abordagem integrativa de análises morfológicas, ecológicas, moleculares e evolutivas, com a inclusão de mais sequências de espécimes neotropicals. Assim, uma melhor compreensão das relações inter e infragenéricas dos táxons poderá ser alcançada.

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