

Gasteroid mycobiota of
Rio Grande do Sul, Brazil:
Nidulariaceae

Fungos gasteroides no
Rio Grande do Sul, Brasil:
Nidulariaceae

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Nidulariaceae Dumort. is the family of the bird's nest fungi, the group of gasteromycetes characterized by the reduced (<10 mm high), globose to bell-shaped basidiomata containing numerous peridioles in which the basidiospores are produced, and lignicolous habit (LLOYD, 1906; BRODIE, 1975; MILLER & MILLER, 1988). The family comprises the genera *Crucibulum* Tul. & C. Tul., *Cyathus* Pers., *Mycocalia* J.T. Palmer, *Nidula* V.S. White, and *Nidularia* Fr. (BRODIE, 1975), all occurring in Brazil except for *Nidula*, known from the Andean-Patagonian forests of temperate South America (GAMUNDÍ & HORAK, 1995; DIEHL, 1999).

Nidulariaceae and *Sphaerobolaceae* J. Schröt. were considered in the *Nidulariales* G. Cunn., but phylogenetic studies have placed the former in the *Agaricales* Underw. and the latter in *Geastrales* Hosaka & Castellano (MONCALVO *et al.*, 2002; MATHENY *et al.*, 2006). In spite of KIRK *et al.* (2008) inclusion of *Nidulariaceae* in the large family *Agaricaceae* Chevall., morphological and molecular data have supported the recognition of this fungal assemblage as monophyletic lineage (ZHAO *et al.*, 2007, 2008).

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The knowledge of *Nidulariaceae* in southern Brazil is based on studies by LLOYD (1906) and RICK (1929, 1961), who reported several species of *Crucibulum*, *Cyathus* and *Nidularia*, especially from the Rio Grande do Sul. Later, ESPOSITO & GUERRERO (1988), SOBESTIANSKY (2005), MEIJER (2006), and CORTEZ *et al.* (2006) added new data for species from the states of Paraná, Santa Catarina and Rio Grande do Sul.

In this paper, the *Nidulariaceae* of Rio Grande do Sul are revised, as part of a wide survey of the gasteroid fungi from the state (CORTEZ *et al.*, 2008a,b; 2009; 2010; 2011).

MATERIALS AND METHODS

Fresh specimens were collected from March 2006 to March 2009 in Rio Grande do Sul, southern Brazil, and are preserved at the ICN herbarium, with some duplicates at UFRN-Fungos. Additional specimens from the BAFC, HURG, ICN, PACA, SMDB, and SP herbaria, were also considered in the survey. Macro- and microscopic analysis of the basidiomata were based on BRODIE's (1975) monograph; microscopic drawings were made with the aid of a light tube after mounts in 5% KOH plus 1% Congo Red. Color names and codes followed KORNERUP & WANSCHER (1978).

RESULTS AND DISCUSSION

Crucibulum laeve (Huds.) Kambly, *Gast. Iowa*: 167, 1936. (Fig. 1a–c)

Basidiomata 4–9 mm high, 5–8 mm diam., shortly cylindrical, mouth not incurved or slightly so, base with a discoid attachment mycelium, cespitose. Peridium about 1–1.5 mm thickness; externally, greyish orange (5B5) to yellowish brown (5D8) when dried, with a velutinous to smooth surface; internally, the peridium is greyish yellow (4B4) to light orange (5A4), with a smooth texture. Epiphragm white (5A1), fleshy. Peridioles 1.5–2 mm diam., discoid, smooth, orange white (5A2) when fresh to brownish grey (5C2) and dark blond (1F1) when dried. Basidiospores (5–) 6–8.5 (–10) × 3.5–4.5 μm , ovoid to ellipsoid, hyaline, smooth and thin-walled, apiculus present.

EXAMINED SPECIMEN — Brazil, RIO GRANDE DO SUL: Caxias do Sul, Reserva Krödt, V/1984, E. Esposito (ICN 56126).

GEOGRAPHICAL DISTRIBUTION — Temperate to subtropical areas (BRODIE, 1975). Brazil: known from São Paulo (BASEIA & MILANEZ, 2001a) and Rio Grande do Sul (ESPOSITO & GUERRERO, 1988).

DISCUSSION — RICK (1961) reported *C. vulgare* Tul. from Rio Grande do Sul but no specimens are preserved. ESPOSITO & GUERRERO (1988) studied cultures obtained from fresh specimens and furnished morphological and biological data of the strains. *Crucibulum parvulum* H.J. Brodie and *C. cyathiforme* H.J. Brodie differ from the present by their thinner peridia and obconic basidiomata (BRODIE, 1984). *Crucibulum laeve* was collected only in the Rio Grande do Sul highlands, on conifer wood (*Araucaria angustifolia*, *Pinus* spp.), where it seems to be uncommon.

***Cyathus berkeleyanus* (Tul. & C. Tul.) Lloyd,
Nidulariaceae: 19, 1906. (Fig. 1d–e, 2a)**

Basidiomata (5–) 7–10 (–13) mm high, (5–) 7–10 mm diam., conical, mouth not to little incurved, base with a distinct yellowish brown (5E7) basal mycelium, densely gregarious. Peridium <1 mm thick; externally, light brown (5D5) to yellowish brown (5E7), with a hirsute surface composed by erected long hairs, striate at the mouth; internally, the peridium is brownish beige (6E3) to silvery, surface plicate-striate at the mouth. Epiphragm membranous, white (5A1), with short and erect yellowish brown (5E5) hairs. Peridioles 1.5–2.5 mm diam., discoid, flattened, grey (5F1) to black, smooth; one-layered cortex with tunica. Basidiospores (7–) 7.5–10 (–11) × 5–7 μm, ovoid to ellipsoid, hyaline to yellowish, smooth and thin-walled, apiculate.

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: Itaara, Parque Pinhal, 25/I/2007, V.G. Cortez 006/07 (ICN 154409), 012/07 (ICN154410), 014/07 (ICN 154411), 27/IV/2007, V.G. Cortez 060/07 (ICN 154412), 067/07 (ICN 154413), 04/V/2007, V.G. Cortez 073/07 (ICN 154414), 17/VIII/2007, V.G. Cortez 151/07 (ICN 154417). Porto Alegre: R. São Manoel, 13/III/1966, A.R. Schultz (ICN 4063); II/1990, Ricardo (ICN 95542). Santa Maria: Estação Experimental de Silvicultura - FEPAGRO, 09/III/2006, G. Coelho & V.G. Cortez 003/06 (ICN 154404), 26/XI/2009, G. Coelho (ICN 154419); Cerrito, 28/V/2007, V.G. Cortez 102/07 (ICN 154415), 107/07 (ICN 154416); Morro da Caturrita, 27/IV/2006, V.G. Cortez 021/06 (ICN 154405); Morro do Elefante, 09/V/2001, V.G. Cortez 026/01 (SMDB 9.246); 09/XI/2002, V.G. Cortez 054/02 (SMDB 9592, UFRN-Fungos 813); 24/IV/2004, V.G. Cortez 003/04 (SMDB 9714); 23/VI/006, V.G. Cortez 060/06 (ICN 154406), 062/03 (ICN 154407), 063/06 (ICN 154408), 25/IX/2007, V.G. Cortez 153/07 (ICN 154418). Torres: X/1980, R.T. Guerrero (ICN 56064). No data (ICN 56559).

GEOGRAPHICAL DISTRIBUTION — Neotropical zone (BRODIE, 1975) and South Africa (BOTTOMLEY, 1948). Brazil: Rio de Janeiro (BRODIE, 1975), São Paulo (BASEIA & MILANEZ, 2001b), Paraná (MEIJER, 2006) and Rio Grande do Sul (new record).

DISCUSSION — The main features of *C. berkeleyanus* are the externally and internally striate peridium and the small basidiospores. *Cyathus limbatus*, *C. montagnei*, and *C. poeppigii* are macroscopically similar, but produce larger basidiospores (>15 μm long). This is the commonest *Cyathus* from seasonal and ombrophilous forests of Rio Grande do Sul, from where it has been gathered in all seasons but, surprisingly, it is reported for the first time.

Cyathus julietae H.J. Brodie, *Svensk Bot. Tidskr.*
61: 94, 1967. (Fig. 1f–g, 2b).

Basidiomata 5–7 mm high, 4.5–7 mm diam., obconical, mouth incurved, base with a distinct brown attachment mycelium, gregarious. Peridium <1 mm thick; externally, dark blond (5D4) to yellowish brown (5D5), with a hirsute surface composed by tufts of long and pyramidal hairs, mouth not striate or plicate, and with short hairs; internally, orange grey (5B2) to reddish blond (5C3), with a smooth texture. Epiphragm membranous, grey (4B1), with brownish orange (5C5) hairs. Peridioles 1.5–2 mm diam., discoid and flattened, grayish brown (5F3) to brown (5F4), slightly wrinkled surface; one-layered cortex with thin tunica. Basidiospores (7–) 7.5–8.5 (–10) \times 5–6.2 μm , ovoid to ellipsoid, hyaline to pale yellow, smooth and thin-walled.

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: Porto Alegre, 5/II/1988, C.L.M. Rodrigues (ICN 56950). Santa Maria, Morro do Elefante, 16/IV/2005, V.G. Cortez 015/05 (ICN 154420); Jardim Botânico UFSM, 01/VII/2008, V.G. Cortez 124/08 (ICN 154421); Colégio Politécnico UFSM, 11/VII/2008, G. Coelho (ICN 154422).

GEOGRAPHICAL DISTRIBUTION: Known from China (ZHOU *et al.*, 2004), Mexico (LEÓN-GÓMEZ & PÉREZ-SILVA, 1988), Jamaica (BRODIE, 1975) and Brazil, from the states of Pernambuco (TRIERVEILER-PEREIRA & BASEIA, 2009) and Rio Grande do Sul (new record).

DISCUSSION — In the field, *C. julietae* is similar to older specimens of *C. berkeleyanus* because of the size of the basidiomata and the conspicuous outer striation and color of peridium, but the inner peridium is conspicuously smooth, in contrast with the plicate one of the latter. Both species also share similar peridioles and basidiospores. BRODIE (1975) also considered it akin to *C. pallidus*, but it has smaller basidiomata (3–5 mm high) and larger basidiospores (7.5–15 μm long). *Cyathus julietae*

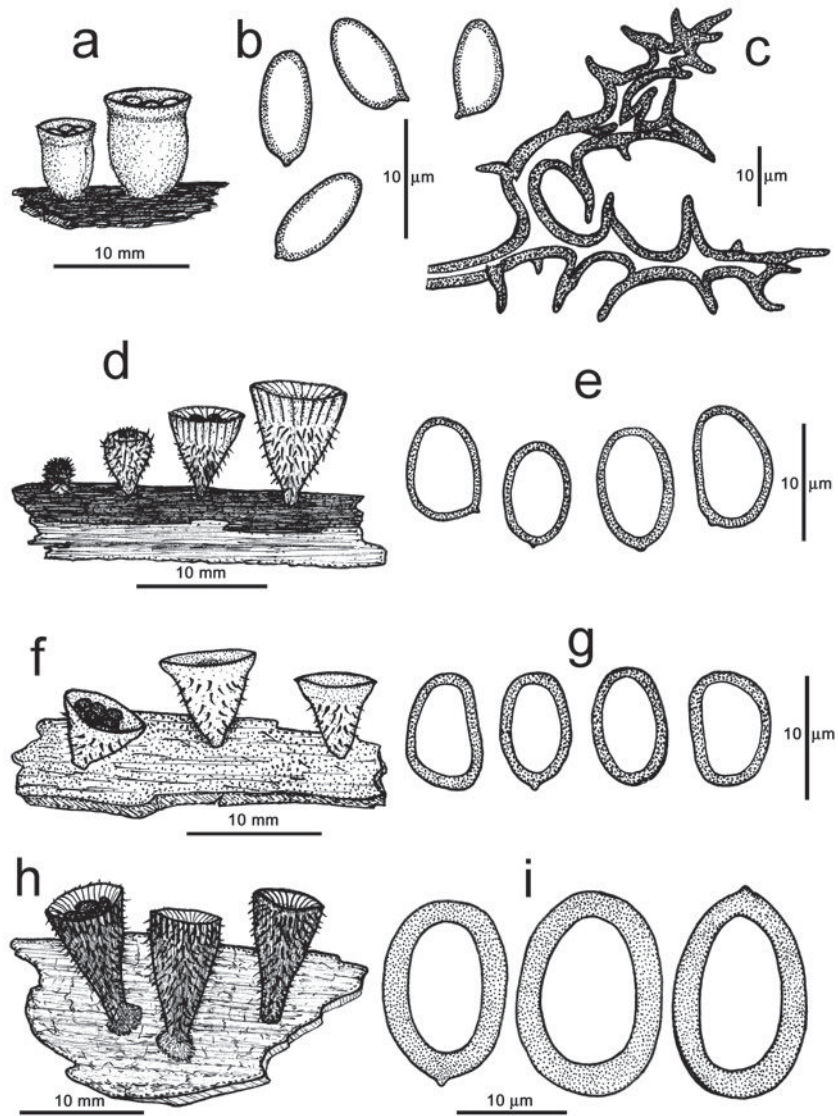


Fig. 1. a,c. *Crucibulum laeve*: a, basidiomata; b, basidiospores; c, peridium hypha. d,e. *Cyathus berkeleyanus*: d, basidiomata; e, basidiospores. f,g. *Cyathus julietae*: f, basidiomata; g, basidiospores. h,i. *Cyathus limbatus*: h, basidiomata; i, basidiospores. Artwork by V.G. Cortez.

is new for southern Brazil, being only reported from northeastern (TRIERVEILER-PEREIRA & BASEIA, 2009).

***Cyathus limbatus* Tul. & C. Tul.,**
Ann. Sci. Nat. 1: 70, 1844. (Fig. 1h–i, 4a).

Basidiomata 9–12 mm high, 5–7 mm diam., conical, mouth not incurved, base with lanose and brown (6E5) attachment mycelium, gregarious. Peridium <1 mm thickness; externally, brown (6E5), with hirsute hairs over a fairly plicate surface mouth; internally, brown (6E4) colored, with a plicate-striate texture. Epiphragm not observed. Peridioles 1.7–2 mm diam., irregular to subcircular, grayish brown (5F3), smooth surface, two-layered cortex. Basidiospores 16–20 × 11–14 μm , ovoid to broadly ellipsoid, hyaline, smooth and thick-walled.

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: Dom Pedro de Alcântara, 01/V/1970, M.H. Homrich (ICN 6055). Gravataí, Itacolomi, 24/V/1970, A. D'Arrigo (ICN 6093). Santa Maria, Morro Mariano da Rocha, 21/III/2007, V.G. Cortez 038/07 (ICN 154423). São Francisco de Paula, FLONA, 25/IV/2009, R.M. Silveira (ICN 154424). Viamão, Schöenwald, 13/VII/1965, F.R. Schöenwald (ICN 3724).

GEOGRAPHICAL DISTRIBUTION — Pantropical (BRODIE, 1975). Brazil: Pernambuco (TRIERVEILER-PEREIRA & BASEIA, 2009), Paraíba (TRIERVEILER-PEREIRA & BASEIA, 2011), São Paulo (BONONI *et al.*, 1981; BASEIA & MILANEZ 2001b), Paraná (MEIJER, 2006) and Rio Grande do Sul.

DISCUSSION — *Cyathus limbatus* is similar to *C. montagnei*, both species occurring in Rio Grande do Sul State. The latter, however, has a single cortex with tunica, in contrast to the double cortex of *C. limbatus* (BRODIE, 1975). ESPOSITO & GUERRERO (1988) misidentified their materials as *C. striatus*, a temperate species which, in fact, seems not to occur in Rio Grande do Sul.

***Cyathus montagnei* Tul. & C. Tul.,**
Ann. Sci. Nat. 1: 70, 1844. (Fig. 3a–b).

Basidiomata 7–10 mm high, 6–8 mm diam., conical, mouth not incurved, base with an attachment mycelium, gregarious. Peridium <1 mm thickness; externally, brown (6D7), with a hirsute surface and conspicuously plicate mouth; internally, it is brownish grey (5F2) colored, with a plicate-striate texture at the mouth. Epiphragm membranous, white (5A1), covered by numerous, erect and yellowish brown (5D8) hairs. Peridioles 2–2.5 mm diam., discoid, flattened, grayish brown (5F3), smooth surface, one-layered cortex with tunica. Basidiospores (15–) 17–20 (–24) × 10–12.5 (–15) μm , ovoid, hyaline, smooth and thick-walled.

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: Gravataí, Morungava, 21/IV/1965, M.H. Homrich (ICN 3632, 3638). Itaara, Parque Pinhal, 27/IV/2007, V.G. Cortez 064/07 (ICN 154427). Porto Alegre, Morro Santana, 04/IV/1970, S. D'Arrigo (ICN 6050); Ponta Grossa, 11/IV/1965, M.H. Homrich (ICN 3644). Salvador do Sul: 20/I/1944, J. Rick (PACA 20909). Santa Maria: Morro do Elefante, 16/IV/2005, V.G. Cortez 017/05 (ICN 154425). São Francisco de Paula: FLONA, 21/IV/2007, V.G. Cortez 057/07 (ICN 154426). São Leopoldo: 1904, J. Rick (SP 33984).

GEOGRAPHICAL DISTRIBUTION — Africa (BOTTOMLEY, 1948), North (LEÓN-GÓMEZ & PÉREZ-SILVA, 1988), Central and South America (BRODIE, 1975). Brazil: states of Pernambuco (TRIERVEILER-PEREIRA & BASEIA, 2013), Bahia (TRIERVEILER-PEREIRA *et al.*, 2009), Rio de Janeiro (BRODIE, 1975), São Paulo (VIÉGAS, 1945), Paraná (MEIJER, 2006) and Rio Grande do Sul (RICK, 1961).

EXAMINED SPECIMENS — The diagnostic features of *C. montagnei* are the externally and internally plicate peridium, larger basidiospores (>15 μm long) and the presence of a tunica (BRODIE, 1975). The presence of the latter structure allows differentiates it from *C. limbatus*; however, this separation is not as obvious in all cases. REID (1977) presented a detailed discussion of the problems involved in identifying both taxa. ESPOSITO & GUERRERO (1988) considered the collection ICN 3632 as *C. striatus*, a species with narrower ellipsoid basidiospores, in contrast to ovoid basidiospores in *C. montagnei*.

***Cyathus olla* (Batsch) Pers.,**

Syn. Meth. Fung. 1: 237, 1801. (Fig. 3c–d).

Basidiomata 5.5–7 mm high, 4–5.5 mm diam., cyathiform or bell-shaped, without a stipe, mouth slightly incurved or recurved, smooth both outside and inside, basal mycelium absent, densely gregarious. Peridium externally grayish orange (5B4), brownish orange (5C4) to yellowish brown (5E5), almost smooth or with very short hairs and a slightly velutinous aspect; internally, it is reddish blond (5C3) to grayish brown (5D3) and has a smooth surface. Peridioles 2–3 mm diam., irregularly lenticular, reddish blond (5C3) to grayish brown (5E3), one-layered cortex with thick tunica. Epiphragm membranous, white (5A1), surface smooth. Basidiospores 8.5–12 \times 6–8 μm , ovoid, apiculate, subhyaline, smooth and thin-walled (<2 μm).

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: São José dos Ausentes, 22/VI/2007, V.G. Cortez 139/07 (ICN 154428).



Fig. 2. a, *Cyathus berkeleyanus* on fallen branches of *Araucaria angustifolia*. b, *Cyathus julietae* on stump of *Pinus* sp. All photos by G. Coelho.

GEOGRAPHICAL DISTRIBUTION — Europe, North and South America (BRODIE, 1975). Brazil: Known from the states Maranhão, São Paulo (BASEIA & MILANEZ, 2001b) and Rio Grande do Sul.

DISCUSSION — This is considered one of the most variable species in the genus, and is usually diagnosed by the combination of the following features: basidiomata with a distinct flaring margin, external surface of the peridium smooth to slightly velutinous, internal surface smooth, and basidiospore size and shape (BRODIE, 1975). RICK (1961) reported specimens of *C. vernicosus* (Bull.) DC. (= *C. olla*) from the state of Rio Grande do Sul, but after the examination of his specimens, we concluded that they belonged to *C. stercoreus*.

Cyathus pallidus Berk. & M.A. Curtis,
J. Linn. Soc., Bot. 10: 346, 1896. (Fig. 3e–f).

Basidiomata 3–5 mm high, 3–5 mm diam., cyathiform, without a stipe, mouth incurved, smooth both outside and inside, basal mycelium present forming a discoid attachment base, gregarious in small groups. Peridium externally yellowish brown (5E5), strigose, with short hairs and acute hairs; internally, it is pale grey (1B1) to pastel grey (1C1) colored, and has a smooth surface. Peridioles 1.2–1.5 mm diam., lenticular, dark grey (1F1) colored, one-layered cortex with tunica. Epiphragm not observed in the examined specimens. Basidiospores 7.5–9 × 4.5–6 µm, ovoid, apiculate, stramineous, with a smooth and thick wall (<2 µm).

EXAMINED SPECIMENS: Brazil, RIO GRANDE DO SUL: Itaara, Parque Pinhal, 11/V/2006, V.G. Cortez 045/06 (ICN 154429).

GEOGRAPHICAL DISTRIBUTION — Subtropical and tropical America (BRODIE, 1975) and Africa (BOTTOMLEY, 1948). Brazil: Pernambuco (TRIERVEILER-PEREIRA & BASEIA, 2009), São Paulo (BASEIA & MILANEZ, 2001b) and Rio Grande do Sul (new record).

DISCUSSION — This species is diagnosed by the small basidiomata and peridioles, pale brown color and strigose surface of the peridium (BRODIE, 1975). The species was reported from Brazil by BRODIE (1975), but without reference to specimens. It is probably the first record of *C. pallidus* from southern Brazil.

Cyathus poeppigii Tul. & C. Tul.,
Ann. Sci. Nat., Bot. 1: 77, 1844. (Fig. 3g–h).

Basidiomata 7–10 mm high, 5–7 mm diam., obconical, with the mouth slightly incurved and plicate both outside and inside, attached to the substrate by a thin and light brown (6D5) basal mycelium. Peridium

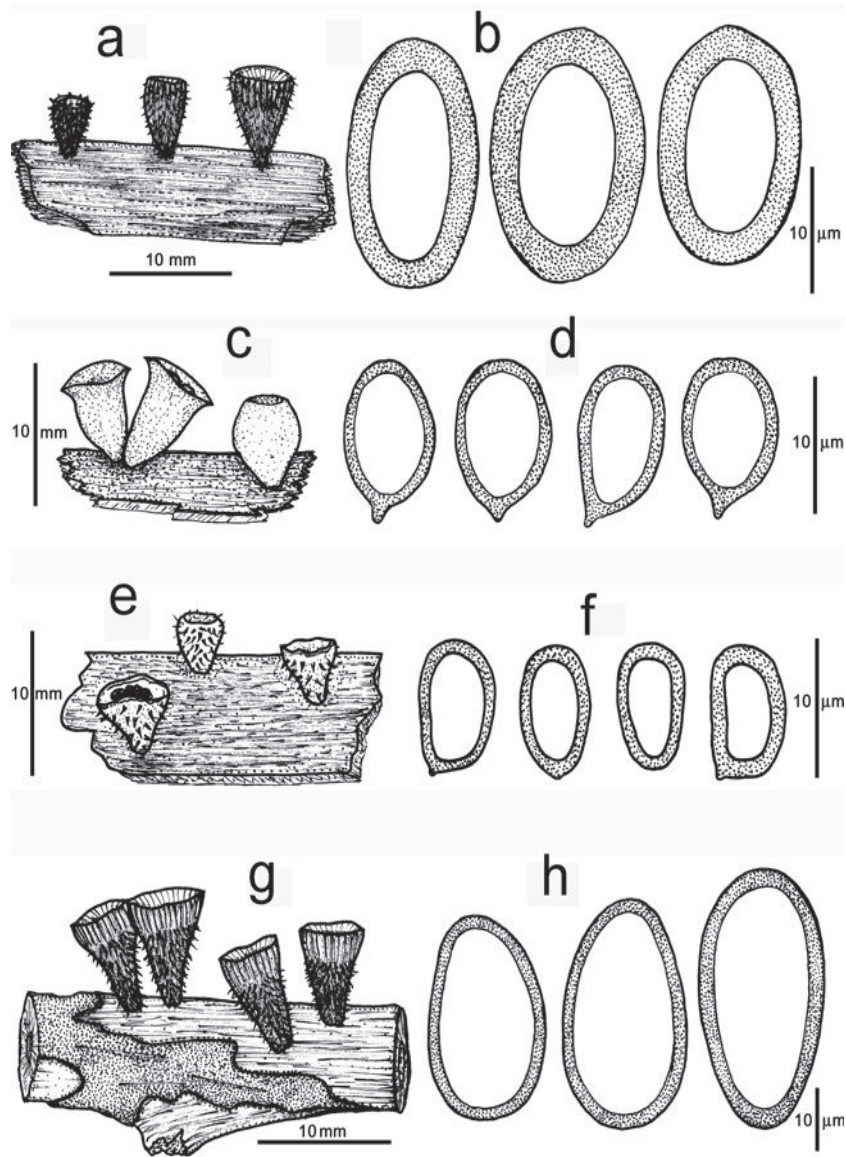


Fig. 3. a,b. *Cyathus montagnei*: a, basidiomata; b, basidiospores. c,d. *Cyathus olla*: c, basidiomata; d, basidiospores. e,f. *Cyathus pallidus*: e, basidiomata; f, basidiospores. g,h. *Cyathus poeppigii*: g, basidiomata; h, basidiospores. Artwork by V.G. Cortez.

externally light brown (6D5) to brown (6D6), with a shaggy surface; internally it is brownish grey (6F2) colored, surface striate. Epiphragm absent in the examined specimens. Peridioles 1.5–2.2 mm diam., lenticular, black, 2-layered cortex, without tunica. Basidiospores (21–) 25–39 (–42) × 15–25 (–33) μ m, ovoid to ellipsoid, subhyaline to stramineous, with smooth and moderately thick wall (2–3 μ m).

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: Arroio dos Ratos: 07/VI/1986, E. Esposito & R.T. Guerrero (ICN 56544, 56558). Caçapava do Sul: BR 392, Ponte Arroio Irapuã, 17/II/2008, V.G. Cortez 032/08 (ICN 154430). Dom Pedro de Alcântara: 12/XI/1965, M.H. Homrich (ICN 4068). Guaíba: Florida, 13/VI/1970, E. Rostirola (ICN 6158*); Estação CEEE, X/1984, R.T. Guerrero (ICN 56128). Porto Alegre: Belém Novo, 03/X/1988, M.S. Hamme (ICN 95537); Jardim Winge, 11/IV/1970, S. D'Arrigo (ICN 6051); Morro Santana, 12/IX/1964, J.P. Costa-Neto (ICN 3583*); 01/IV/1966, M.H. Homrich (ICN 4066). Salvador do Sul: III./1983, R.T. Guerrero (ICN 56127). Santa Maria: 1935, J. Rick (PACA 12476, 12481, 12484). São Leopoldo: 1905, J. Rick (ICN 3494, SP 22.908); 1931, J. Rick (PACA 12475), 1932, J. Rick (PACA 12479). Viamão: Parque Saint' Hilaire, no date, M.H. Homrich (ICN 2340, SP 50586), 18/IV/1966, F. Flores (ICN 5350*), 23/V/1970, M.L. Lorscheitter & L.R.M. Baptista (ICN 6120*).

GEOGRAPHICAL DISTRIBUTION — Pantropical (ZHAO *et al.*, 2006). Brazil: São Paulo (BASEIA & MILANEZ, 2001b), Paraná (MEIJER, 2006) and Rio Grande do Sul (RICK, 1961).

DISCUSSION — This species is known only from Southeast and South Brazil (BASEIA & MILANEZ, 2001b) but probably it occurs in all the country. The large ellipsoid basidiospores are a diagnostic feature of *C. poeppigii*. RICK's (1961) specimens, reported as *C. ambiguus* Tul & *C. Tul.*, are in fact the present species – this probable synonymy is discussed by BRODIE (1975). Some of the specimens examined (*) were found sterile or immature, and their identification is tentative, based only on macroscopical features (see LLOYD, 1906).

Cyathus stercoreus (Schwein.) De Toni,
Syll. Fung. 7: 40, 1888. (Fig. 4b, 5a–b).

Basidiomata 7–12 mm high, 4–8 mm diam., obconical, with the mouth incurved and smooth both outside and inside, attached to the substrate by thin rhizomorphs. Peridium externally white (4A1) to yellowish white (4A2) when young, then grayish yellow (4B to 6D5) to yellowish brown (5D5) at maturity, with a velutinous surface; internally, it is brownish grey (5E2–5F2) colored, and has a smooth surface. Epiphragm

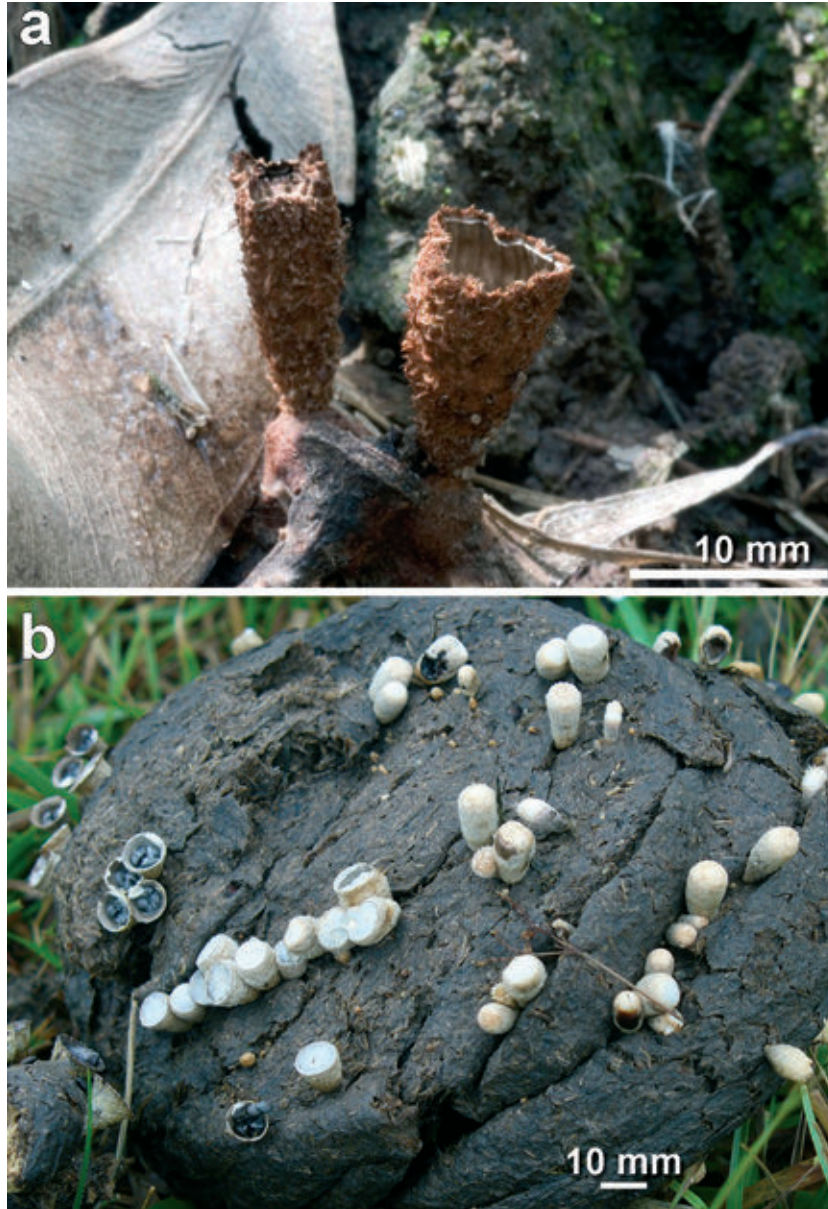


Fig. 4. a, *Cyathus limbatus* on plant debris. Photo: G. Coelho. b, *Cyathus stercoreus* on cow dung. Photo: V.G. Cortez.

membranous, white (4A1) to grey (4B1). Peridioles 2–2.5 mm diam., discoid, brownish grey (5F2) to black, smooth, 2-layered cortex, tunica absent. Basidiospores 24–37 × 23–32 μ m, globose to subglobose, hyaline, smooth and thick-walled (2.5–4 μ m).

EXAMINED SPECIMENS — Brazil, RIO GRANDE DO SUL: Arroio do Padre: RS 737, 15/II/2008, V.G. Cortez 020/08 (ICN 154439). Arroio dos Ratos: 07/VI/1986, E. Esposito & R.T. Guerrero (ICN 56546, 56549, 56550, 56554). Barra do Quaraí: Parque do Espinilho, 14/VI/2007, V.G. Cortez 126/07 (ICN 154436). Cachoeira do Sul: Fazenda Edyr Lima, 18/XI/2006, V.G. Cortez 073/06 (ICN 154433). Caçapava do Sul: BR 392, 17/II/2008, V.G. Cortez 029/08 (ICN 154441); Guaritas, 17/II/2008, V.G. Cortez 039/08 (ICN 154442); RS 357, 16/II/2008, V.G. Cortez 026/08 (ICN 154440). Guaíba: Centro Agronômico, 27/III/1972, M.H. Homrich 584 (ICN 6269); Estação CEEE, X/1984, R.T. Guerrero (ICN 56128), VI/1986, E. Esposito (ICN 56545, 56548), E. Esposito & R.T. Guerrero (ICN 56547, 56551, 56552, 56553). Manoel Viana: RS 377, 15/VI/2007, V.G. Cortez 137/07 (ICN 154437). Porto Alegre: Ponta Grossa, 11/IV/1965, M.H. Homrich & Leiter (ICN 3824). Quaraí: Palmar de Coatepe, 14/VI/2007, V.G. Cortez 125/07 (ICN 154435). Rio Grande: Cassino, 27/V/1992, C. Bicho (HURG 3735); Mato Costa Verde, 15/VI/1992, M.S. Farias et al. (HURG 3758); 17/X/1997, A.C.S. Campos (HURG 1684). Rio Pardo: Capivarita, 05/VII/1966, M.H. Homrich (ICN 6023, 6024). Salvador do Sul: 08/V/1945, J. Rick (PACA 22789), X/1945, J. Rick (PACA 20481). Santa Maria: 1935, J. Rick (PACA 12428, 12471, 12477, 12482, 12483); Morro da Caturrita, 27/IV/2006, V.G. Cortez 025/06 (ICN 154432); Passo da Ferreira, 03/II/2006, V.G. Cortez 001/06 (ICN 154431); Vila Maringá, 22/VI/2003, J.P. Arzivenko (SMDB 9642, UFRN-Fungos 822); UFSM, 26/III/2009, V.G. Cortez 014/09 (ICN 154443). Santa Vitória do Palmar: Taim, 15/VII/1986, E. Esposito & R.T. Guerrero (ICN 56474). São Francisco de Paula: Passo do S, 04/XII/2006, V.G. Cortez 076/06 (ICN 154434); Potreiro Velho, 16/X/2005, J.M. Hermann (ICN 154444). São Leopoldo: 1905, J. Rick (PACA 12474). São Lourenço do Sul: Pedra Mole, 15/II/2008, V.G. Cortez 018/08 (ICN 154438). Torres: Praia da Cal, 16/XI/1965, M.H. Homrich (ICN 4062). Viamão: Schöenwald, 04/VIII/1965, F.R. Schöenwald (ICN 3792), 07/VIII/1965, R. Schöenwald (ICN 3786), 09/V/1970, M.H. Homrich (ICN 6056); 30/VI/1970, S. D'Arrigo (ICN 6162). ADDITIONAL EXAMINED SPECIMENS: Brasil. SÃO PAULO. São Paulo: F. Hoehne (PACA 12473). USA. IOWA. Iowa: 11/IX/1934, G.W. Martin (ICN 3507, SP 39106). WASHINGTON. Spokane: W.E. Flowers (PACA 12470).

GEOGRAPHICAL DISTRIBUTION — Cosmopolitan (BRODIE, 1975). Brazil: Mato Grosso do Sul (RICHARDSON, 2001), São Paulo (BASEIA & MILANEZ, 2001b), Paraná (MEIJER, 2006) and Rio Grande do Sul (ESPOSITO & GUERRERO, 1988).

DISCUSSION — The coprophilous habitat and the large size of the globose basidiospores are the features used to distinguish it from the other species in the genus. This is the most common dung-inhabiting species of the genus and is found on all continents (BRODIE, 1975). It was found mostly in the native meadows of Pampa biome, by virtue of intensive livestock cattle in that region, which in fact comprises of one the main threats affecting this fragile and important biome of Brazil (OVERBECK *et al.*, 2007).

Nidularia pulvinata (Huds.) Kambly,
Gast. Iowa: 167, 1936. (Fig. 5c–e)

Basidiomata 2–3 mm high, 1–6 mm diam., subglobose to globose, brownish orange (5C6) to yellowish brown (5D8). Peridium firm to coriaceous with a floccose to cottony surface, irregularly opening in mature basidiomes to expose the peridioles; microscopically composed by thickened and stramineous to yellowish walled hyphae, 4–8 μm diam., clamped and with spiny projections along the wall. Peridioles numerous, <1 mm, dark brown (6F8), with a rugose and viscid surface; microscopically formed by brownish and thick-walled, 2–5 μm diam. hyphae, branched, with or without short spiny projections. Basidiospores 6–8 \times 4.5–6 μm , ovoid to ellipsoid, hyaline, with a smooth and slightly thickened wall, without a germ-pore but with a conspicuous apiculus.

EXAMINED SPECIMENS: Brazil, RIO GRANDE DO SUL: São Francisco de Paula, CPCN Pró-Mata (PUCRS), 24/I/2004, J.M. Hermann (ICN 139163). ADDITIONAL SPECIMEN EXAMINED: USA. Iowa, 22/VII/1939, G.W. Martin (ICN 3508).

GEOGRAPHICAL DISTRIBUTION — Neotropical (BRODIE, 1975). Brazil: São Paulo (BASEIA & MILANEZ, 2001c) and Rio Grande do Sul (LLOYD, 1906; RICK, 1929; CORTEZ *et al.*, 2006).

DISCUSSION — *Nidularia pulvinata* is considered a rare species, and several surveys did not report it (MARTINEZ, 1956; BRODIE, 1967; LEÓN-GÓMEZ & PÉREZ-SILVA, 1988); however, it has been sporadically reported in the Neotropical region (WHITE, 1902; SPEGAZZINI, 1927; COKER & COUCH, 1928). The species was reported from Brazilian states of São Paulo and Rio Grande do Sul and the genus was reported from the state of Paraná by MEIJER (2001), but without indication of species.

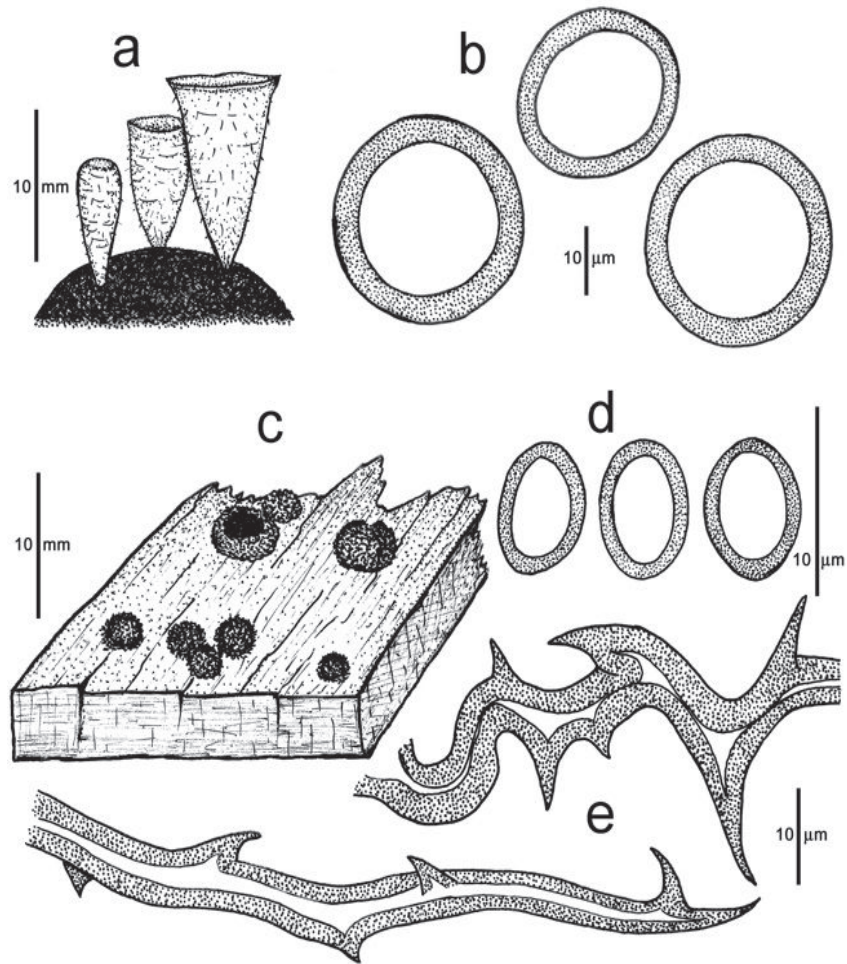


Fig. 5. a, b. *Cyathus stercoreus*: a, basidiomata; b, basidiospores. c, e. *Nidularia pulvinata*: c, basidiomata; d, basidiospores; e, peridium hyphae. Artwork by V.G. Cortez.

Key to the Nidulariaceae of Rio Grande do Sul, Brazil

1. Basidiomata globose to subglobose, epiphragm absent.....2
1. Basidiomata cup to bell-shaped, epiphragm present.....3
2. Peridium <2mm thick, persistent.....*Nidularia pulvinata*
2. Peridium ephemeral or absent.....*Mycocalia* cf. *denudata**
3. Peridium <1.5mm thick, white to yellow.....*Crucibulum laeve*
3. Peridium thinner, grey to dark brown (genus *Cyathus*).....4
4. Peridium velutinous, smooth both inside and outside.....5
4. Peridium with hairs in tufts, striate inside, outside or both.....6
5. Basidiospores 8.5–12 µm long, ovoid, on litter.....*C. olla*
5. Basidiospores 24–37 µm, subglobose, on dung.....*C. stercoreus*
6. Inner peridium smooth.....7
6. Inner peridium striate.....8
7. Basidiomata 3–5 mm high.....*C. pallidus*
7. Basidiomata 5–7 mm high.....*C. julietae*
8. Basidiospores 7.5–10 µm long.....*C. berkeleyanus*
8. Basidiospores 16–20 µm long.....9
8. Basidiospores 21–42 µm long.....*C. poeppigii*
9. Peridioles with a single cortex and tunica.....*C. montagnei*
9. Peridioles with a double cortex.....*C. limbatus*

OTHER NIDULARIACEAE

RECORDED FROM RIO GRANDE DO SUL

– *Cyathus striatus* (Huds.) Hoffm.: Misidentified by RICK (1961) and ESPOSITO & GUERRERO (1988), their specimens belong to *C. berkeleyanus*, *C. limbatus* and *C. montagnei*, as previously discussed. North American specimens were compared: USA. COLUMBIA STATE. Montgomery, Great Falls, 22.VII.1958, O.K. Fidalgo & J.A. Stevenson (ICN 3516, SP 50657). IOWA STATE. Iowa, 24.VIII.1939, G.W. Martin (ICN 3509, SP 42320).

– *Cyathus ambiguus* Tul.: According to Brodie (1975), it is a probable synonym of *C. poeppigii*, but Rick's (1961) specimens are *C. stercoreus*.

– *Cyathus byssisedus* (Jungh.) Tul.: This is a synonym of *C. montagnei* (Brodie 1975), but material reported by Rick (1961) is actually *C. stercoreus*.

– *Mycocalia* cf. *denudata* (Fr. & Nordholm) J.T. Palmer: The species was reported from Rio Grande do Sul (SOBESTIANSKY, 2005), but the specimens were not examined, neither collected. The cited material was determined by André de Meijer, who kindly provided the following description:

“*Basidiomata* loosely gregarious, globose, when fresh up to 4×3 mm, brown; surface layer thin, not yet broken apart to expose the peridioles. *Peridioles* numerous, <0.3 mm diam., white to yellowish, without funiculus. *Basidiospores* abundant, $5.5\text{--}6 \times 4.5\text{--}5$ μm , broadly ellipsoid, obovoid, hilar appendage small; hyaline. *Basidia* clavate, 4-spored. *Hyphae* 2 μm broad, also strongly branched hyphae present; all hyphae thin-walled, hyaline, with clamp-connections. (Brazil. RIO GRANDE DO SUL. Nova Petrópolis, XI/1991, G. Sobestiansky 332, in “mixed forest” on moss-covered dead dicotyledonous branch).”

SUMÁRIO

Na revisão dos fungos gasteroides do Rio Grande do Sul, Brasil, foram estudadas as espécies de *Nidulariaceae*. Dez espécies foram identificadas, pertencentes aos gêneros *Crucibulum* (*C. laeve*), *Cyathus* (*C. berkeleyanus*, *C. julietae*, *C. limbatus*, *C. montagnei*, *C. olla*, *C. pallidus*, *C. poeppigii*, *C. stercoreus*), e *Nidularia* (*N. pulvinata*). *Cyathus berkeleyanus*, *C. julietae* e *C. pallidus* são citadas pela primeira vez no Rio Grande do Sul. Todas as espécies são descritas, ilustradas e uma chave para identificação é fornecida.

PALAVRAS-CHAVE: fungos ninho-de-pássaro; gasteromicetos; taxonomia

SUMMARY

In a revision of the gasteroid fungi from Rio Grande do Sul State, Brazil, the species of *Nidulariaceae* were studied. Ten species were identified, belonging to the genera *Crucibulum* (*C. laeve*), *Cyathus* (*C. berkeleyanus*, *C. julietae*, *C. limbatus*, *C. montagnei*, *C. olla*, *C. pallidus*, *C. poeppigii*, *C. stercoreus*), and *Nidularia* (*N. pulvinata*). *Cyathus berkeleyanus*, *C. julietae* and *C. pallidus* are new records from Rio Grande do Sul. All species are described and illustrated and a dichotomous key is presented.

KEY WORDS: bird's nest fungi; gasteromycetes; taxonomy

RÉSUMÉ

Dans une révision des gasteroids d'Etat de Rio Grande Sul, Brésil, les espèces de *Nidulariaceae* ont été étudiées. Dix espèces ont été identifiées appartenant au genre *Crucibulum* (*C. laeve*), *Cyathus* (*C. berkeleyanus*, *C. julietae*, *C. imbatus*, *C. montagnei*, *C. olla*, *C. pallidus*, *C. poeppigii*, *C. stercoreus*), et *Nidularia* (*N. pulvinata*). Le *Cyathus berkeleyanus*, *C. julietae* et *C. pallidus*, ce sont de nouveaux registres de Rio Grande Sul. Toutes les espèces sont décrites, illustrées et une clef pour l'identification est fournie.

MOTS CLÉS: champignons nid d'oiseaux; gasteromycetes; taxonomie

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BIBLIOGRAPHY

- BASEIA, I. G. & A. I. MILANEZ. 2001a. *Crucibulum laeve* (Huds.) Kambly in Cerrado vegetation of São Paulo, Brazil. *Acta Botanica Brasilica* 15: 13–16.
- BASEIA, I. G. & A. I. MILANEZ. 2001b. *Cyathus* (Gasteromycetes) in areas of the Brazilian Cerrado region, São Paulo State. *Mycotaxon* 80: 493–502.
- BASEIA, I. G. & A. I. MILANEZ. 2001c. *Nidularia pulvinata* (Schwein.) Fries (Gasteromycetes): a new record from Brazil. *Revista Brasileira de Botânica* 24: 479–481.
- BONONI, V. L. R.; S. F. B. TRUFEM & R. A. P. GRANDI. 1981. Fungos macroscópicos depositados no herbário do Instituto de Botânica de São Paulo. *Rickia* 9: 37–53.
- BOTTOMLEY, A.M. 1948. Gasteromycetes of South Africa. *Bothalia* 4: 473–810.
- BRODIE, H. J. 1967. New records of *Nidulariaceae* from the West Indies. *Trans. Br. Mycol. Soc.* 50: 473–478.
- BRODIE, H. J. 1975. *The bird's nest fungi*. Toronto: Toronto University.
- BRODIE, H. J. 1984. More bird's nest fungi (*Nidulariaceae*). A supplement to "The bird's nest fungi" (1975). *Lejeunia* 112: 1–70.
- COKER, W. C. & J. N. COUCH. 1928. *The Gasteromycetes of the Eastern United States and Canada*. Chapel Hill: University of North Carolina.
- CORTEZ, V. G.; I. G. BASEIA & R. T. GUERRERO. 2006. Additions to the mycobiota (*Agaricales*, *Basidiomycota*) of Rio Grande do Sul. II: The bird's nest fungus *Nidularia pulvinata* (Schwein.) Fr. *Biociências* 14: 15–18.
- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2008a. Gasteromicetos (*Basidiomycota*) no Parque Estadual de Itapuã, Viamão, Rio Grande do Sul, Brasil. *Revista Brasileira de Biociências* 6: 291–299.
- CORTEZ, V. G.; I. G. BASEIA; R. T. GUERRERO & R. M. B. SILVEIRA. 2008b. Two sequestrate cortinarioid fungi from Rio Grande do Sul, Brasil. *Hoehnea* 34: 513–518.
- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2009. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Tulostomataceae*. *Mycotaxon* 108: 365–384.

- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2010. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Arachnion* and *Disciseda* (*Lycoperdaceae*). *Acta Biológica Paranaense* 39: 19–27.
- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2011a. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Boletales*. *Journal of Yeast and Fungi Research* 2: 44–52.
- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2011b. *Lycoperdon ovoidisporum* sp. nov. from Brazil. *Sydowia* 63: 1–7.
- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2011c. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Lysuraceae* (*Basidiomycota*). *Acta Scientiarum, Biological Sciences* 33: 87–92.
- CORTEZ, V. G.; I. G. BASEIA & R.M.B. SILVEIRA. 2011d. Two noteworthy *Phallus* from southern Brazil. *Mycoscience* 52: 436–438.
- CORTEZ, V. G.; M.A. SULZBACHER; I.G. BASEIA; Z.I. ANTONIOLLI & R.M.B. SILVEIRA. 2011e. New records of *Hysterangium* (*Basidiomycota*) in *Eucalyptus* plantations of south Brazil. *Revista Brasileira de Biociências* 9: 220–223.
- CORTEZ, V. G.; I. G. BASEIA & R.M.B. SILVEIRA. 2012. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Calvatia*, *Gastropila* and *Langermannia* (*Lycoperdaceae*). *Kew Bulletin* 67: 471–482.
- CORTEZ, V. G.; I. G. BASEIA & R. M. B. SILVEIRA. 2013. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Lycoperdon* and *Vascellum*. *Mycosphere* 4: 745–758.
- DIEHL, P. 1999. Anatomy of the peridium in the genus *Nidula* (*Nidulariales*, *Basidiomycetes*). *Sydowia* 52: 16–29.
- ESPOSITO, E. & R. T. GUERRERO. 1988. Estudo de culturas de cinco espécies de *Nidulariales* (*Basidiomycetes*) do Rio Grande do Sul, Brasil. *Napaea* 4: 1–9.
- GAMUNDÍ, I. J. & E. HORAK. 1995. *Fungi of the Andean-Patagonian forests*. Buenos Aires: Vazquez Mazzini.
- KIRK, P. M.; P. F. CANNON; D. W. MINTER & J. A. STALPERS. 2008. *Dictionary of the Fungi*. 10th ed. Wallingford: CABI.
- KORNERUP, A. & J. H. WANSCHER. 1978. *Methuen handbook of colour*. 3rd ed. London: Eyre Methuen.
- LEÓN-GÓMEZ, C. & E. PÉREZ-SILVA. 1988. Especies de *Nidulariales* (*Gasteromycetes*) comunes en México. *Revista Mexicana de Micología* 4: 161–183.
- LLOYD, C. G. 1906. The *Nidulariaceae* or “Bird’s-nest fungi”. Cincinnati.
- MARTINEZ, A. 1956. Las *Nidulariales* Argentinas. *Revista de Investigaciones Agrícolas* 10: 281–311.

- MATHENY, P. B.; J. M. CURTIS; V. HOFSTETTER; M. C. AIME; J. M. MONCALVO; Z. W. GE; Z. L. YANG; J. C. SLOT; J. F. AMMIRATI JR.; T. J. BARONI; N. L. BOUGHER; K. W. HUGHES; D. J. LODGE; R. KERRIGAN; M. T. SEIDL; D. K. AANEN; M. DENITIS; G. M. DANIELE; D. E. DESJARDIN; B. R. KROPP; L. L. NORVELL; A. PARKER; E. C. VELLINGA; R. VILGALYS & D. S. HIBBETT. 2006. Major clades of *Agaricales*: a multilocus phylogenetic overview. *Mycologia* 98: 982–995.
- MEIJER, A. A. R. 2001. Mycological work in the Brazilian state of Paraná. *Nova Hedwigia* 72: 105–159.
- MEIJER, A. A. R. 2006. A preliminary list of the macromycetes from the Brazilian State of Paraná. *Boletim do Museu Botânico Municipal (Curitiba)* 68: 1–55.
- MILLER, O. K. & H. H. MILLER. 1988. *Gasteromycetes: morphological and development features*. Eureka: Mad River.
- MONCALVO, J. M.; R. VILGALYS; S. A. REDHEAD; J. E. JOHNSON; T. Y. JAMES; M. C. AIME; V. HOFFSTETTER; S. J. W. VERDUIN; E. LARSSON; T. J. BARONI; R. G. THORN; S. JACOBSSON; H. CLÉMENÇON & O. K. MILLER. 2002. One hundred and seventeen clades of euagarics. *Molecular Phylogenetics and Evolution* 23: 357–400.
- OVERBECK, G.E.; S.C. MÜLLER; A. FIDELIS; J. PFADENHAUER; V.D. PILLAR; C.C. BLANCO; I.I. BOLDRINI; R. BOTH & E.D. FORNECK. 2007. Brazil's neglected biome: The South Brazilian Campos. *Perspectives in Plant Ecology, Evolution and Systematics* 9: 101–116.
- REID, D.A. 1977. Some Gasteromycetes from Trinidad and Tobago. *Kew Bulletin* 31: 657–690.
- RICHARDSON, M.J. 2001. Coprophilous fungi from Brazil. *Brazilian Archives of Biology and Technology* 44: 283–289.
- RICK, J. 1929. Nidulariaceas riograndenses. *Egatea* 14: 177–181.
- RICK, J. 1961. Basidiomycetes Eubasidii in Rio Grande do Sul, Brasilia. 6. *Iheringia, Série Botânica* 9: 451-480.
- SOBESTIANSKY, G. 2005. Contribution to a macromycete survey of the states of Rio Grande do Sul and Santa Catarina in Brazil. *Brazilian Archives of Biology and Technology* 48: 437–457.
- SPEGAZZINI, C. 1927. Gasteromycetas Argentinas. *Sociedad Argentina de Ciencias Naturales* 8: 421–437.
- TRIERVEILER-PEREIRA, L. & I. G. BASEIA. 2009. Revision of the herbarium URM IV. *Nidulariaceae (Basidiomycota)*. *Nova Hedwigia* 89: 361–369.
- TRIERVEILER-PEREIRA, L. & I. G. BASEIA. 2011. Contribution to the knowledge of gasteroid fungi (*Agaricomycetes, Basidiomycota*) from the state of Paraíba, Brazil. *Revista Brasileira de Biociências* 9: 167–173.

- TRIERVEILER-PEREIRA, L. & I. G. BASEIA. 2013. *Cyathus* species (*Basidiomycota: Fungi*) from the Atlantic Forest of Pernambuco, Brazil: taxonomy and ecological notes. *Revista Mexicana de Biodiversidad* 84: 1–6.
- TRIERVEILER-PEREIRA, L., K. M. T. BEZERRA, J. L. BEZERRA & I. G. BASEIA. 2009. First records of *Geastraceae* and *Nidulariaceae* (*Basidiomycota, Fungi*) from Bahia, Northeastern Brazil. *Revista Brasileira de Biociências* 7: 316–319.
- VIÉGAS, A.P. 1945. Alguns fungos do Brasil X. Gastromicetos. *Bragantia* 5: 583–595.
- WHITE, V. S. 1902. The *Nidulariaceae* of North America. *Bulletin of the Torrey Botanical Club* 29: 251–280.
- ZHAO, R. L., D. E. DESJARDIN, K. SOYTONG & K. HYDE. 2006. Proposed synonyms in *Cyathus*. *Mycotaxon* 97: 327–335.
- ZHAO, R. L., R. JEEWON, D. E. DESJARDIN, K. SOYTONG & K. HYDE. 2007. Ribosomal DNA phylogenies of *Cyathus*: Is the current infrageneric classification appropriate? *Mycologia* 99: 385–395.
- ZHAO, R. L., D. E. DESJARDIN, K. SOYTONG & K. HYDE. 2008. A new species of bird's nest fungi: characterisation of *Cyathus subglobisporus* sp. nov. based on morphological and molecular data. *Persoonia* 21: 71–76.
- ZHOU, T. X., L. H. ZHAO, R. L. ZHAO, & Y. H. CHEN. 2004. Bird's nest fungi from China. *Fungal Diversity* 17: 243–251.