



Cyathus species (Basidiomycota: Fungi) from the Atlantic Forest of Pernambuco, Brazil: taxonomy and ecological notes

Especies de *Cyathus* (Basidiomycota: Fungi) del bosque atlántico de Pernambuco: taxonomía y notas ecológicas

Larissa Trierweiler-Pereira¹✉ and Iuri Goulart Baseia²

¹Departamento de Micologia, Universidade Federal de Pernambuco. Av. Nelson Chaves s/n, CEP 50670-420, Recife, PE, Brazil.

²Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Campus Universitário, CEP 59072-970, Natal, RN, Brazil.

✉ lt_pereira@yahoo.com.br

Abstract. *Cyathus* specimens were collected over a one-year period in 4 remnants of the Atlantic Forest in Pernambuco, Brazil. According to traditional morphological analysis, the following species were identified: *C. intermedius*, *C. montagnei*, *C. setosus* and *C. triplex*. These 4 species had previously been recorded from Brazil, but *C. setosus* is reported for the first time from northeastern Brazil. The holotype of *C. setosus* was examined and we found differences in the spore dimensions from those described in the original publication. An identification key for the species of *Cyathus* recorded from Pernambuco is provided.

Key words: bird's nest fungi, Gasteromycetes, Neotropical mycota, taxonomy.

Resumen. Se recolectaron ejemplares de *Cyathus* durante 1 año en 4 vestigios de bosque atlántico en Pernambuco, Brasil. Según el análisis morfológico tradicional, se identificaron: *C. intermedius*, *C. montagnei*, *C. setosus* y *C. triplex*, las cuales se conocen en el país, pero *C. setosus* es registrada por primera vez en la región noreste de Brasil. El holotipo de *C. setosus* se examinó encontrándose diferencias en el tamaño de las esporas con la publicación original. Se presenta una clave de identificación para las especies de *Cyathus* conocidas en Pernambuco.

Palabras clave: hongos 'nidos de pájaro', Gasteromycetes, hongos neotropicales, taxonomía.

Introduction

Few studies in Brazil have focused on the taxonomy of Nidulariaceae Dumort. (bird's nest fungi), which include the genera *Crucibulum* Tul. et C. Tul., *Cyathus* Haller and *Nidularia* Fr. et Nordholm (Baseia and Milanez, 2001a, b, 2003; Cortez et al., 2006; Trierweiler-Pereira and Baseia, 2009; Trierweiler Pereira et al., 2009). Members of these genera usually produce small basidiomata (up to 20 mm) on soil, dung, rotten wood or other plant debris (Brodie, 1975).

To date, approximately 14 species of *Cyathus* have been reported from Brazil (*C. berkeleyanus* [Tul. et C. Tul.] Lloyd, *C. intermedius* [Mont.] Tul. et C. Tul., *C. julietae* H. J. Brodie, *C. limbatus* Tul. et C. Tul., *C. microsporus* Tul. et C. Tul., *C. montagnei* Tul. et C. Tul., *C. olla* [Batsch] Pers., *C. pallidus* Berk. et M. A. Curtis, *C. poeppigii* Tul. et C. Tul., *C. pygmaeus* Lloyd, *C. setosus* H. J. Brodie, *C. stercoreus* [Schwein.] De Toni, *C. striatus* [Huds.] Willd. and *C. triplex* Lloyd), and 1 new species, *Cyathus amazonicus*

Trierweiler-Pereira et. Baseia, was recently described (Trierweiler-Pereira et al., 2009). Eight species have been reported from the state of Pernambuco, in northeastern Brazil (Trierweiler-Pereira and Baseia, 2009).

The aim of this work is to report the occurrence of *Cyathus* species in 4 areas of Atlantic forest in the state of Pernambuco and discuss some ecological aspects of these species.

Materials and methods

Cyathus specimens were surveyed from June, 2008 to May, 2009 in 4 remnants of Atlantic forest in the state of Pernambuco, Brazil: "Parque Dois Irmãos" (DI), "Reserva Ecológica Carnijó" (CA), "Mata do Estado" (ME) and "Parque Ecológico João de Vasconcelos Sobrinho", also known as "Brejo dos Cavalos" (BC). These areas correspond to lowland coastal forests (DI, CA), and highland humid forests (ME, BC). The precipitation in these areas is higher during autumn and winter, especially from May to August.

Fungal specimens were collected in selected stands and kept in plastic containers with individualized compartments for transport (Lodge et al., 2004). Later, the collected material was analyzed and identified at Laboratory of Diversity and Taxonomy, Department of Mycology, UFPE (Brazil). Colors on the species descriptions were coded according to Kornerup and Wanscher (1978).

Peridium and peridioles were cut by hand with a razor blade and sections were mounted in 3% KOH and 3% aqueous solution of phloxine. Line drawings were made with a camera lucida. The abbreviation 'L_m × W_m' corresponds to the arithmetical means of length and width. Voucher specimens are kept at URM and the holotype of *C. setosus* (DAOM) was also analyzed. Herbaria acronyms follow Thiers (2011).

Descriptions

Cyathus intermedius (Mont.) Tul. et. C. Tul., Ann. Sci. Nat., Bot., sér. 3(1): 72 (1844) (Figs. 1A, E)

Basidiomata broadly obconic, without stipe, 5.5-8.0 mm high and 4.0-8.0 mm wide at the mouth; outer surface of the peridium not plicate, yellowish brown (KW 5E6), densely hirsute, becoming glabrous in age, hairs yellowish brown (KW 5E6); inner surface not plicate, dark blond (KW 5D4), shiny. Peridioles ellipsoid to globose in outline, gray (KW 5F1), shiny, 2.0-2.5 mm diam., one-layered cortex with thin tunica. Basidiospores ellipsoid to subglobose, hyaline, smooth (16-) 17-19.5 (-20) × (9-) 10-11 µm, thick-walled, walls 2-3 µm thick.

Taxonomic summary

Distribution. Pantropical and subtropical (Gómez and Pérez-Silva, 1988; Esqueda et al., 2011); in Brazil known from Pernambuco (Trierveiler-Pereira and Baseia, 2009).

Studied specimens: **Brazil:** Pernambuco, Moreno, RPPN Carnijó, 17.VI.2008, Trierveiler-Pereira et Baltazar 15, URM 82064. Additional specimens: **Brazil:** Pernambuco, Recife, Beberibe, 28.X.1954, Lacerda s/n, URM 1096.

Remarks. This species is characterized by the absence of folds in the peridium (externally or internally), hairy exoperidium, peridiole with thin tunica and one-layer cortex. According to Brodie (1977), this species belongs to the group of *C. gracilis* H. J. Brodie. *C. intermedius* is macromorphologically similar to *C. pallidus* Berk. et. M. A. Curtis, but the former has larger and darker basidiomata (Gómez and Pérez-Silva, 1988).

Cyathus montagnei Tul. et. C. Tul., Ann. Sci. Nat., Bot., sér. 3(1): 70 (1844) (Figs. 1B, F)

Basidiomata obconic, slender obconic to funnel-shaped, stipe very short or absent, 7.0-10 mm high and 5.0-9.0 mm wide at the mouth; outer surface of the peridium finely to strongly plicate, yellowish brown (KW 5E5) to brownish beige (KW 6E3), woolly, hairs long, blond (KW 4C4), becoming glabrous in age; inner surface finely to strongly plicate, grayish brown (KW 5E3), silvery. Peridioles ellipsoid to subcircular in outline, olive brown (KW 4F4) to yellowish brown (KW 5F4), shiny, 1.4-2.7 mm diam., one-layered cortex with tunica. Basidiospores ellipsoid, subglobose to ovoid, hyaline, smooth, 17-22 (-24) × 10-15 µm, thick-walled, walls 2-3 µm thick.

Taxonomic summary

Distribution. Pantropical (Brodie, 1975; Gómez and Pérez-Silva, 1988); in Brazil known from Rio Grande do Sul, São Paulo, Bahia, Pernambuco and Pará (Trierveiler-Pereira and Baseia, 2009).

Studied specimens: **Brazil:** Pernambuco, Caruaru, Brejo dos Cavalos, 20.VI.2008, Trierveiler-Pereira 35, 39, URM 82054, 82055; *ibid.*, 25.VIII.2008, Trierveiler-Pereira 164, URM 82057; *ibid.*, 03.VI.2009, Baltazar et al., 241, URM 82058; São Vicente Férrer, Mata do Estado, 26.VI.2008, Trierveiler-Pereira 51, URM 82056. Additional specimens: **Brazil:** Pernambuco, Recife, 11.VI.1953, Gayão s/n, URM 658; Igarassu, Reserva Florestal da Usina São José, VII.2003, Baseia s/n, URM 77570.

Remarks: *C. montagnei* is similar to *C. striatus* due to its plicate exoperidium and basidiospores size. According to Brodie (1975), it is possible to differentiate these 2 species since *C. striatus* is brownish externally and yellowish brown internally. Moreover, *C. striatus* is a rare species in the tropics.

Cyathus setosus H.J. Brodie, Canad. J. Bot. 45(1): 1 (1967) (Figs. 1C, G, 2A-F)

Basidiomata broadly obconic, without stipe, 7.0-11 mm high and 7.0-9.0 mm wide at the mouth; outer surface of the peridium not plicate, yellowish brown (KW 5D8, 5E5), densely hirsute, hairs long, up to 1.0 mm in length, golden brown (KW 5D7), mouth margin with conspicuous setae, usually darker than peridium, up to 1.0 mm high; inner surface finely plicate, grayish brown (KW 5D3), shiny. Peridioles ellipsoid to angulate in outline, olive brown (KW 4E4), 2.0-2.5 mm diam., two-layered cortex, inconspicuous tunica. Basidiospores ellipsoid to ovoid, hyaline, smooth, 13-15 × 8.0-12 µm, thick-walled, walls 1-2 µm thick.

Taxonomic summary

Distribution. Neotropical and subtropical (Brodie, 1984; Esqueda et al., 2011); in Brazil known from Roraima (Jennifer Wilkinson - personal communication).

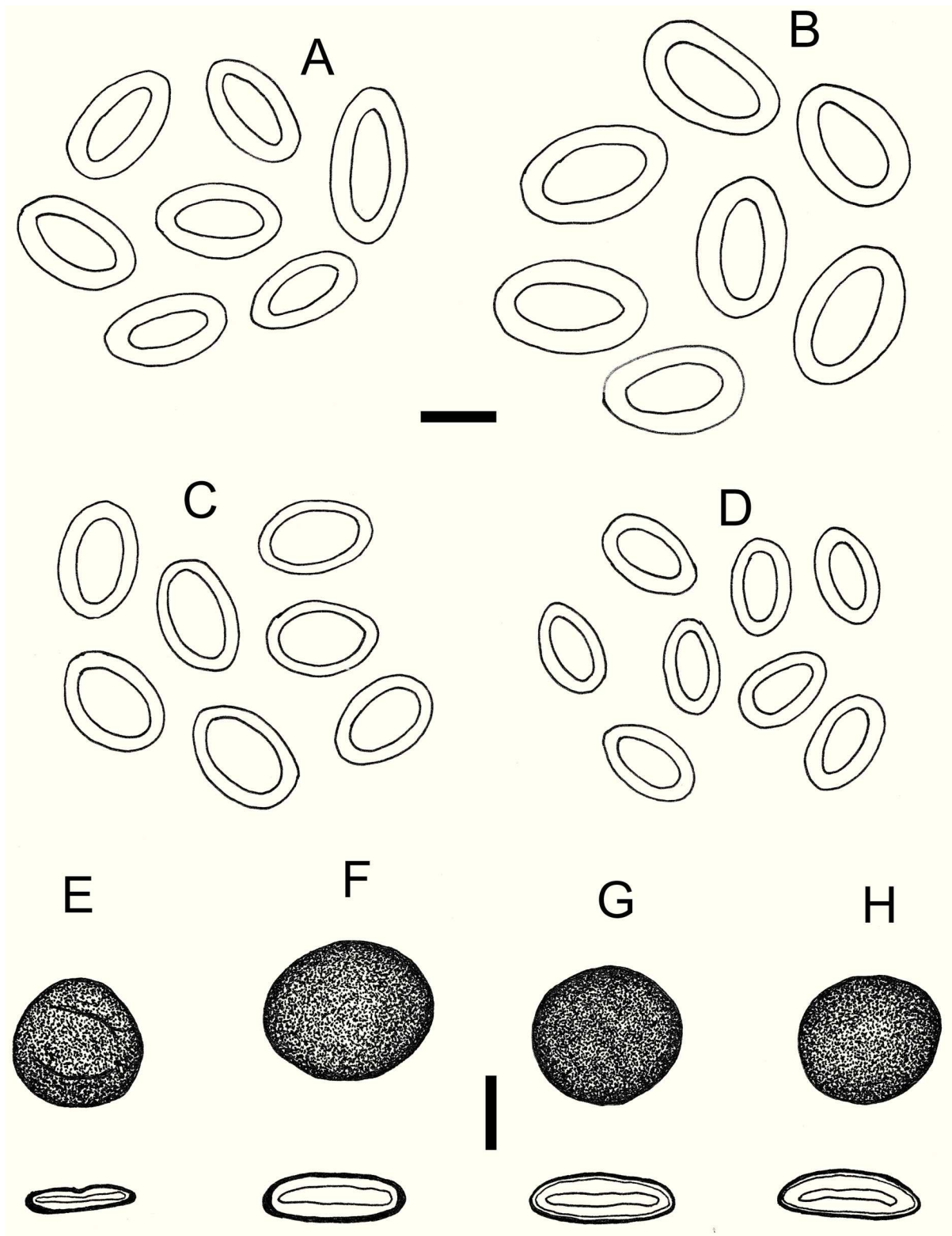


Figure 1. *Cyathus setosus*. A-B, Brazilian material; C-F, holotype; A-D, basidiomata; E, peridioles; F, peridiole in transversal section. Scale bars: 2.5 mm.

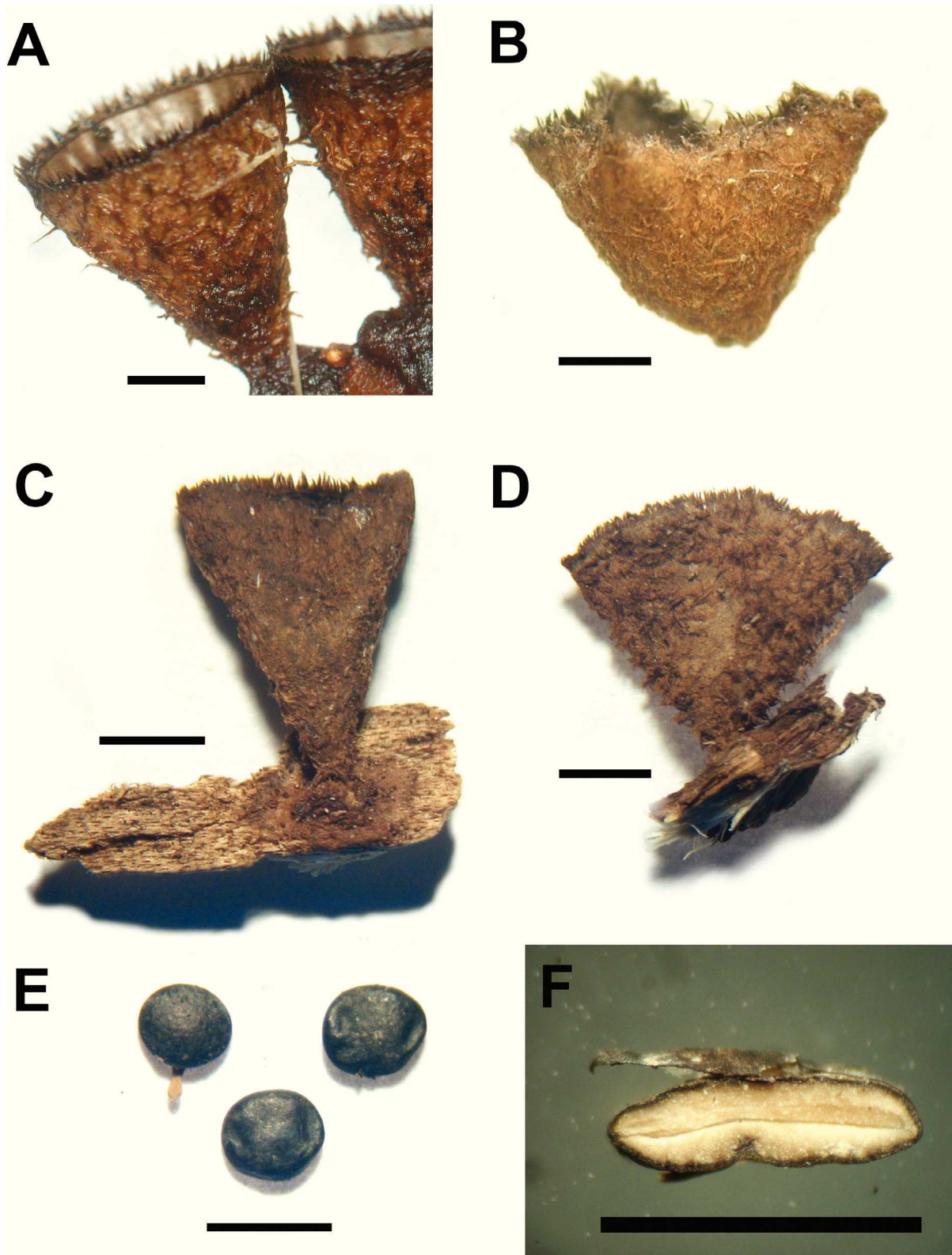


Figure 2. Basidiospores (A-D) and peridioles (E-H) of *Cyathus* species from Pernambuco. A, E: *Cyathus intermedius*; B, F: *Cyathus montagnei*; C, G: *Cyathus setosus*; D, H: *Cyathus triplex*. Scale bars: A-D= 10 μ m; E-H= 1 mm).

Studied specimens. **Brazil:** Pernambuco, Recife, Parque Dois Irmãos, 09.VII.2008, Trierveiler-Pereira et Baltazar 71, URM 82059; *ibid*, 07.V.2009, Trierveiler-Pereira et Baltazar 220, URM 82061; Moreno, RPPN Carnijó, 16.X.2008, Trierveiler-Pereira et Baltazar 196, URM 82060. Additional specimen: **Jamaica:** Hanover Parish, Woodsville, 09.I.1996, H. J. Brodie #6619a, DAOM 200815.

Remarks. *C. setosus* is characterized by the presence of dark setae, small base emplacement, broadly obconic and dark basidiomata, outer surface not plicate and inner surface faintly plicate, and large peridioles without tunica. The cortex is two-layered and this feature is clearly observed in the Brazilian material. The dark setae, diagnostic feature of this species, microscopically consist of hyphal pegs of dark brown, thick walled hyphae (3-6 μm wide). As observed by Brodie (1967) in his original description the spore size may vary. However, he described the species with basidiospores 17-24 \times 10-14 μm , whereas the Brazilian material has smaller dimensions (13-15 \times 8.0-12 μm). According to our analysis of the holotype, the basidiospores are (-15) 16-20 \times (10-) 10.5-12 (-13) μm ($n = 50$; $L_m \times W_m = 17.15 \times 11.5 \mu\text{m}$). Brodie (1967) described the peridioles as angular in outline, but we have also observed ellipsoid peridioles in the holotype collection.

The occurrence of *C. setosus* in Brazil was reported by Brodie (1984), but the exact location was not specified. However, the collector number given in this publication (#78010) corresponds to a collection from the state of Roraima, northern Brazil (DAOM 200851). This study reports the first occurrence of *C. setosus* from northeastern Brazil.

Cyathus triplex Lloyd, Mycol. Writ. 2, Nidulariaceae: 23 (1906)

(Figs. 1D, H)

Basidiomata obconic, without stipe, 6.0-10 mm high and 3.5-8.0 mm wide at the mouth; outer surface of the peridium not plicate, yellowish brown (KW 5E5), woolly, hairs, brownish orange (KW 5C5), that seem anastomosed; inner surface slightly ridged length wise, grayish brown (KW 5F3). Peridioles ellipsoid in outline, grayish brown (KW 5F2), shiny, 2.0-2.5 mm diam., two-layered cortex with thin tunica. Basidiospores ellipsoid, hyaline, smooth, 13-18 \times 8.0-10 μm , thick-walled, walls 1.5-2.5 μm thick.

Taxonomic summary

Distribution. Pantropical (Brodie, 1975); in Brazil known from São Paulo, Pernambuco and Pará (Trierveiler-Pereira and Baseia, 2009).

Studied specimens. **Brazil:** Pernambuco, Recife, Parque Dois Irmãos, 09.VII.2008, Trierveiler-Pereira et Baltazar 68, URM 82062; Moreno, RPPN Carnijó, 08.VII.2008, Trierveiler-Pereira 80, URM 82063. Additional specimen: **Brazil:** Pernambuco, Recife, Parque Dois Irmãos, I.2004, Baseia s/n, URM 77567.

Remarks. *C. triplex* is characterized by the peridium not plicate, peridioles with tunica and two-layered cortex. The species is similar to *C. setosus*, but dark setae are absent and the tunica is present. *Cyathus pallidus* is also a similar species, but it has lighter basidiomata, smaller basidiospores and one-layered cortex (Brodie and Dennis, 1954).

Discussion

In this study, *Cyathus* basidiomata were usually collected during the rainy season (winter). Most specimens were collected from June to August, although *C. setosus* was also collected in May and October. Herbarium data (Trierveiler-Pereira and Baseia, 2009) show that different species were collected at different times of the year, even in the drier months (*C. pallidus* and *C. triplex* were collected in January). Based on these observations, we can conclude that while investigating the diversity of *Cyathus* in this region, collections should be carried out during the entire year.

The specimens examined in this study were more common in lowland coastal forests (DI and CA), although *C. montagnei* was only found in highland humid forests (BC and ME). However, Trierveiler-Pereira and Baseia (2009) examined specimens of *C. montagnei* from lowland coastal forests which indicates that this species is not restricted to highland forests.

The identified species were found on rotten wood (fallen trunks or twigs), and curiously, 1 specimen of *C. setosus* was found on the petiole of a palm leaf (*Bactris acanthocarpa* Mart.). Most *Cyathus* species recorded from Pernambuco were collected on rotten wood (*C. intermedius*, *C. montagnei*, *C. pallidus*, *C. striatus* and *C. triplex*), although there are also reports from dung (*C. limbatus*), soil (*C. pygmaeus*) and other unusual substrata (*C. julietae* from *Mangifera indica* L. seeds and *C. montagnei* from *Cocos nucifera* L. fruit.).

The diversity of *Cyathus* species represented in this study is lower than we expected, since other species previously known from the state were not detected during field expeditions. Other tropical and cosmopolitan species which are known from Brazil, such as *C. berkeleyanus*, *C. poepiggi* and *C. stercoreus*, are also expected to occur in Pernambuco.

Key to *Cyathus* species known from Pernambuco, Brazil

1. Peridioles with one-layered cortex.....	2
1'. Peridioles with two-layered cortex.....	7
2. Basidiospores up to 15 µm in length.....	3
2'. Basidiospores larger.....	5
3. Basidiospores 8-10 × 5-6 µm.....	<i>C. julietae</i>
3'. Basidiospores larger.....	4
4. Basidiomata 6.5-8.0 mm high, outer surface with long hairs, peridioles 2.0-2.25 mm diam.....	<i>C. pallidus</i>
4'. Basidiomata 4.0-6.0 mm high, outer surface almost smooth, peridioles 1.5-1.75 mm diam.....	<i>C. pygmaeus</i>
5. Peridium walls not plicate.....	<i>C. intermedius</i>
5'. Peridium walls plicate externally and internally.....	6
6. Peridium internally yellowish brown.....	<i>C. striatus</i>
6'. Peridium internally shiny gray.....	<i>C. montagnei</i>
7. Peridium plicate externally and internally.....	<i>C. limbatus</i>
7'. Peridium not plicate or faintly plicate internally.....	8
8. Dark setae present at the apex of peridium.....	<i>C. setosus</i>
8'. Dark setae absent.....	<i>C. triplex</i>

Acknowledgements

We thank the authorities of “RPPN Carnijó”, “Parque Dois Imãos”, “Parque Ecológico João de Vasconcelos Sobrinho” and “Mata do Estado” (Pernambuco, Brazil) for permission to collect; friends and colleagues for help during field work; and the “Conselho Nacional de Desenvolvimento Científico e Tecnológico” (CNPq) for providing a master’s scholarship to LTP. We are most grateful to the herbarium staff of DAOM, URM and ICN for collaboration in the loan of materials and to Jennifer Wilkinson (DAOM) for important information about Brodie’s collections.

Literature cited

- Baseia, I. G. and A. I. Milanez. 2001a. *Crucibulum laeve* (Huds.) Kambly in cerrado vegetation of São Paulo State, Brazil. *Acta Botanica Brasilica* 15:13-16.
- Baseia, I. G. and A. I. Milanez. 2001b. *Nidularia pulvinata* (Schwein.) Fries (Gasteromycetes): a new record from Brazil. *Revista Brasileira de Botânica* 24:479-481.
- Baseia, I. G. and A. I. Milanez. 2003. *Cyathus* (Gasteromycetes) in areas of the Brazilian cerrado region, São Paulo State. *Mycotaxon* 80:493-502.
- Brodie, H. J. 1967. *Cyathus setosus*, a new member of the Nidulariaceae from Jamaica. *Canadian Journal of Botany* 45:1-3.
- Brodie, H. J. 1975. The bird’s nest fungi. University of Toronto Press, Toronto. 199 p.
- Brodie, H. J. 1977. A key to the species of *Cyathus* (Nidulariaceae). *Botaniska notiser* 130:453-459.
- Brodie, H. J. 1984. More bird’s nest fungi (Nidulariaceae). A supplement to “The bird’s nest fungi” (1975). *Lejeunia* 112:1-69.
- Brodie, H. J. and R. W. G. Dennis. 1954. The Nidulariaceae of the West Indies. *Transactions of the British Mycological Society* 37:151-160.
- Cortez, V. G., I. G. Baseia and R. T. Guerrero. 2006. Additions to the microbiota (Agaricales, Basidiomycetes) of Rio Grande do Sul, Brazil II: The bird’s nest fungi *Nidularia pulvinata* (Schwein.) Fr. *Revista Brasileira de Biociências, Porto Alegre* 14:15-18.
- Esqueda, M., A. Sánchez, M. L. Coronado, A. Gutiérrez, M. Lizárraga and R. Valenzuela. 2011. Nuevos registros de hongos gasteroides en la Reserva de la Biosfera Sierra de Álamos-Río Cuchujaqui. *Revista Mexicana de Micología* 34:43-51.
- Gómez, C. L. and E. Pérez-Silva. 1988. Especies de Nidulariales comunes en México. *Revista Mexicana de Micología* 4:161-183.
- Kornerup, A. and J. H. Wanscher. 1978. *Methuen handbook of colours*, 3rd edition. Eyre Methuen, London. 252 p.
- Lodge, D. J., J. A. Ammirati, T. E. O’Dell, G. M. Mueller, S. M. Huhndorf, C. J. Wang, J. N. Stokland, J. P. Schmit, L. Ryvardeen, P. R. Leacock, M. Mata, L. Umaña, Q. Wu and D. L. Czederpiltz. 2004. Terrestrial and lignicolous macrofungi. *In* Biodiversity of fungi. Inventory and monitoring methods, G. M. Mueller, G. F. Bills and M. S. Foster (eds.). Elsevier Academic Press, Boston. p 127-172.
- Thiers, B. 2011. Index Herbariorum: A global directory of public herbaria and associated staff. Available at: <http://sweetgum.nybg.org/ih/>; last access: 03.XI.2011.
- Trierveiler-Pereira, L. and I. G. Baseia. 2009. Revision of the Herbarium URM IV. Nidulariaceae (Basidiomycota). *Nova Hedwigia* 89:361-369.
- Trierveiler-Pereira, L., A. C. Gomes-Silva and I. G. Baseia. 2009. Notes on gasteroid fungi of the Brazilian Amazon rainforest. *Mycotaxon* 110:73-80.