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Grammothele species from southern Brazil

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Abstract — Three species of *Grammothele* found in Rio Grande do Sul State in southern Brazil — *G. fuligo*, *G. lineata*, *G. subargentea* — are described and illustrated. *Grammothele fuligo* is recorded for the first time from extra-Amazonian Brazil. The genus produces resupinate basidiomata with bluish-gray to dark-gray pore surfaces and with very shallow pores; microscopically, it is diagnosed by a dimitic hyphal system, clamped generative hyphae, dextrinoid skeletal hyphae, and abundant dendrohyphidia.

Key words — *Grammotheleaceae*, resupinate polypore, Brazilian Atlantic Rain Forest

Introduction

The genus *Grammothele* was described by Berkeley & Curtis (1868) and was historically classified in the *Corticiaceae* s. lat. based on its effused basidiomata with poorly developed, irregular pores and a hymenium restricted to the basal part of the tubes (Ryvarden 1992). Kirk et al. (2008) include the genus in the family *Grammotheleaceae* Jülich (1981), citing eight pantropical species. Larsson (2007), however, places *Grammothele* in *Polyporaceae* based on its dimitic hyphal system and supported by *Grammothele fuligo* DNA sequence analyses.

According to Ryvarden & Johansen (1980), the genus is related to *Theleporus* Fr., a resupinate genus that also has shallow tubes with the hymenia restricted to tube bases and dendrohyphidia but which differs from *Grammothele* in having a di- to trimitic hyphal system with dendroid skeletal or binding hyphae. *Porogramme* (Pat.) Pat. is also very similar but lacks dendrohyphidia. *Tinctoporellus* Ryvarden, a genus that shares macro and micro morphology and culture features (Rajchenberg 1983), can be also confused with *Grammothele;* however, in *Tinctoporellus* the hymenophore is distinctly tubular and the dendrohyphidia are absent.

Knowledge of the genus in Brazil is poor: Rick (1938) described *Grammothele ceracea* from Rio Grande do Sul State, but Rajchenberg (1987a) considered it a nomen dubium. Rick (1960) also recorded *G. lineata* and *G. subargentea*

(as *Poria hydnopora* (Berk.) Sacc. and *Poria subargentea* Speg., respectively). Lowe (1964) cited *G. delicatula* from southeast Brazil, but this species is now placed in the genus *Dichomitus* (Masuka & Ryvarden 1999). Several authors since Rick (Rajchenberg & Meijer 1990, Jesus 1996, Jesus et al. 1998, Ryvarden & Meijer 2002, Gibertoni et al. 2004, Drechsler-Santos et al. 2008) have recorded *Grammothele* taxa from Brazil, but none provide keys, descriptions, or illustrations.

A key, descriptions, and comparisons among *Grammothele* species from southern Brazil are presented below. The studied specimens were collected in the Atlantic Rain Forest, which covers the low to medium elevations of the eastern slopes of the mountain formation along the coast from southern to northeastern Brazil and which is characterized by a high mean temperature and constant high precipitation throughout the year (Morellato & Haddad 2000).

Materials and methods

Basidiomes were collected along the north coast of Rio Grande do Sul State in the austral limit of the Atlantic Rain Forest in forests remnants extending between 29°12'–24'S and 49°42'–50°07'W. Additional specimens of *Grammothele subargentea* from other regions of the State were also examined. Macro- and microscopic analyses followed procedures set forth by Núñez & Ryvarden (2001). Microscopic examination was made from freehand sections mounted drops of 5% KOH mixed with 1% phloxine solution; amyloid or dextrinoid reactions were observed in Melzer's reagent. Specimens were identified using keys and descriptions by Rajchenberg (1984) and Ryvarden & Johansen (1980). Description abbreviations are modified from Coelho (2005), with Pm = pore average, Dm = diameter mean, Lm × Wm = means of length and width, Q = range of length/width ratios, Qm = length/width mean, and n = x/y (with x = number of measurements from a given number (y) of specimens). Color names and codes are from Kornerup & Wanscher (1978). All the specimens are preserved at the Botany Department Herbarium, Universidade Federal do Rio Grande do Sul (ICN).

Taxonomy

Key to *Grammothele* species in Brazil

1. On decayed monocotyledons (especially palms); pores 5–11/mm ..... 1. ***Grammothele fuligo***

1'. On decayed dicotyledons, pores 2–4/mm **2**

2. Tubes very shallow, ≤ 200 µm deep, encrusted brown hyphal pegs present in hymenium and subiculum, basidiospores ellipsoid, 4.5–6.0 × 2.5–3.0 µm ..... 2. ***G. lineata***

2'. Tubes deeper, ≤ 0.7 mm deep, hyphal pegs lacking, basidiospores cylindrical to ellipsoid ~6.5–8.5 × 3–4 µm ..... 3. ***G. subargentea***

Descriptions

1. *Grammothele fuligo* (Berk. & Broome) Ryvarden

Transactions of the British Mycological Society 73: 15, 1979. Figs 1–6, 20

Basidiomata annual, resupinate, widely effused, strongly adnate, ceraceous when fresh, becoming hard and brittle; margin wide to narrow, greyish violet (17.C4). Pore surface dark violet (17.F4; 18.D5), dull violet (18.D4) to grayish violet (18.E5; 19.D6); pores regular and angular, with thin and entire dissepiments, invisible to the naked eye, 5–11/mm, Pm = 8.47, n = 60/2. Tubes very shallow, up to 0.5 mm deep, subiculum dark brown and very thin, up to 50 μm thick.

Hyphal system dimitic. Generative hyphae hyaline, with clamps, thin walled, 1.0–3.0 μm wide, Dm = 1.93, n = 90/3, much branched, abundant near the hymenium; skeletal hyphae dominating in context and tube walls, thick-walled to almost solid, strongly dextrinoid, 2–5 μm wide, Dm = 3.45, n = 90/3, unbranched or rarely with some branches, parallelly arranged in the trama. Dendrohyphidia present, abundant along the pore edges, arising from generative hyphae, strongly branched in the apices, also observed along the sterile walls of the pores. Hymenium without cystidia. Basidia clavate, tetraspored, with large sterigmata, 19–23 × 5–7 μm. Basidiospores cylindrical to narrowly ellipsoid, sometimes slightly curved, hyaline, thin-walled, smooth and non dextrinoid, (5.5–)6–8 × 3–3.5 μm, Lm × Wm = 6.57 × 3.10, Q = 1.83–2.67, Qm = 2.14, n = 90/3.

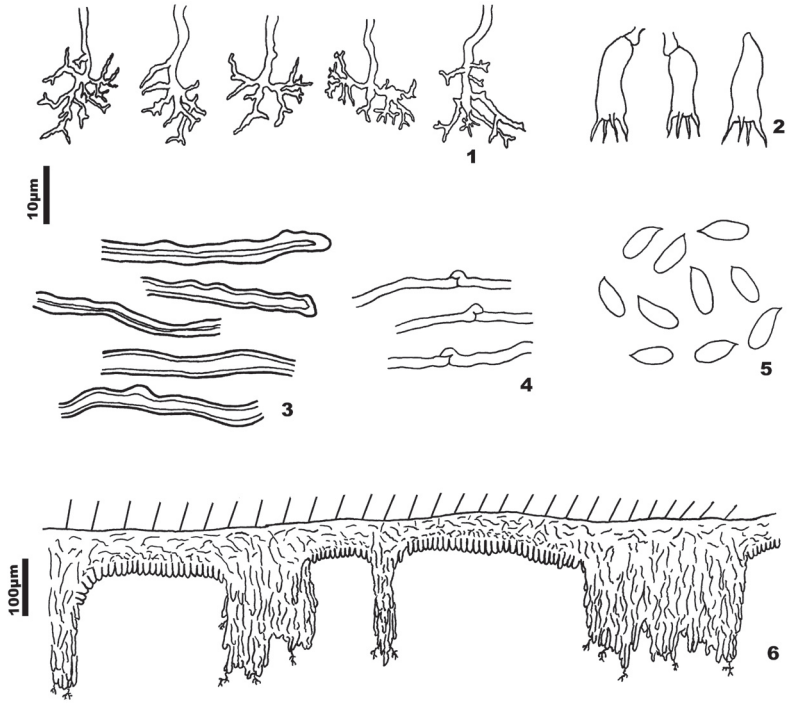
Cultural characteristics. Unknown.

Habitat. On decayed monocotyledons, found on the decayed palms of *Syagrus romanzoffiana* (Cham.) Glassman and *Euterpe edulis* Mart. (*Arecaceae*). According to Ryvarden & Johansen (1980) and Coelho et al. (2006) this species can also be found on bamboo species. Causing a white wood-rot in the hosts.

Distribution. Pantropical, previously known only from tropics following the distribution of palms from East Africa (Ryvarden & Johansen 1980), China (Dai et al. 2004), India (Virdi 1990), Jamaica (Ryvarden 2000), Japan (Nuñez & Ryvarden 2001), Venezuela (Iturriaga & Ryvarden 2001), Hawaii (Gilbertson et al. 2002), Belize (Ryvarden 2007), and Brazil (Roraima, Jesus 1996; Amazonas, Jesus et al. 1998). This is the first record of *Grammothele fuligo* from a subtropical biome.

Specimens examined: BRAZIL. Rio Grande do Sul State, municipality of Dom Pedro de Alcântara, Mato da Cova Funda, 16.XII.2007, *leg. M.A. Reck 126/07* (ICN 139976); municipality of Morrinhos do Sul, Lajeadinho, 04.VII.2008, *leg. M.A. Reck 076/08* (ICN 154190); *leg. M.A. Reck 077/08* (ICN 154191); *leg. M.A. Reck 078/08* (ICN 154192).

Remarks. This species is usually easy to recognize in the field because of its association with monocotyledons and blue grayish colour. At first sight, this



Figs. 1–6. Microscopic characters of *Grammothele fuligo*.
1. Dendrohyphidia. 2. Basidiospores. 3. Skeletal hyphae. 4. Generative hyphae.
5. Basidia. 6. Longitudinal section of the basidiome.

fungus resembles a *Corticiaceae* species, but under the lens it shows very shallow pores on a very thin basidiomata. *Grammothele fuligo* can be separated from *G. lineata* and *G. subargentea* mainly by the specific host and small pores. *Porogramme albocincta* (Cooke & Massee) J. Lowe (Ryvarden & Johansen 1980), which might be confused with *G. fuligo* due to the similar basidiome color, grows on dicot wood and lacks dendrohyphidia. Some pinkish coloured resupinate species of *Junghuhnia* Corda, such as *J. meridionalis* (Rajchenb.) Rajchenb. (Rajchenberg 1987b), which has very small pores and a waxy consistency, is also macroscopically similar to *G. fuligo* but can be distinguished by its encrusted thick-walled hymenial cystidia, non-dextrinoid skeletal hyphae, and reddish brown basidiome colour. Our specimens differed from the East African specimens described by Ryvarden & Johansen (1980) by larger (5–11/mm vs. 8–16/mm) pores and shorter [(5.5–)6–8 µm vs. 7–9 µm] basidiospores.

As noted by Ryvarden & Johansen (1980), *G. fuligo* is found in forests only where palm and/or bamboo is abundant. The studied area contains the richest palm and bamboo habitats in Rio Grande do Sul State (Rambo 1950).

This is the first record of *G. fuligo* from Rio Grande do Sul State.

2. *Grammothele lineata* Berk. & M.A. Curtis
Journal of the Linnean Society, Botany 10: 327, 1868. Figs 7–13, 21

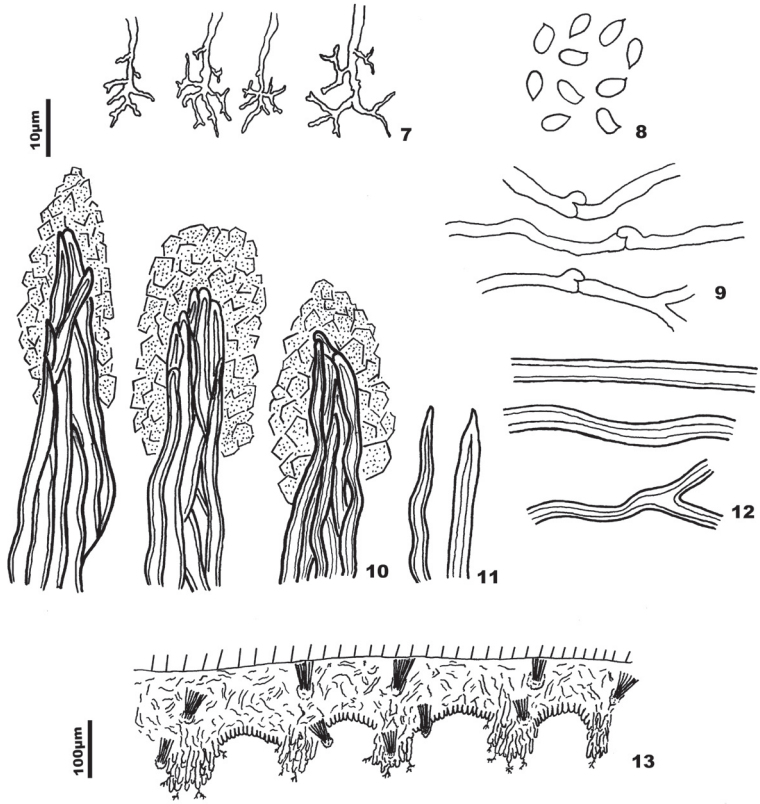
Basidiomata annual, resupinate, strongly adnate, hard and brittle, thin, up to 0.3 mm thick, with reticulate furrows; sterile margin thin, reddish lilac (14.B3) to purplish grey (14.B2), regular and farinose; pore surface violet grey (18.B2; 18.C2) to greyish violet (18.C3), also greyish lilac (15.C2), finely spotted with dark points here and there; pores irregular, angular and very shallow, (2–)3–4 (–5)/mm, Pm = 3.53, n = 60/2, with irregular dissepiments, that occur in a teeth pattern, or in labyrinth form, tube layer very thin, 200 µm thick; subiculum very thin, up to 180 µm wide, concolorous with the pore surface, becoming darker with age.

Hyphal system dimitic. Generative hyphae with clamps, hyaline and thin-walled, branched and tortuous, 1.0–2.5µm wide, Dm = 1.68, n = 90/3, difficult to find in dried specimens; skeletal hyphae hyaline to pale brown in KOH solution, thick-walled to solid, straight to regularly branched and, in that case resembling binding hyphae, dextrinoid, strongly dextrinoid in mass, 1.5–3.5 µm wide, Dm = 2.33, n = 90/3; after drying the hyphal structure becomes agglutinated and very difficult to separate. Hyphal pegs triangular, present in all the basidiomata, arising from the trama or the subiculum, constituted by parallel and unbranched skeletal hyphae with sword-like apices, with a yellowish brown tint, mostly encrusted by crystals, 55–110 × 10–30 µm, Lm × Wm = 75.30 × 21.37, Q = 2.60–6.20, Qm = 3.68. n = 90/3. Hymenium without cystidia. Dendrohyphidia abundant, present in the hymenium and dissepiments, hyaline, very sinuous and branched, arising from the generative hyphae, difficult to find when dried. Basidia clavate, tetraspored, 10.5–16 × 3–6 µm. Basidiospores ellipsoid to narrowly ellipsoid, rarely cylindric, hyaline, smooth and thin-walled, IKI–, 4.5–6.0 × 2.5–3.0 µm, Lm × Wm = 5.20 × 2.83, Q = 1.50–2.20, Qm = 1.84, n = 90/3.

Cultural characteristics. See David & Rajchenberg (1985). Causing a white wood-rot.

Substrata: on decayed angiosperm branches.

Distribution: Pantropical, widely distributed. Recorded from Argentina (Rajchenberg 1984, Wright & Wright 2005), Costa Rica (Carranza & Ryvarden 1998), Panama (Nuñez & Ryvarden 1999), East Africa (Ryvarden & Johansen 1980), Taiwan (Lin & Chen 1990), and Venezuela (Iturriaga & Ryvarden 2001).



Figs. 7–13. Microscopic characters of *Grammothele lineata*.
7. Dendrohyphidia. 8. Basidiospores. 9.Generative hyphae. 10.Encrusted hyphal pegs.
11. Sword like skeletal hyphae. 12.Skeletal hyphae. 13. Longitudinal section of the basidiome.

Cited previously from Brazil from the States of Rio Grande do Sul (Rick 1960), Roraima (Jesus 1996), Alagoas, and Pernambuco (Gibertoni et al. 2004).

Specimens examined: BRAZIL. Rio Grande do Sul State, municipality of Dom Pedro de Alcântara, Mato da Cova Funda, 16.XII.2007, *leg. M.A. Reck 121/07* (ICN 139971); municipality of Morrinhos do Sul, Perdida, 23.II.2008, *leg. M.A. Reck 014/08* (ICN 154011); Lajeadinho, 04.VII.2008, *leg. M.A. Reck 075/08* (ICN 154189).

Remarks: *Grammothele lineata* is macroscopically characterized by tubes so shallow that the basidiomata may be confused with smooth (i.e., poreless) corticioid fungi and by the grayish pink tint of the hymenial surface. Microscopically, it is unmistakable vis à vis other *Grammothele* species due to

the presence of encrusted and darkened hyphal pegs and ellipsoid basidiospores. Upon drying, the hyphal pegs may appear as small dark points in the tubes. Basidiospores of our materials measure slightly wider (2.5–3.0 µm) than those described by Ryvarden & Johansen (1980; 1.5–2.5 µm). Lin & Chen (1990) describe the encrusted hyphal pegs as shaped like pine trees.

This species was frequent and quite easy to find in the studied area, appearing mainly inside the forest.

3. *Grammothele subargentea* (Speg.) Rajchenb.
Mycotaxon 17: 280, 1983. FIGS 14–19, 22

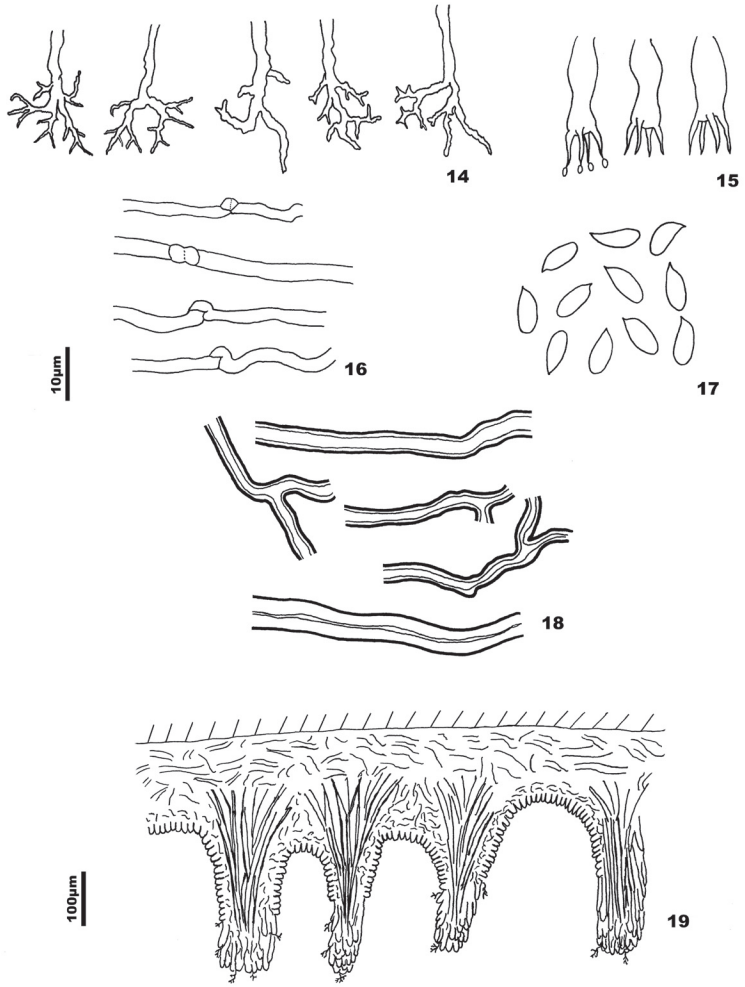
BASIDIOMATA annual, resupinate, adnate, totally effused, gelatinous to corky when fresh, becoming hard upon drying; margin irregular, lilac (15.B4) to pastel violet (15.A4), thin and farinose; pore surface reddish violet (16.B8), also reddish lilac (14.C4) to greyish lilac (16.C2), with regular and angular pores, 2–4/mm, Pm = 2.87, n = 60/2, dissepiments entire and thin, tubes shallow, up to 0.7 mm deep; subiculum very thin, up to 100 µm thick, reddish, becoming darker with age.

HYPHAL SYSTEM dimitic. Generative hyphae with clamps, hyaline and thin-walled, much branched and difficult to find in dried specimens, 1.0–2.5 µm wide, Dm = 1.75, n = 90/3; skeletal hyphae pale yellow to cinnamon in KOH sol., thick-walled, scarcely branched, sinuous to straight, abundant, strongly dextrinoid, 1.5–4.0 µm wide, Dm = 2.75, n = 90/3. Dendrohyphidia abundant in the fresh specimens, occurring both in the dissepiment edges and hymenium, arising from generative hyphae, hyaline, very branched and sinuous. HYMENIUM without cystidia. Basidia clavate, tetraspored, 14–20 × 4–6 µm. Basidiospores cylindric, rarely subellipsoid, hyaline, smooth and thin-walled, (6–)6.5–8.5 × (–2.5)3–4 µm, Lm × Wm = 7.45 × 3.37, Q = 1.88–2.67, Qm = 2.23, n = 90/3.

CULTURAL CHARACTERISTICS. See Rajchenberg (1983) and David & Rajchenberg (1985). Causing a white wood-rot.

SUBSTRATA: on decayed wood of angiosperms.

DISTRIBUTION: South America and East Africa (Rajchenberg 1984). In the Neotropics, *G. lineata* has been reported from both in subtropical and tropical areas in Argentina (Rajchenberg 1984, Wright & Wright 2005, Robledo & Rajchenberg 2007), Belize (Ryvarden 2007), Paraguay (Popoff & Wright 1998), and Venezuela (Iturriaga & Ryvarden 2001). In Brazil, it was previously recorded from the States of Rio Grande do Sul (Rick 1960, Reck & Silveira 2008), Roraima (Jesus 1996), Paraná (Rajchenberg & Meijer 1990, Ryvarden & Meijer 2002), Alagoas, Pernambuco, Paraíba (Gibertoni et al. 2004), and Santa Catarina (Drechsler-Santos et al. 2008). *Grammothele lineata* was easily found in the study area, fruiting mainly on decayed wood inside the forest.



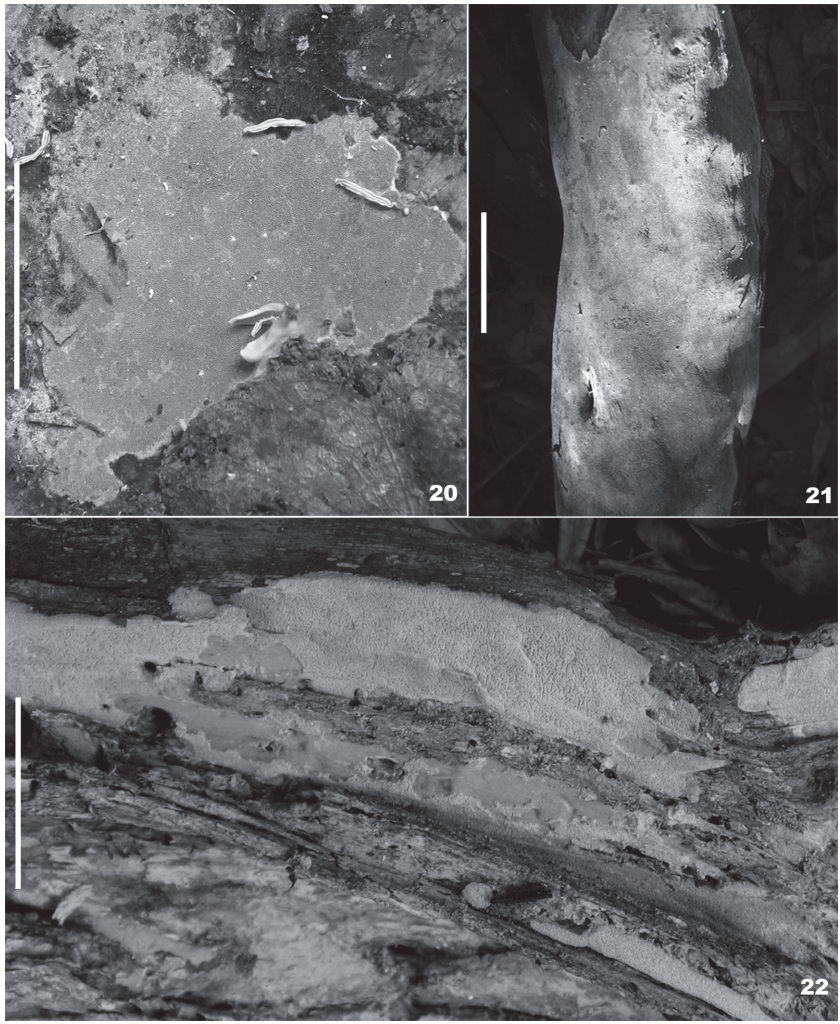
Figs. 14–19. Microscopic characters of *Grammothele subargentea*.
14. Dendrohyphidia. 15. Basidiospores. 16.Basidia. 17.Generative hyphae.
18. Skeletal hyphae. 19. Longitudinal section of the basidiome.

Specimens examined: BRAZIL. Rio Grande do Sul State, municipality of Dom Pedro de Alcântara, Mato da Cova Funda, 27.III.2007, *leg. M.A. Reck 017/07* (ICN 139884); 25.XI.2007, *leg. M.A. Reck 118/07* (ICN 139968); 16.XII.2007, *leg. M.A. Reck 145/07* (ICN 139995); *M.A. Reck 146/07* (ICN 139996); municipality of Mampituba, Silveirão, 17.IV.2007, *leg. M.A. Reck 051/07* (ICN 139904); 15.IV.2007, *leg. M.A. Reck 090/07* (ICN 139940).

Additional Material: BRAZIL. Rio Grande do Sul State, municipality of Viamão, 16.IV.2005, *leg. M.A. Reck 033/05* (ICN 139214); 21.XI.2003, *leg. M.A. Reck 033/05* (ICN

139233); municipality of Porto Alegre, Morro Santana, 14.XII.2007, *leg. M.C. Westphalen 077/07* (ICN 154129)

Remarks: The vivid pink colour of the fresh basidiomata characterizes this species. In comparison with *Grammothele fuligo* and *G. lineata*, *G. subargentea* alone possesses a hymenium that can cover the vertical sides of the tubes. Rajchenberg (1983) cites its abundant dendrohyphidia, cylindric basidiospores,



Figs. 20–22. Basidiomes of *Grammothele*.
20: *G. fuligo*. 21: *G. lineata*. 22. *G. subargentea*.
Scale bars = 5 cm.

and dextrinoid skeletal hyphae as features sufficient to include it in *Grammothele*. *Gloeoporus dichrous* (Fr.) Bres. (Gilbertson & Ryvarden 1986) and *Skeletocutis roseola* (Rick ex Theiss.) Rajchenb. (Silveira & Guerrero 1991) have a similarly colored pore surface, but both can be separated based on their effuse-reflexed basidiomes and minute (<2 µm diam) allantoid spores. Our material agrees with Rajchenberg's (1984), observation that the substrate generally shows a reddish line near the basidiome margin, somewhat similar to *Tinctoporellus epimiltinus* (Berk. & Broome) Ryvarden, a resupinate greyish species that reddens the substrata (Rajchenberg 1984) but that lacks dendrohyphidia and has smaller (≤ 9/mm) pores (Ryvarden & Johansen 1980). Molecular studies may be necessary to clarify the relationship between the two species, as *G. subargentea* and *T. epimiltinus* also have similar culture features (Rajchenberg 1983).

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