Species of *Ganoderma* Karsten in a subtropical area (Santa Catarina State, Southern Brazil)

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RESUMO – **Espécies de *Ganoderma* Karsten em uma Área Subtropical (Santa Catarina, Brasil)**. O estudo das espécies de *Ganoderma* no estado de Santa Catarina (sul do Brasil) levou a determinação de sete espécies: *G. annulare* (Fr.) Gilbn., *G. applanatum* (Pers.) Pat., *G. australe* (Fr.) Pat., *G. lucidum* (W. Curt.: Fr.) Karst., *G. oerstedii* (Fr.) Murr., *G. resinaceum* Boud. e *G. subamboinense* (Henn.) Bazzalo & Wright. Apresenta-se um padrão de distribuição geográfica dessas espécies para o Estado. *G. oerstedii, G. lucidum* e *G. subamboinense* são novos registros para o estado de Santa Catarina.

Palavras-chave: fungos, Basidiomycetes, taxonomia, biodiversidade, distribuição.

ABSTRACT – The study of *Ganoderma* species in the state of Santa Catarina (Southern Brazil) found seven species: *G. annulare* (Fr.) Gilbn., *G. applanatum* (Pers.) Pat., *G. australe* (Fr.) Pat., *G. lucidum* (W. Curt.: Fr.) Karst., *G. oerstedii* (Fr.) Murr., *G. resinaceum* Boud. and *G. subamboinense* (Henn.) Bazzalo & Wright. A distribution geographical pattern of these species for the State is provided. *G. oerstedii, G. lucidum* and *G. subamboinense* are new records from Santa Catarina State.

Key words: fungi, Basidiomycetes, taxonomy, biodiversity, distribution.

INTRODUCTION

The genus *Ganoderma* was created by Karsten in 1881 based on *Polyporus lucidus* Leys.: Fr. All *Ganoderma* species lack cystidia, have echinulate basidiospores and cause a white rot in their substrata. Our knowledge of species of *Ganoderma* Karsten (Ganodermataceae) has been, and still is, rather chaotic, principally due to their polymorphism (Ryvarden, 1991; 2000). The taxonomical criteria are diverse considering different authors (Gottlieb & Wright, 1999a; 1999b), so the correct name for many taxa used in different works remained unclear (Moncalvo & Ryvarden, 1997). *Ganoderma* species employ wood like resource, as saprotrophs as well parasites. Considering the main vegetational types of the state of Santa Catarina (26º00' to 30º00' S lat, 48º30' to 54º00' W long) presents three of them: Dense Tropical Rain Forest (Atlantic Rain Forest), Araucaria Forest and Seasonal Deciduous Tropical Forest (Morellato & Haddad, 2000; IBGE, 1997). Our studies on this genus have been intensified since 1990, with collections on these regions, especially in Atlantic Rain Forest. During the 19th century the following species were reported (Bresadola, 1896; Hennings, 1897) for the state (Blumenau City), *G. amboinense* (Lam.: Fr.) Pat. and *G. renidens* Bres. [= *Amauroderma renidens* (Bres.) Torr.]. More recently Loguercio-Leite & Wright (1991) recorded *G. tornatum* (Pers.) Bres [=*G. australe* (Fr.) Pat.], afterwards Gerber (1996) cited *G. annulare* (Fr.) Gilbn., *G. applanatum* (Pers.) Pat. and *G. resinaceum* Boud *ex* Pat., for Santa Catarina Island.

MATERIAL AND METHODS

This study has been undertaken with periodical collections and identification of the materials. At the same time, we isolated tissue cultures from the basidiomes for further studies. The study of the basidiomes was made on macro (size, colour, number pores/mm, length of tubes) and microscopic

characters (somatic and reproductive structures). Free-hand sections were made and stained with 1% phloxine, 5% KOH, and Melzer's reagent. Dermic elements were examined in thin sections perpendicular to the pileus surface. Colours are according to Munsell (1975) and Herbaria abbreviations follow Holmgren *et al*. (1990). FLOR collections were compared with specimens of BAFC.

Names and authorities of species followed Moncalvo & Ryvarden (1997).

RESULTS AND DISCUSSION

Remarks were included for each species besides a synoptic comparison between all species considered (Tab. 1) and the distribution pattern of species recorded for the state of Santa Catarina (Fig. 1).

Ganoderma annulare (Fr.) Gilbn., **Mycologia**, v. 53, p. 505. 1961.

Basionym: *Polyporus annularis* Fr., **Nov. Symb. Mycol.**, p. 52. 1851.

Distribution: BRASIL, SANTA CATARINA, **Cunha Porã**, 20.I.1991, Foresti & Foresti (FLOR 10832), (FLOR 10833); **Florianópolis**, 12.XI.1993, Gerber & Cabral (FLOR 10947), 30.IV.1993, Gerber (FLOR 11113), 22.IX.1994, Foresti, Neves & Degenhardt (FLOR 11147).

Additional material: INDONESIA, JAVA 1907 (BAFC 29422).

Remarks: It is characterized by thick basidiomes, hard pileus, thin context or absent, features which agree with the description of the species. Spores 8.4-11.2 × 4.9-7 µm similar to those described by Gilbertson & Ryvarden (1986), and Zhao (1989), 11-14 × 7-8 µm and 9-12 × 6-8 µm, respectively. However, Moncalvo & Ryvarden (1997) considered *Ganoderma annulare* a illegitimate name, since the basionym is illegitimate as nomem superfluous (*op. cit.*, p. 20-21), and they affirmed that "... (it) has to be renamed and typified...".

Ganoderma applanatum (Pers.) Pat., **Hyemn. Eur.**, p. 143. 1887.

Basionym: *Boletus applanatus* Pers., **Obs. Myc.**, v. 2, p. 2. 1799.

Distribution: BRASIL, SANTA CATARINA, **Florianópolis**, 20.II.1992, Foresti, Leite, Romero & Folle (FLOR 10848), 06.IX.1993, Gerber & Cabral (FLOR10940), 27.I.1994 (FLOR 10958), 23.II.1994, Gerber, Leite & Cabral (FLOR 10969), 29.III.1994, Gerber & Halmenschlager (FLOR 10982), 28.VI.1994 (FLOR 11012), 07.IV.1994, Marthendall (FLOR 11121); **Água Doce**, 23.VIII.1992, Folle & Willerding (FLOR 10861), (FLOR 10863); **Garopaba**, 29.I.1994, Loguercio-Leite (FLOR 11118); **Caçador**, 20.XI.1994, Rohling (FLOR 11149); **Santo Amaro da Imperatriz**, 06.X.2000, Groposo 46 (FLOR 11892), 10.XI.2000, Groposo 69 (FLOR 11896), Groposo 70 (FLOR 11897), 28.III.2001, Groposo 118 (FLOR 31326), 28.V.2001, Groposo 146 (FLOR 11936); **Palhoça**, 18.VII.2001, Groposo 179 (FLOR 11956), Groposo 187 (FLOR 11948).

Additional material: ARGENTINA, MISIONES, **El Soberbio**, 28.IV.1966, Gómez (BAFC 22850); **Bdo. De Irigoyen**, 23.II.1971, Tell (BAFC 22852).

Remarks: Basidiomes are pluristratified with a thin context layer between strata. The pileus surface is pale grey and the context pale brown or dark brown with a pale brown layer close to the cutis, which is trichodermic. Spores 7-10.5 × 4.2-7 µm agree with the measurements [7-9 (10.4) × 4.3-6.2 µm] given by Zhao (1989), but differing from Gilbertson & Ryvarden (1986), who described the spores as (8-) 9-12 × 6.5-8 µm.

G. australe (Fr.) Pat., **Bull. Soc. Mycol. France**, v. 4, p. 1712. 1887.

Basionym: *Polyporus australis* Fr. **Elench. Fung.**, v. 1, p. 108. 1828 [1821].

Distribution: BRASIL, SANTA CATARINA, **Cunha Porã**, 20.I.1991, Foresti & Foresti (FLOR 10831), 18.I.1992, Foresti (FLOR 10846); **Iraceminha**, 10.II.1991, Foresti & Foresti (FLOR 10834), (FLOR 10835), (FLOR 10836), (FLOR 10837), (FLOR 10867); **Florianópolis**, 28.IV.1991, Foresti (FLOR 10840), 20.X.1991 (FLOR 10844), 25.IX.1991, Queirós (FLOR 10845), 19.II.1992 (FLOR 10849), 07.III.1992, Folle (FLOR 10854), 07.IV.1992, Loguerio-Leite & Amaral (FLOR 10857), 11.VI.1992, Folle & Willerding (FLOR 10858), 10.X.1992 (FLOR 10862), 11.III.1993, Neves (FLOR 10868), 11.XI.1992, Martendal (FLOR 10870), 18.II.1993, Jarenkow (FLOR 10872), 09.VI.1993, Gerber, Baptista, Neves & Cabral (FLOR 10879), 11.X.1993, Gerber & Cabral (FLOR 10942), 23.II.1994, Gerber, Leite & Cabral (FLOR 10973), 28.IV.1994, Gerber, Halmenschlager & Cabral (FLOR 10990), (FLOR 10991), (FLOR 10992), 30.V.1994, Gerber & Cabral (FLOR 10997), (FLOR 11001), 27.IV.1993, Leite & Foresti (FLOR 11110), 02.V.1993, Gerber (FLOR 11112), 16.III.1995, Foresti, Gerber & Althoff (FLOR 11119), (FLOR 11122), 18.V.1994, Leite (FLOR 11125), 22.V.1994, Castilho (FLOR 11130), 02.VI.1994, Foresti & Foresti (FLOR 11133), (FLOR 11134), (FLOR 11135), 02.III.1994, Marin (FLOR 11140), 18.VIII.1994, Neves & Foresti (FLOR 11142), 20.XI.1994, Leite (FLOR 11144), Marin (FLOR 11146); **Tijucas**, 14.VI.1991, Queirós (FLOR 10843); **Ilhota**, 07.III.1992, Willerding & Folle (FLOR 10850), (FLOR 10851), (FLOR 10852), (FLOR 10853); **Águas Mornas**, 06.IV.1992, Cheren & Soldateli (FLOR 10856); **Água Doce**, 23.VIII.1992, Folle & Willerding (FLOR 10860), (FLOR 10864), (FLOR 10865); **Chapecó**, 26.VIII.1992, Folle & Willerding (FLOR 10866); **Timbó**, 23.X.1993, Willerding (FLOR 11116); **Santo Amaro da Imperatiz**, 19.VI.1994, Gerber, Foresti & Leite (FLOR 11138); **Garopaba**, 03.IV.1994, Leite (FLOR 11120), 13.VI.1994, Leite (FLOR 11139); **Paulo Lopes**, 22.II.2001, Leite 98 (FLOR 11906), Leite 101 (FLOR 11908).

Remarks: The context is concolorous with the tubes, without context layers between them, the cutis is anamixodermic; and there is a dark line under its cutis. It is very similar to *G. applanatum,* but these characteristics separate from the other species; besides that the distribution is other distinctive feature according Steyaert (1975). Spores 7-11.2 × 4.2-7 µm, agree with the measurements (6-13 × 4.5-8 µm) given by Steyaert (1975) as *G. tornatum* (Pers.) Bres. Moncalvo & Ryvarden (1997) considered that Steyaert (1967) selected *P. tornatus* Pers. (1826) as the basonym, but *P. australe* Fr. (1828) was been published as a part of Systema Mycologicum in 1 January 1821, according ICNB. Therefore *G. australe* is the valid name.

Ganoderma lucidum (W. Curt.: Fr.) Karst., **Rev. Mycol.**, v. 3, p. 17. 1881.

Basionym: *Polyporus lucidus* W. Curt.: Fr. **Syst. Mycol.**, v. 1, p. 353. 1821.

Distribution: BRASIL, SANTA CATARINA, **Florianópolis**, 06.II.1986, Furlani & Zanin (FLOR 10421), 08.I.1986, Furlani, Loguercio-Leite & Zanin (FLOR 10248); **Videira**, 28.II.1995, Degenhardt (FLOR 11117), 20.X.1994 (FLOR 11143).

Additional material: ARGENTINA, MISIONES, **Cataratas del Iguazú**, 14.III.1980, Bazzalo M-3375 (BAFC 25055); **Garupá**, 16.IV.1976, Cricel (BAFC 24433); **Jacuy**, II.1965, Gómez (BAFC 24418).

Remarks: The *G. lucidum* complex has the basidiome with a hymeniodermic cutis. The upper surface is red to blackish-brown, laccate and shining, stipe blackish-brown. Spores 11-13.5 × 7.5-8.5 µm slightly longer if we compare them with Steyaert's (1972) data, 8.5-13 × 5.5-8.5 µm, Gilbertson & Ryvarden (1986), 9-12 × 5.5-8 mm and 9-11 × 6-7 µm Zhao (1989). *G. lucidum* is a species complex, it has been reported worldwide, but might be restrict to Europe as revealed by molecular data (Moncalvo & Ryvarden, 1997).

G. oerstedii (Fr.) Murr., **Bull. Torrey Club**, v. 29, p. 606. 1902.

Basionym: *Polyporus oerstedii* Fr., **Nova Acta Soc. Sci. Upsal.**, Ser. 3, p. 1. 1851.

Distribution: BRASIL, SANTA CATARINA, **Guaramirim**, 23.X.1992, Willerding (FLOR 10869).

Additional material: BRASIL, MINAS GERAIS, **Belo Horizonte**, 24.IV.1995 (FLOR 11170); **ARGENTINA**, MISIONES, **Puerto Piray**, 25.X.1973, Wright, Deschamps & del Busto M-2351 (BAFC 24437).

Remarks: It is characterized by dimidiate to reniforme basidiomes, frequently with an umbo, tuberculate, laccate and brilliant pileus, with the upper surface towards dark reddish brown and the margin yellow-cream. Margin thick; context dark brown, thicker than the tubes. Spores 8.4-11.9 × 4.2-7 µm, smaller when compared with Murrill (1908) who describes the spores as 8 × 6 µm (*G. tuberculosum*) and with Bazzalo & Wright (1982) 9-14 × 6-9 µm, but similar to Steyaert (1980), 9-12.5 × 6-9 µm.

G. resinaceum Boud., **Bull. Soc. Mycol. Fr.**, v. 5, p. 72. 1889.

Distribution: BRASIL, SANTA CATARINA, **Florianópolis**, 15.V.1991, Foresti (FLOR 10838), 13.V.1991 (FLOR 10842), 04.II.1992, Willerding (FLOR 10847), 06.VII.1993, Foresti (FLOR 11109), 25.V.1994 (FLOR 11131), Marin (FLOR 11132), (FLOR 11145), 19.VIII.1993, Gerber & Cabral (FLOR 10939); **Santo Amaro da Imperatriz**, 06.X.2000, Groposo 53 (FLOR 11891), 28.V.01, Groposo 148 (FLOR 11935); **Palhoça**, 18.VII.2001, Groposo 165 (FLOR 11955).

Additional material: ARGENTINA, MATACOS, **Formosa**, II.1983, A. A. Maranta (BAFC 29156).

Remarks: *G. resinaceum* is very close to *G. lucidum*; the former has "smooth type" spores and the latter one "rugose type" according to Bazzalo & Wright (1982). *G. resinaceum* is usually sessile and grows at the base of living trees, whereas *G. lucidum* is characteristically stipitate and occurs on dead wood or root. Spores 7-11 × 4.2-7 µm, but data from the literature are very variable, Murrill (1908) described them as 9-11 × 6-8 µm, Steyaert (1972) as 8-13 × 6.5-9.5 µm, Bazzalo & Wright (1982) as 9-13 × 5-8 µm, Ryvarden (1976) and Ryvarden & Gilbertson (1993) as 9-11.5 × 4.5-7 µm; measures of 9-11.5 × 5-7 µm are reported in Ryvarden (2000) and 7.8-10.5 × 5-6.9 µm in Zhao (1989).

G. subamboinense (Henn.) Bazzalo & Wright, **Mycotaxon**, v. 16, p. 302. 1982.

Basionym: *Fomes subamboinense* Henn., **Hedwigia**, v. 43, p. 175. 1904.

Distribution: BRASIL, SANTA CATARINA, **Florianópolis**, 28.IV.1991, Foresti, Leite & Folle (FLOR 10841), 11.VI.1992, Folle & Willerding (FLOR 10859).

Additional material: ARGENTINA, MISIONES, **Puerto Libertad**, Blumenfeld (BAFC 29294).

Remarks: Spores smaller than *G. lucidum* and frequently with gasterospores. Spores 7-11.2 × 4.2-7 µm and rare gasterospores, 19.6 × 15.7 µm. Compared with Bazzalo & Wright (1982) with spores 6-9 × 4-6 µm

TABLE 1 – Synoptic comparison of selected characters between species of *Ganoderma*, from Santa Catarina State, Brazil.

Characters	*G. annulare*	*G. applanatum*	*G. australe*	*G. lucidum*	*G. oerstedii*	*G. resinaceum*	*G. subamboinense*
Pores/mm	4 up to 6	3 up to 5	4 up to 6	4 up to 5	3 up to 4	3 up to 5	4 up to 5
Surface	zonate, sulcate concentrically	similar	similar	laccate	rugose, laccate, yellowish bright	similar	rugose, sulcate concentrically, dark red bright
Stipe	no	no	yes	yes	no	no	yes
Spores	4.9-7×8.4-11.2	4.2-7×7-10.5	4.2-7×7-11.2	7.5-8.5×11-13.5	4.2-7×8.4-11.9	4.2-7×7-11.2	4.2-7×7-11.2
Gasterospores	no	no	rare	no	no	no	sometimes
Context Colour*	1, 2	3, 4	11, 12, 13	5	2	6, 7, 8	5, 7, 9, 10
Context Deep	2-4 mm	7-45 mm	1.5-10 mm	4 - 6 mm	21 mm	9-90 mm	3-4.5 mm
Tubes	pluri	pluri	pluri	uni	uni	pluri	pluri
Tubes Deep	1-9 mm	2-10 mm	2-28 mm	0.5-4 mm	1-2 mm	1-10 mm	2-4 mm
Context between tubes	no	yes	no	no	no	yes	no
Line above cutis	no	no	yes	no	no	no	no
Pilear crust	anamixoderm	trichoderm	anamixoderm	hymenioderm	characoderm	hymenioderm	hymenioderm

* Context Colour: 1. Reddish brown (4/4 5YR); 2. Dark reddish brown (3/4 5YR); 3. Dark reddish brown (3/3 5YR); 4. Red dusky (3/3 10YR); 5. Very pale brown (8/3, 7/4 10YR); 6. Yellow (7/8 10YR); 7. Light yellowish brown (6/4 10YR); 8. Dark brown (4/4, 4/6 7.5YR); 9. Yellowish brown (5/8 10YR); 10. Pale yellow (8/4 2.5YR); 11. Brown (3/4, 4/4, 4/6, 5/8 7.5YR); 12. Yellowish brown (3/3, 3/4, 4/4, 4/6 5YR); 13. Yellowish red (3/4, 5/8, 6/8 10YR); 14. Yellowish brown (5/4 10YR); 15. Yellow (8/6 2.5Y; 8/6 10YR), according to Munsell (1975).

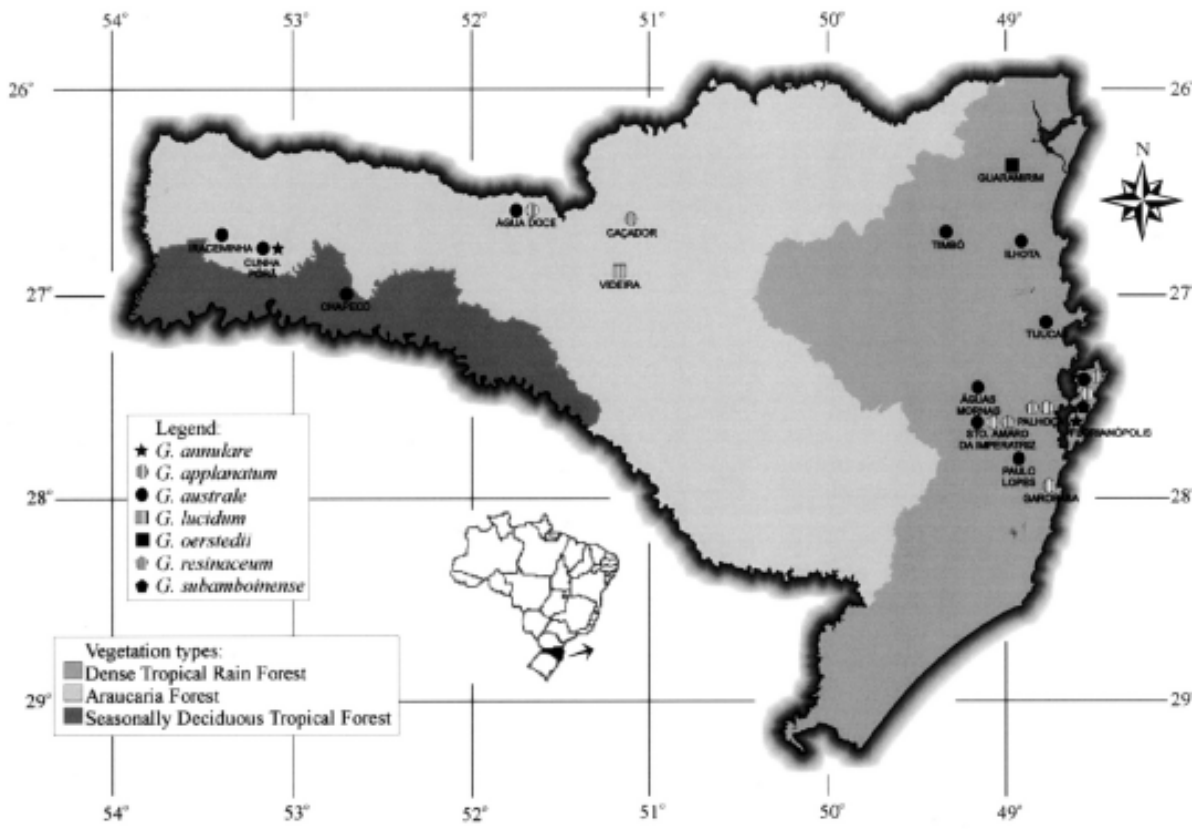

Fig. 1 –Distribution map of *Ganoderma* species on Santa Catarina State, Brazil.

and gasterospores with 7-14 × 6-12 µm, ours are substantially longer. Moncalvo & Ryvarden (1997) propose to validate the combination of Bazzalo & Wright (1982), who did not formally propose it before. Ryvarden (2000) considered it a synonymous of *G. multiplicatum* (Mont.) Pat.

CONCLUSIONS

The study of 94 specimens collected on Santa Catarina State (Brazil) produced the following informations, *G. australe* was the most collected species, showing a wide distribution pattern, since it was collected in all three phytogeographical regions of the State. Furthermore it was the only species collected at the Seasonal Deciduous Tropical Forest. All species were found at the Dense Tropical Rain Forest. On the other hand, *G. annulare*, *G. applanatum* and *G. lucidum* (42,85%) were also collected at the Araucaria Forest. Considering the seven species of this survey, three of them, *G. oerstedii, G. lucidum*, and *G. subamboinense* are new records from the state of Santa Catarina. *G. annulare*, *G. applanatum* and, *G. resinaceum* are recorded for the first time from continental area of the state of Santa Catarina. Previously *G. amboinense* (Lam.: Fr.) Pat. was recorded for Blumenau by Hennings (1897), however in this survey no one specimen were recollect.

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