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Ganoderma subgenus *Ganoderma* in Mexico

Ganoderma subgénero *Ganoderma* en México

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Abstract

For this work, more than 120 specimens recently collected in the field or from ENCB, IBUG, and XAL herbaria were studied. Furthermore, 15 types from nine herbaria were studied to compare with Mexican samples. Twelve species of *Ganoderma* subgenus *Ganoderma* are reported from Mexico, viz. *G. colossus*, *G. curtisii*, *G. mexicanum*, *G. oerstedii*, *G. oregonense*, *G. perturbatum*, *G. resinaceum*, *G. sessile*, *G. sessiliforme*, *G. subincrustatum*, *G. weberianum*, and *G. zonatum*. From them, *G. perturbatum* is new to Mexico. Descriptions and illustrations of each species and a key are provided.

KEYWORDS: *Ganoderma lucidum sensu lato*, *G. oerstedii*, *G. perturbatum*, taxonomy.

Resumen

Se estudiaron más de 120 especímenes que se recolectaron recientemente en campo o que provienen de los herbarios ENCB, IBUG y XAL. Además se revisaron 15 especímenes tipo de nueve herbarios para comparar con las muestras mexicanas. Se reconocen 12 especies de *Ganoderma* subgénero *Ganoderma*, las cuales son *G. colossus*, *G. curtisii*, *G. mexicanum*, *G. oerstedii*, *G. oregonense*, *G. perturbatum*, *G. resinaceum*, *G. sessile*, *G. sessiliforme*, *G. subincrustatum*, *G. weberianum* y *G. zonatum*. De ellas, *G. perturbatum* es nueva para México. Se presentan descripciones e ilustraciones de las especies y una clave.

PALABRAS CLAVE: *Ganoderma lucidum sensu lato*, *G. oerstedii*, *G. perturbatum*, taxonomía.

Introduction

Ganoderma P. Karst. comprises two subgenera: *Ganoderma* and *Elfvingia* (P. Karst.) Imaz. The first is characterized by its glossy pileus surface and hymenodermic pileipellis; in contrast, *Elfvingia* has dull pileus without cuticle cells (Patouillard, 1898; Tellería, 1980; Ryvarden, 2000). According to Moncalvo and Ryvarden (1997), 231 valid and legitimate *Ganoderma* names have been published: 63 species with a dull pileus and 168 with a laccate pileus. Many of these names are synonyms; one reason for this surplus of names is the fact that there have been few works where the types of earlier species have been taken into account and studied. Furthermore, there are few papers that had compared species described from different continents and thus many species are only known from the type locality and in many cases poorly circumscribed.

There have been a number of publications on the American *Ganoderma* species, such as Bazzalo and Wright (1982), Gilbertson and Ryvarden (1986), Gottlieb and Wright (1999), and Ryvarden (2000, 2004). The last one recorded 20 species of the

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genus in the Neotropic. Nevertheless, surveys of specific areas are required in order to know the distribution of the species. Thirteen species of the subgenera *Ganoderma* have previously been reported from Mexico: *G. colossus* (Fr.) C.F. Baker, *G. curtisii* (Berk.) Murrill, *G. fornicatum* (Fr.) Pat., *G. lucidum sensu lato*, *G. mexicanum* Pat., *G. oregonense* Murrill, *G. resinaceum* Boud., *G. sessile* Murrill, *G. sessiliforme* Murrill, *G. subincrustatum* Murrill, *G. tsugae* Murrill, *G. weberianum* (Bres. & Henn. ex Sacc.) Steyaert, and *G. zonatum* Murrill (e.g., Patouillard, 1898; Murrill, 1912; Furtado, 1965; Guzmán, 1977, 1983; Welden and Guzmán, 1978; Guzmán-Dávalos and Guzmán, 1979; Anel and Guzmán, 1987; Bandala *et al.*, 1993; Ramos Sosa and Cappello García, 2009; Mendoza *et al.*, 2011). Many of these species were probably mistakenly determined, e.g., specimens named as *G. lucidum*, *G. resinaceum*, and *G. sessile*.

Here, partial results of a systematic study on *Ganoderma*, which includes taxonomy, phylogenetic analysis with molecular and morphological data, and presence of secondary metabolites are presented. The main aims of this study were: 1) to provide a reliable record of the Mexican species of *Ganoderma* subgen. *Ganoderma*, 2) to describe and illustrate the species, and 3) to clarify the circumscription of some taxa. The species with dull pileus surface (subgenus *Elfvingia*), as *G. applanatum* (Pers.) Pat., *G. australe* (Fr.) Pat., and *G. lobatum* (Schwein.) G.F. Atk., known from Mexico (Guzmán 1972, 1977), are not considered in this paper.

Materials and methods

This paper is based on more than 40 specimens collected in the field by one of us (Torres-Torres) and examination of approximately 80 specimens deposited in the Mexican herbaria ENCB, IBUG, and XAL. Furthermore, 15 types from BPI, FH, H, K, NY, O, PC, SP, and UPS were studied. Herbaria abbreviations follow Holmgren *et al.* (1990).

Morphological feature descriptions were made from fresh and dry material. The color references are according to Kornerup and Wanscher (1963). Microscopical observations were made from sections mounted in 10 % KOH and Melzer's reagent, besides Congo red, floxine, and cotton blue were used. Basidiospore shape was determined according to Q ratio (length-width) of 20 randomly selected basidiospores. The context types (homogeneous, not completely homogeneous, and duplex) were described in Torres-Torres and Guzmán-Dávalos (2012). The drawings of microscopical structures were made with a 100× oil-immersion objective. The measures of the basidiospore pillars were made using Axio Vision 4 software with a Zeiss Axioscop microscope. The pillars, following Torres-Torres and Guzmán-Dávalos (2012), can be 1) free: as independent dots, 2) sub-free: free dots mixed with shortly elongated structures, 3) partially anastomosed: when more than two pillars grow together to form an irregular surface, and 4) reticulate: when the ornamentations forms almost a complete net (Figures 13, 16-17). In general, determination of the Mexican specimens was made through comparison with the type or types of related species. Furthermore, the keys of Bazzalo and Wright (1982) and Ryvarden (2004) were used, besides the descriptions of Steyaert (1972) and Corner (1983).

Results

In the present paper, descriptions and a key of Mexican species of *Ganoderma* subgen. *Ganoderma*, are provided. From the 12 species reported here, *G. perturbatum* (Lloyd) Torrend is a new record for Mexico. Based on the revision of the types, the descriptions of *G. colossus*, *G. oerstedii* (Fr.) Torrend, and *G. oregonense* are corrected.

In the key, besides the 12 species of *Ganoderma* subgenus *Ganoderma* known from Mexico, other tropical and temperate species not yet recorded for the country, but taxonomically similar with Mexican species, are included for comparison purposes. These are *G. capense* (Lloyd) Teng, *G. conccinum* Ryvarden, *G. dorsale* (Lloyd) Torrend, *G. longistipitatum* Ryvarden, *G. meredithiae* Adas. & Gilb., *G. multicornis* Ryvarden, *G. nitidum* Murrill (see under *G. oerstedii*), *G. orbiforme* (Fr.) Ryvarden, *G. ravenelii* Steyaert, and *G. subfornicatum* Murrill. *Ganoderma fornicatum* and *G. tsugae*, previously recorded from Mexico (Bandala *et al.*, 1993), were not confirmed in this study (specimens were not found in the consulted herbaria).

KEY OF THE MEXICAN SPECIES OF *GANODERMA*

Mexican species in bold; also related species not yet found in Mexico are included, see above.

1. Basidiomata light weighted, spongy, robust, and generally large 2

1. Basidiomata with other features 4

2. Pileus yellow, yellowish-orange or brownish-orange, but never reddish-black; basidiospores 14-19 × 9-13 mm, reticulated ..... ***G. colossus***

2. Pileus with reddish-black tones 3

3. Basidiomata rounded-flabelliform to occasionally reniform, 6-20 cm thick, context generally duplex; basidiospores 10-15 × 7-10 mm ..... ***G. oregonense***

3. Basidiomata reniform to flabelliform, up to 5 cm thick, generally stipitate, context homogeneous; basidiospores 9-13 × 6-8 mm ..... ***G. tsugae*** (cited from Mexico, but not in this study)

4. Context duplex 5

4. Context not completely homogeneous to homogeneous 12

5. Basidiomata stipitate, at times substipitate when growing on wood 6

5. Basidiomata sessile to substipitate 11

6. Basidiospores with subacute apex 7

6. Basidiospores distinctively truncate 9

7. Basidiomata generally less than 6 × 7 cm; basidiospores 12-14 × 8-9 µm 8

7. Basidiomata generally bigger, basidiospores 15-17 × 10-11 µm ..... *G. longistipitatum* (not in this study)

8. Context without resinous deposit, cuticle cells with incrustations in the apex ..... *G. dorsale* (cited from Mexico as *G. fornicatum*, not in this study)

8. Context with resinous deposit, cuticle cells without incrustations in the apex ..... *G. concinnum* (not in this study)

9. Basidiospores oblong to cylindrical, 10-15 × 5-7 µm ..... *G. ravenelii* (not in this study)

9. Basidiospores ellipsoid to oblong, 9-13 × 6-8 µm; resinous bands in the context very evident 10

10. Cuticle cells entire or occasionally with two to three protuberances ..... ***G. curtisii***

10. Cuticle cells with many protuberances and branches; restricted to *Pinus* forests ..... *G. meredithiae* (not in this study)

11. Pileus with narrow zonation, context with resinous bands only in the base; cuticle cells very diverticulated, antler-like; basidiospores 11-13 × 7.5-8 µm ..... *G. multicornum* (not in this study)

11. Pileus with wider zonation, context with resinous bands from the base to almost the periphery; cuticle cells entire, basidiospores 12-16 × 8-10 µm ..... ***G. sessile***

12. Cuticle cells entire or with occasional protuberances (maximum two) 13

12. Cuticle cells distinctively diverticulated 19

13. Basidiomata stipitate; basidiospores with subacute apex, pillars thick and partially anastomosed ..... ***G. perturbatum***

13. Basidiomata sessile to substipitate; basidiospores truncate, pillars different 14

14. Context pale to very light brown; basidiospores with subfree pillars 15
    14. Context yellowish-brown to reddish-brown; basidiospores with different type of pillars 16
15. Pileus crust very hard, difficult to penetrate with fingernail, context bruising to yellow; cylindrical to narrowly clavate cuticle cells with granulations in the apex, basidiospores 8-10 × 6-7 µm ..... ***G. weberianum***
    15. Pileus crust easy to penetrate with fingernail, context not bruising; clavate cuticle cells, without granulations in the apex, basidiospores 9-11 × 6-8 µm ..... ***G. sessiliforme***
16. Basidiospores with partially anastomosed pillars 17
    16. Basidiospores with free pillars 18
17. Basidiomata broadly attached, plane; context without resinous deposit; basidiospores 9-11 × 5-7 µm ..... *G. capense* (not in this study)
    17. Basidiomata generally with a contracted base to substipitate, concave to infundibuliform; context with resinous incrustations close to the base; basidiospores 9-12 × 6-8 µm ..... ***G. subincrustatum***
18. Cuticle cells clavate, almost cylindrical to occasionally widely clavate, basidiospores 11-14 × 6-8 µm ..... ***G. resinaceum***
    18. Cuticle cells narrowly clavate to cylindrical with subcapitate apex, basidiospores 8-10 × 6-7 µm ..... ***G. mexicanum***
19. Basidiomata woody-corky, very light weighted, pileus violet-brown with yellowish-orange shades; basidiospores 11-14 × 5-8 µm, oblong to cylindrical ..... ***G. zonatum***
    19. Basidiomata and pileus with other characteristics; basidiospores widely ellipsoid to ellipsoid or ellipsoid to oblong .. 20
20. Basidiospores 9-13 × 6-8 µm, pillars up to 0.4 µm thick, free 21
    20. Basidiospores with thick pillars (0.4-0.6 µm), partially anastomosed 22
21. Cuticle cells with the clavate shape conserved, generally with one to three short and thick protuberances and/or branches ..... *G. nitidum* (not in this study, see under Remarks of *G. oerstedii*)
    21. Cuticle cells commonly with a constriction, one to two thick and long branches, up to seven short and thick protuberances ..... *G. subfornicatum* (not in this study)
22. Context with resinous bands evident throughout the context; basidiospores 10-13 × 7-9 µm, widely ellipsoid to ellipsoid, with partially anastomosed pillars, almost reticulated ..... ***G. oerstedii***
    22. Context with resinous incrustations only in the base of the basidiomata; basidiospores 11-13 × 6-8 µm, ellipsoid to oblong, with subfree pillars ..... *G. orbiforme* (not in this study)

Taxonomy

The majority of the basidiospores in the genus are yellowish-brown, with wrinkled hyaline to reddish-yellow perisporium and wrinkled endosporium, except in *G. mexicanum* and *G. zonatum* where both layers are smooth, or the endosporium semi-wrinkled in the last one. Only when it is a new record the complete locality of the studied specimens are given.

Ganoderma colossus (Fr.) C.F. Baker, Brotéria 425, 1918.

=*Ganoderma obockense* Pat., Bull. Soc. Mycol. Fr. 3: 119, 1887.

Figures 1, 13

Basidiomata 13-26 × 16-24 cm, up to 9 cm thick, annual, sessile to substipitate, mainly single, never imbricate, soft, spongy, very light in weight. Pileus rounded to flabelliform, surface glossy to dull, first shiny, then dull, with a laccate crust, cracked after drying, easy to remove and to penetrate with fingernail, without zonation; deep-yellow (4A8), lighter towards the periphery, then yellowish-orange (5B8) or eventually darkening with age; margin lighter than the base, thick, rounded. Context 4.7-8 cm thick, soft, spongy, homogeneous, azonate, cream (4A3) to orange-white (5A3), without resinous bands. Pores 2-4 per mm, white to cream (4A2) when fresh, darkening to brownish-orange (6C5) when aging or drying; tubes 0.3-2 cm long, pale to vinaceous-brown (8E4). Hyphal system dimitic in the context and hymenium, and trimitic in the pileipellis. Generative hyphae 1.5-5 µm diam., with large and conspicuous clamps; sclerified generative hyphae up to 3.5 mm diam., yellowish, scarce. Skeletal hyphae 2.5-6 µm diam., thick- to extremely thick-walled, non-branched to arboriform. Binding hyphae friable or 1.5-2 µm diam., subthick-walled up to 0.8 µm. Pileipellis a crustohymeniderm, cells 32-75 × 5.5-14.5 µm diam, narrow to broadly clavate, without or with up to four lateral or apical small protuberances, some with short branches in the apex, thin-walled, yellowish, negative in Melzer's reagent. Basidiospores 14.4-19.2 × (8.8-) 9.6-11 (-13.2) µm, Q = 1.36-1.75, ellipsoid to oblong, apex acute to subacute, without visible apical germ, only observed in immature basidiospores, negative in Melzer's reagent; exosporium with inter-walled pillars up to 0.7 µm thick, forming an almost complete reticule. Basidia 29.5 × 8 mm, clavate, hyaline. Basidiola 19-24 × 9-12 µm, broadly clavate, hyaline. Cystidia 18-24 × 5.5-6.5 mm, conical to broadly conical, thin-walled, hyaline to yellowish.

Specimens examined. Veracruz, *Guzmán 35708* (XAL), *Ventura 12195*, *Pérez-Ortíz 1016* (ENCB). Quintana Roo, *Guzmán 20516* (XAL). Chiapas, 5-7 km of Nicapan, Chinchonal area, 550 m, 15 Jul 1983, *Castillo 2803* (XAL), *Suárez 81* (ENCB).

Other specimens examined. Costa Rica, on *Cedrela odorata*, *Oersted s.n.* (UPS, lectotype of *G. colossus*). Somalia, on *Mimosa* sp., *Farrot s.n.* (PC, holotype of *G. obockense*).

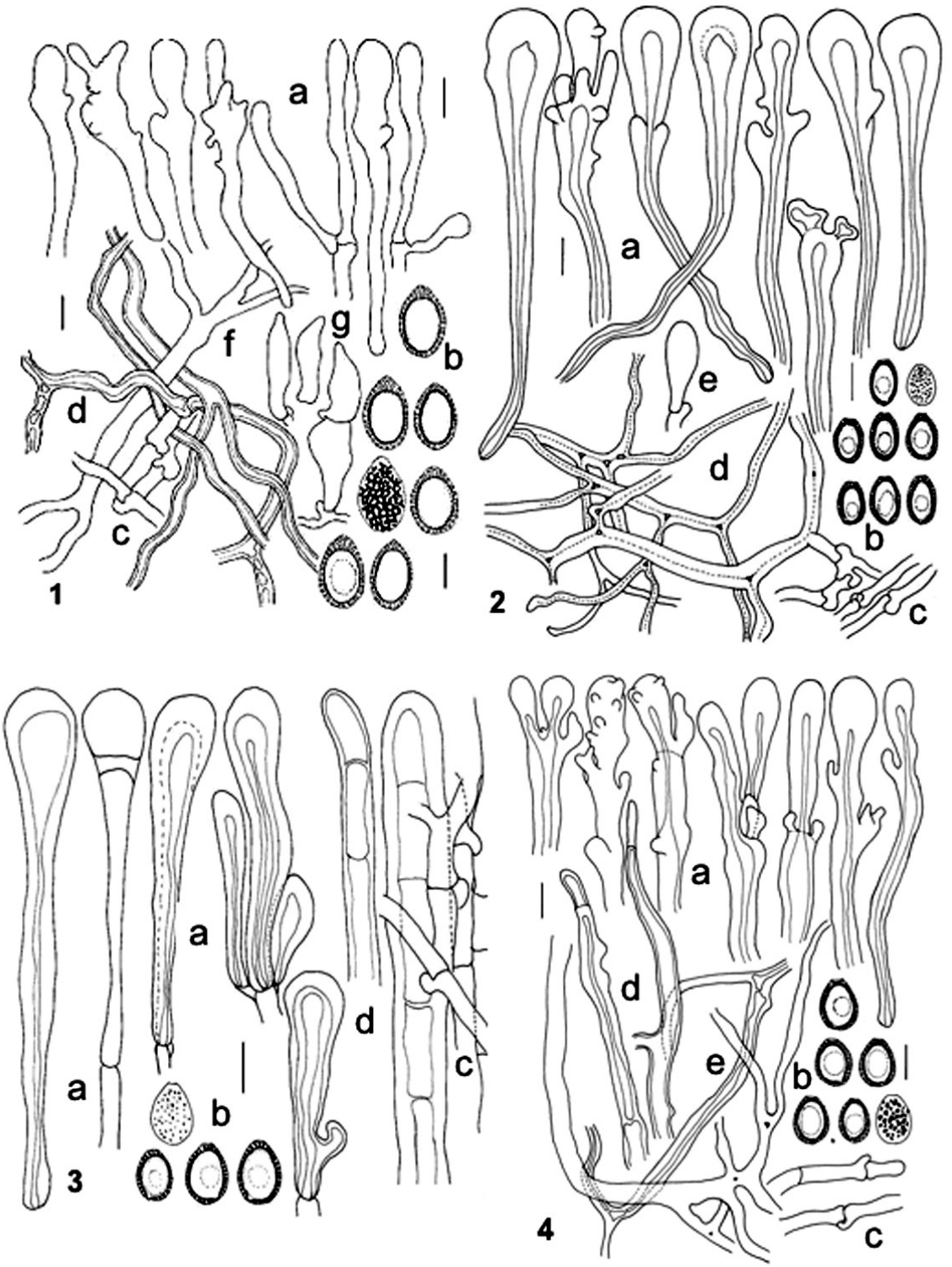
Habitat. Solitary, in secondary tropical forest, secondary low tropical rain forest, or grassland; on wood, ground, or volcanic sand.

Distribution. Tropical species recorded from Africa, Asia, Australia, Brazil, Costa Rica, French West Indies, USA, and Venezuela. In Mexico its distribution is mainly in the tropical zone south of the country.

Remarks. A spongy light weighted basidiomata, laccate easily indented crust, large almost reticulate basidiospores, and thin-walled cuticle cells, make this a distinctive species. The Mexican specimens corresponded with the type except that the latter has abundant chlamydospores.

Furtado (1965), Adaskaveg and Gilbertson (1988), Ryvarden and Johansen (1980), and Gilbertson and Ryvarden (1986) described cuticle cells as entire, and Núñez and Ryvarden (2000) and Ryvarden (2000, 2004) considered them slightly diverticulated; the specimens studied had some cells with branched apex, besides the diverticula. Núñez and Ryvarden (2000) and Ryvarden (2004) mentioned cuticle cells apically encrusted, which was not observed in Mexican materials, and neither in the type. Ryvarden and Johansen (1980) described thick-walled cuticle cells; nevertheless the cells of the type and Mexican specimens are thin-walled, as described by Gilbertson and Ryvarden (1986). On the other hand, cystidia as defined here, were not mentioned by other authors, but recorded as cystidiols by Ryvarden and Johansen (1980). Furthermore, sclerified generative hyphae are described for this species.

Steyaert (1972) suggested that *G. oregonense* might be a temperate variety of *G. colossus*. The two species are similar in several characters, as they both have soft, spongy, very light in weight and pale context, and large basidiospores with subacute apex. However, they mainly differ in the dark color of the basidiomata and basidiospores with free pillars in *G. oregonense*. Furthermore, phylogenetic analyses (Moncalvo, 2000) indicated



Figures 1–4. 1. *Ganoderma colossus*. A. Cuticle cells. B. Basidiospores. C-F. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Sclerified generative hyphae. E. Skeletal hyphae. F. Binding hyphae. G. Cystidia. 2. *G. curtisii*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. E. Basidiolum. 3. *G. mexicanum*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. 4. *G. oerstedii*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. E. Binding hyphae. Bar = 8 µm.

little relationship between the two species. Hong and Jung (2004) using SSU gene suggested that *G. colossus* might be placed in *Thomophagus* (Fr.) Murrill. However, more studies will be necessary to settle its generic position (Welti and Courtecuisse, 2010).

Ganoderma colossus is a rare species with remarkable features. It was reported from Mexico for the first time by Murrill (1905) from Yucatán, and since then it has been recorded in tropical and subtropical vegetation from the country (Guzmán, 1977) and the states of Morelos, Oaxaca (Welden and Guzmán, 1978), Quintana Roo (Guzmán, 1983), Tabasco (Ramos Sosa and Cappello García, 2009), Veracruz (Welden and Guzmán, 1978), and Yucatán (Furtado, 1965; Chio and Guzmán, 1982). It is a new record for Chiapas.

Ganoderma curtisii (Berk.) Murrill, North Amer. Flora 9: 120, 1908.

For a complete description see Torres-Torres and Guzmán-Dávalos (2005).

Figure 2

Specimens examined. Hidalgo, *Gimate 152-A* (ENCB). Jalisco, *Herrera-Fonseca 1013*, *Orozco 5*, *Torres-Torres 526, 527, 532, 541, 554*, *Valenzuela s.n.*, *Mejía-Jiménez s.n.*, *Guzmán-Dávalos 1723, 7447*, *Orozco 5*, *Villaseñor-Ibarra 282*, *Pérez de la Rosa s.n.* (IBUG). Morelos, *Frias Neve 18* (ENCB).

Other specimens examined. USA, *Ravenel 2936* (K, holotype of *G. ravenelii*).

Habitat. Solitary or gregarious; in oak, oak-pine, and mesophytic forests; on wood or commonly on ground.

Distribution. Recorded from Africa, China, India, Japan, Mexico, and USA.

Remarks. Its stipitate basidioma, pileus color, the lacquer that very easily disappears, and the duplex context with resinous bands, combined with its occurrence in temperate or subtropical forests, but always associated to oak, characterize the species. *Ganoderma curtisii* has an apparent wide distribution, nevertheless was not recorded by Corner (1983) neither by Gilbertson and Ryvarden (1986). In Mexico, it is a common species in oak and pine-oak forests, but also was found in subtropical forests with oak. Torres-Torres and Guzmán-Dávalos (2005) discussed the morphological variation of *G. curtisii* in Mexican specimens. The species was described with entire club-shaped cuticle cells and this concept is the same used by many authors (Haddow, 1931; Steyaert, 1980; Ojeda-López *et al.*, 1986); nevertheless, we found a great variability in the number of protuberances in the cuticle cells.

Two species, *G. meredithiae* Adask. & Gilb. and *G. ravenelii* Steyaert, are morphologically similar to *G. curtisii*. The first one is mainly differentiated by its cuticle cells, which are more diverticulated, and it is restricted to *Pinus* (Adaskaveg and Gilbertson, 1988). The second has basidiospores 10-14.5 × 5-6.5 µm following to Steyaert (1980), and 11.2-15.2 × 5.2-7.2 µm, oblong to cylindrical according to our observation of the type specimen, with no resinous bands in the context. It is probable that *G. ravenelii* occurs in Mexico; one specimen (*Téllez 1025*) has basidiospores distinctively oblong to cylindrical, but it is a young specimen and very few basidiospores were measured.

Ganoderma mexicanum Pat., Bull. Soc. Myc. Fr. 14: 54, 1898

For a complete description see Torres-Torres *et al.* (2012).

Figure 3

Specimens examined. Mexico, Estado de México, D. de Jonacatepec, Tepalcingo, 22 Oct 1890, s.collector, s.n. (FH-4823, lectotype).

Habitat. On hardwoods.

Distribution. Known only from the type locality.

Remarks. The type is in a poor condition, so a detailed study was not possible; nevertheless, it has narrowly clavate unbran-

ched to scarcely branched cuticle cells and small basidiospores with an apparent smooth perisporium. However, few basidiospores were checked because most of them were in bad state. *Ganoderma mexicanum* is morphologically similar to *G. sessile,* but the last one has bigger basidiospores (see below) and duplex context. The species has not been mentioned in subsequent studies neither has been recorded by Mexican authors; nevertheless, we consider it as a valid, but rare species by its unique features. Recently, it was recorded from Brazil (Torres-Torres *et al*., 2012).

Ganoderma oerstedii (Fr.) Murrill, Bull. Torrey bot. Club 29: 606, 1902.

= *Ganoderma tuberculosum* Murrill, North American Flora 9: 123, 1908.

Figures 4, 20

Basidiomata 8-25 × 7-26 × 3-4.2 cm, average 2.5-3.5 cm thick, up to 4.5 cm thick in the base, perennial, sessile, widely attached, single to generally imbricate, woody. Pileus flabelliform, rounded-flabelliform to semicircular, surface generally glossy, shine not easily lost, with a laccate crust, not cracking, not easily removed, easy to penetrate with fingernail, concentrically sulcate; reddish-brown (9F8, 8F8) close to the base, gradually changing to orange-brown, henna (7E8) to deep yellow (5B8) toward the margin in some specimens, or generally fully violet-brown (10F8, 11F6, 11F7); margin whitish, lighter than pileus to concolorous, thin to thick, smooth to sulcate. Context 1.5-4 cm thick, average 2-3 cm, thinner toward the periphery, fibrous, not completely homogeneous, concentrically zonate, yellowish-brown (6F8) to orange-brown or dark reddish-brown (7F6, 7F8) close to the tubes, with resinous bands from the base to half or more of the basidioma. Pores 4-5 per mm, whitish, yellowish-white (1A2), or butter-yellow (4A5) when fresh, darkening to ochraceous when aging, bruising or drying; tubes 0.6-1.8 cm long, individual layer 0.4-0.9 cm, unstratified to stratified, concolorous with lower part of the context. Hyphal system trimitic. Generative hyphae 3-5 µm diam., non-septate. Skeletal hyphae 3-7.5 µm diam., thick-walled to solid, septate to non-septate, non-branched to arboriform. Binding hyphae 3-6 µm diam., solid, difficult to observe. Pileipellis a crustohymeniderm, cells 56-88 × 5-18 µm diam., narrowly clavate to clavate, generally with two branches and up to seven short and thick protuberances, thick-walled, first reddish in groups, negative to occasionally slightly amyloid in Melzer's reagent after 36 h. Basidiospores 10.4-13.6 × 7.2-8.8 (-9) µm, Q = 1.3-1.5, ellipsoid, apex truncate, with apical germ pore; exosporium with inter-walled pillars up to 0.6 µm thick, partially anastomosed.

Specimens examined. Guerrero, Mpio. of Arcelia, La Mina, 1 km NE of Achotla, alt. 850 m, 2 Aug 2004, *Torres-Torres 546*. Jalisco, Mpio. of Autlán, Centro Universitario de la Costa Sur, Universidad de Guadalajara, alt. 930 m, 25 Aug 2004, *Torres-Torres 563*; Mpio. of Guadalajara, close to Glorieta La Minerva, alt. 1550 m, on dead trunk of *Casuarina*, 7 Oct 1987, *Manzano 480*, Av. Plan de San Luis, alt. 1500 m, 18 Sep 1988, *Cárdenas-Hernández 12* (IBUG), Facultad de Ingenierías, Universidad de Guadalajara, alt. 1550 m, on trunk of *Squinus molle*, 20 Jun 1992, *Gaspar 25*; Mpio. of Zapopan, Colonia Guadalupe, alt. 1500 m, on dead *Casuarina*, 27 Oct 2003, *Torres-Torres 408*. Oaxaca, Mpio. of Colotlán, park of the Plaza Artesanal de Barro Negro, alt. 1550 m, 19 Oct 2004, *Torres-Torres 573*; Mpio. of Oaxaca, Oaxaca City, Hotel Misión de Los Ángeles, alt. 1550, 21 Oct 2004, *Torres-Torres 575* (all in IBUG).

Other specimens examined. Costa Rica, s. locality, on wood, s. date, s. coll. (UPS, neotype of *G. oerstedii*). Honduras, s. locality, 1906, *Peck s.n.* (NY, holotype of *G. tuberculosum*).

Habitat. Solitary or gregarious; evergreen tropical forests or secondary tropical or subtropical vegetation; on living trees and dead wood.

Distribution. Recorded from Argentina, Brazil, Caribbean Islands, Costa Rica, Honduras, and Mexico (Chiapas, Morelos, Sinaloa, Veracruz).

Remarks. The diagnostic characters of this species are the color of the basidiomata, context with resinous bands, cuticle cells with protuberances and/or branches, and its partially

anastomosed basidiospore pillars. The examined specimens are in accordance with the types mentioned above, except that these have generally wider ellipsoid basidiospores (Q = 1.17-1.51 in *G. oerstedii* neotype, and Q = 1.17-1.4 in *G. tuberculosum* holotype). Ryvarden (2000, 2004) described the cuticle cells as entire; nevertheless, although the neotype of *G. oerstedii* is in a poor condition, cuticle cells with protuberances and branches were presented. On the other hand, the measures of the basidiospores recorded by Ryvarden (2000, 2004) for the types (12-15 × 8-10 µm) are larger than the ones we observed in the same types, 11-12.8 × 7.2-9.4 (-10.5) µm in *G. oerstedii*, and (9.6-) 10.4-12.8 × (7.2-) 8-9.6 µm in *G. tuberculosum*, and in the Mexican specimens.

Ganoderma oerstedii is, together with *G. subincrustatum*, the most common species in urban zones all over the country (especially as a parasite of many kinds of trees). It is often the case that specimens of this species are deposited in herbaria and cited in the literature incorrectly identified as *G. lucidum*, *G. resinaceum*, and *G. sessile*. Recently, López and García (2005) recorded *G. nitidum* from Veracruz; however, it seems that corresponds to *G. oerstedii*, because their Figure 6 clearly illustrate basidiospores with partially anastomosed pillars, and *G. nitidum* has free pillars. *Ganoderma oerstedii* was recently recorded for Mexico by Mendoza *et al*. (2011).

Ganoderma oregonense Murrill, North Amer. Flora 9: 118, 1908.

Figures 5, 14, 17

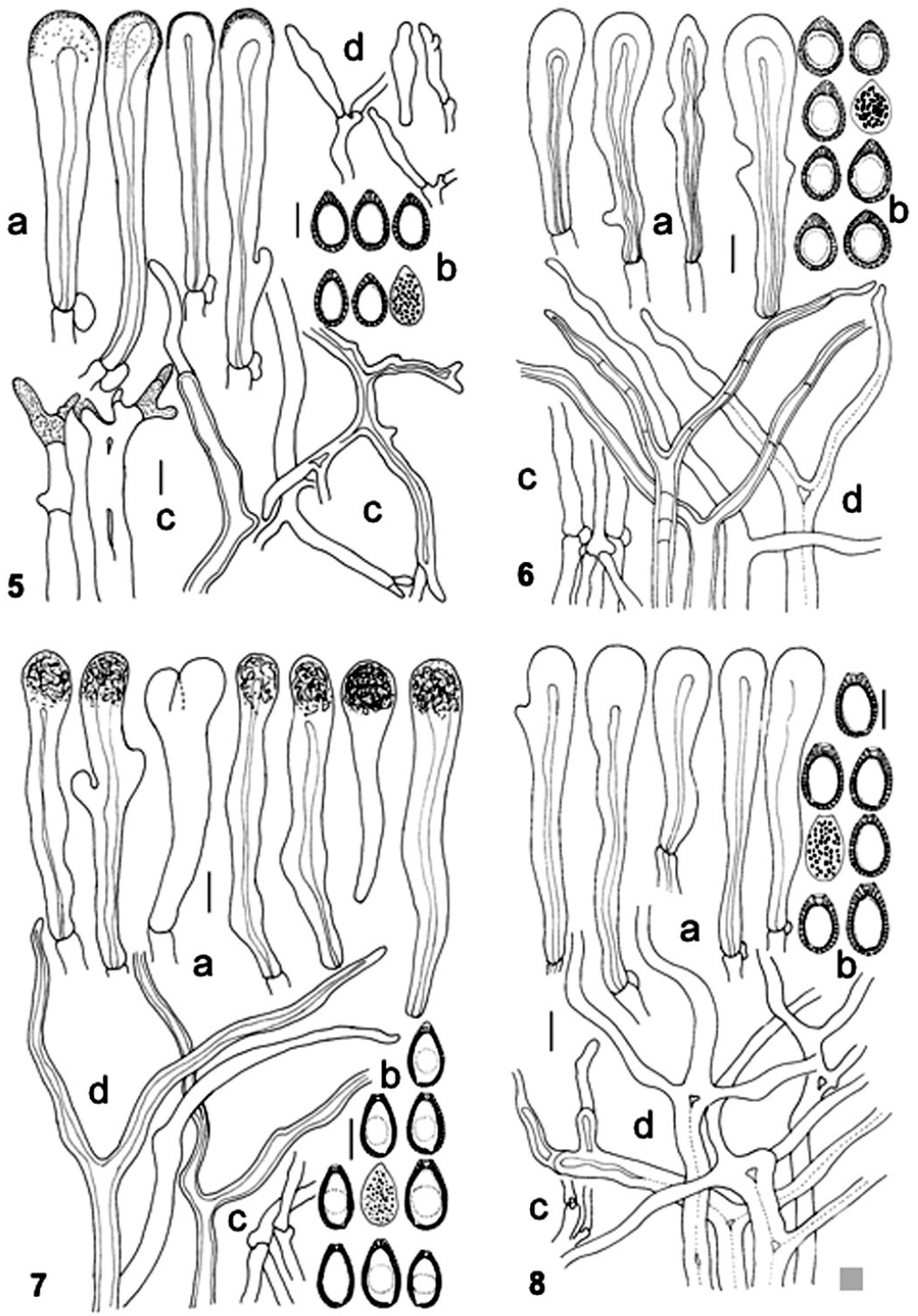
Basidiomata 7-23 × 10-30 cm, up to 12 cm thick, annual, mainly sessile to substipitate, generally with contracted base, single or rarely imbricate, soft when fresh, very light in weight when dry. Pileus rounded-flabelliform, surface dull to semiglossy with remainders of shine, with a laccate crust, cracked after drying and easy to penetrate with fingernail but not easy to remove, azonate to slightly zonate; dark reddish-brown to almost black close to the base, then violet-brown (10F) to henna (7E8), lighter in the periphery, some specimens completely reddish-black; margin lighter than the base to concolorous, thick. Substipe when present 4-13 × 4-4.5 cm, cylindrical, reddish-black, darker than pileus. Context 2.4-11.3 cm thick, soft-corky, duplex, azonate, orange-white (5A2) or cream-orange-pink above, light brown or sunburn to raw-sienna (6D5, 6D7) near the tubes, with an apricot (5B6) thin fringe below the laccate crust, without resinous bands. Pores 3-4 per mm, yellowish-white (3A2) to orange-brown or raw-sienna (6D7); tubes 0.3-0.6 cm thick, stratified to unstratified, fragile, light vinaceous-brown, almost concolorous with the lower part of the context. Hyphal system trimitic. Generative hyphae 2.5-5.5 µm diam., with conspicuous clamps. Skeletal hyphae 2-10 µm diam., thick-walled, some with narrow lumen, non-septate or septate near the apex, non-branched to arboriform. Binding hyphae 3-8 µm diam., thick-walled. Pileipellis a crustohymeniderm, cells 44-102 × 6.5-20 µm diam., narrow to broadly clavate, with conspicuous basal clamps, without protuberances or only a single one, thick-walled, strongly to slightly amyloid in Melzer's reagent. Basidiospores 10.8-14.4 × 7.2-8.8 (-9.6) µm, Q = 1.5-1.78, ellipsoid to oblong, apex subacute, without visible apical germ pore, only observed in immature basidiospores; exosporium with inter-walled pillars 0.6-0.8 µm thick, subfree. Basidia 24-40 × 7-9 µm, clavate, hyaline. Cystidia in the hymenia 16-28 × 3-5.5 µm, fusiform to narrowly utriform, some with scarce protuberances, thin-walled, hyaline to yellowish.

Specimens examined. Estado de México, *Acosta 653*, *González 282*, *Guzmán 4675, 4939* (ENCB). Hidalgo, *Aguirre-Jones s.n.* (ENCB). Veracruz, *Guzmán 28886* (XAL).

Other specimens studied. USA, Tillamook Coast, on old log of *Picea sitchensis*, Jul-Aug 1905, *Kirkwood s.n.* (NY, lectotype of *G. oregonense*).

Habitat. Solitary; in *Pinus hartwegii*, *Pinus-Abies*, *Abies* spp., *Abies religiosa*, or coniferous forests; on wood of *Picea*, *Pinus*, or *Abies*.

Distribution. Species recorded from Canada, Central and South America, Mexico, and USA.



Figures 5–8. 5. *Ganoderma oregonense*. A. Cuticle cells. B. Basidiospores. C. Skeletal hyphae of crustohymenodermis. D. Cystidia. Fig. 6. *G. perturbatum*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. 7. *G. resinaceum*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. 8. *G. sessile*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. Bar = 8 µm.

Remarks. The more important macromorphological features for its identification are the dark colored pileus contrasting with the pale colored context and the large spongy very light in weight basidiomata. Cystidia have not been previously described for this species. The lectotype of *G. oregonense* is in a bad state, including its context, in which the duplex character was not observed. However, we observed the basidiospores, 10.8-12.8 (-13.6) × 7.2-8 µm diam., relatively smaller than the Mexican specimens. In the nomenclatural study of Moncalvo and Ryvarden (1997), under the type specimen of *G. oregonense* the date is not mentioned and the name of the collector is given as the locality. A specimen from Quintana Roo of *G. colossus* was mistakenly identified as *G. oregonense* by Guzmán (1963) and later corrected by the author himself (Guzmán, 1983).

This species is morphologically similar to *G. tsugae* Murrill, an independent species; however, it is difficult to define the characters to separate them. Overholts (1953) suggested the thickness and length of the tubes as the main features to distinguish them; furthermore, he described smaller basidiospores for *G. tsugae*, of 9-11 × 6-8 µm. Gilbertson and Ryvarden (1986) considered the large size of the basidiomata, large pores, and wider basidiospores as the diagnostic features of *G. oregonense*; they described basidiospores of 13-17 × 8-10 µm for *G. oregonense* and 13-15 × 7.5-8.5 µm for *G. tsugae*. On the other hand, they considered homogeneous context for *G. oregonense*. Overholts (1953) and Gilbertson and Ryvarden (1986) described a slightly darker layer in the context next to the tubes in *G. tsugae*.

Ganoderma perturbatum (Lloyd) Torrend, Bróteria Bot. 18: 34, 1920.

For a complete description see Torres-Torres *et al.* (2012).
Figures 6, 15-16

Specimens examined. Colima, Archipiélago Revillagigedo, road to top of Monte Everman, Isla Socorro, 18 Dec 1993, *Grupo Ecológico Forestal Tonatiuh s.n.* (IBUG).

Other specimens studied. Brazil, Region Grande do Sul, Lageado, s.date, *J. Rev Rick s.n.*, Lloyd herb. num. *55*740 (BPI, lectotype of *G. perturbatum*).

Habitat. Solitary or gregarious; tropical forests; on wood or ground.

Distribution. Brazil and Mexico.

Remarks. The species may be easily recognized by its dark and shiny pilear surface, the remarkable subacute basidiospores, and the characteristic cuticle cells. Few species in *Ganoderma* have broad ellipsoid basidiospores with subacute apex and cuticle cells with a distinctive dark yellow inner stratum. In the type specimen, the cuticle cells are generally wider (49-88 × 7-20 µm) than in the specimens examined.

Steyaert (1967) suggested that *G. perturbatum* could be a form of *G. lucidum*, as some macromorphological features and the shape of the basidiospores are similar. However, the neotype of *G. lucidum* (Finland, Fennici Exsiccati 239, s.date, H), selected by Gottlieb and Wright (1999), has whitish context and narrower cuticle cells than *G. perturbatum*. Ryvarden (2000) considered *G. perturbatum* as a synonym of *G. resinaceum*, but the last one has thinner, sessile to substipitate basidiomata (as in *G. lucidum*), truncate, ellipsoid basidiospores, with abundant free pillars, and relatively narrow cuticle cells (see below).

Ganoderma perturbatum is close to *G. dorsale* (Lloyd) Torrend; they were suggested as synonyms by Steyaert (1967). The revision of the type of *G. dorsale* (Region Grande do Sul, on buried wood, s.date, BPI, Lectotype) suggests that they are independent species, differing mainly in the duplex context and cuticle cells with unistratified wall, generally with granular incrustated apex. The last one is also related to *G. concinnum* Ryvarden (Ryvarden, 2000) (Colombia, Chocó, Mpio. of Riosucio, Sautata, Parque Nacional Katios, 28-30 Jun 1978, *Ryvarden 16840*, O, Holotype), which has thin resinous bands and duplex context, relatively longer stipe, and longer and thinner basidiospores [12-14 × 8-9(-10) µm]. *Ganoderma perturbatum* is rare and was only known from Brazil (Torres-Torres *et al.*, 2012). It is presented here the first record for Mexico.

Ganoderma resinaceum Boud., Bull. Soc. Mycol. Fr. 5: 72, 1889.

For a complete description see Torres-Torres *et al.* (2012).

Figures 7, 23

Specimens examined. Colima, Mpio. of La Huerta, Bahía de La Manzanilla, W Bahía de Tenacatita, alt. 50 m, on trunk, 11 Jul 1974, *Guzmán 11647* (IBUG).

Other specimens examined. France, *Boudier s.n.*, (PC, holotype).

Habitat. Mainly gregarious; in tropical forests; on wood.

Distribution. Pantropical, extending into warmer regions of the temperate zones.

Remarks. Macromorphologically, *G. resinaceum* may be confused with *G. boninense* Pat., *G. praelongum* Murrill, and *G. pulverulentum* Murrill, among others. Nevertheless, the particular combination of characters (basidiomata color, fibrous-spongy context without resinous bands, almost cylindrical to clavate cuticle cells, and ellipsoid basidiospores, with free and relatively thin pillars) makes possible to identify it. Many specimens published and/or deposited in Mexican herbaria and labeled as *G. resinaceum* or *G. sessile* (e.g., Welden and Guzmán, 1978; Guzmán-Dávalos and Guzmán, 1979; Ojeda-López *et al.*, 1986; Anel and Guzmán, 1987), correspond to *G. oerstedii* or *G. subincrustatum*.

Ganoderma sessile Murrill, Bull. Torrey bot. Club 29: 604, 1902.

Figures 8, 19, 24

Basidiomata 5.5-13 × 5-13 cm, 1-3 cm thick in the base, annual, sessile, single to imbricate, woody-corky, light in weight. Pileus semicircular, rounded flabelliform to flabelliform, surface slightly to radially rugose, glossy, with a laccate crust, not cracking, slightly easy to remove, easy to penetrate with fingernail, concentrically sulcate mainly toward the margin; violet-brown (10F6) or photo-brown (9F8) in the 80 to 90 % of the surface, reddish-brown (8F8) to brownish-orange (6C8) in the periphery, or fully violet-brown very dark almost black; margin whitish, henna (7E8), lighter than pileus or concolorous, thin. Context up to 1.5 cm thick in the base, 0.7-0.9 cm average, fibrous-corky, duplex, azonate, pale-orange to light-orange (5A3, 5A4) above and reddish-golden to light brown (6C7) close to the tubes; resinous bands generally diffuse and difficult to observe, almost up to the margin. Pores 4-5 per mm, yellowish-white (3A2), darkening to brown (6D8) when bruising or aging; tubes 0.8-1 cm thick, up to 1.4 cm in the base, concolorous with the inferior part of the context. Hyphal system trimitic. Generative hyphae 2.5-4 µm diam., with large and conspicuous clamps. Skeletal hyphae 1.5-12 µm diam., generally solid, arboriform, very branched. Binding hyphae 1.5-4 µm diam., solid to thick-walled. Pileipellis a crustohymeniderm, cells (40-) 60-88 × 8-16 µm, clavate, without or with one lateral protuberance, thick-walled, multistratified, walls amyloid and content immediately black with Melzer's reagent. Basidiospores 11.2-14.4 (-16.4) × 7.2-8.8 µm, Q = 1.5-1.86, ellipsoid to oblong, apex truncate, with apical germ pore; exosporium with inter-walled pillars 0.56-0.64 µm thick, subfree.

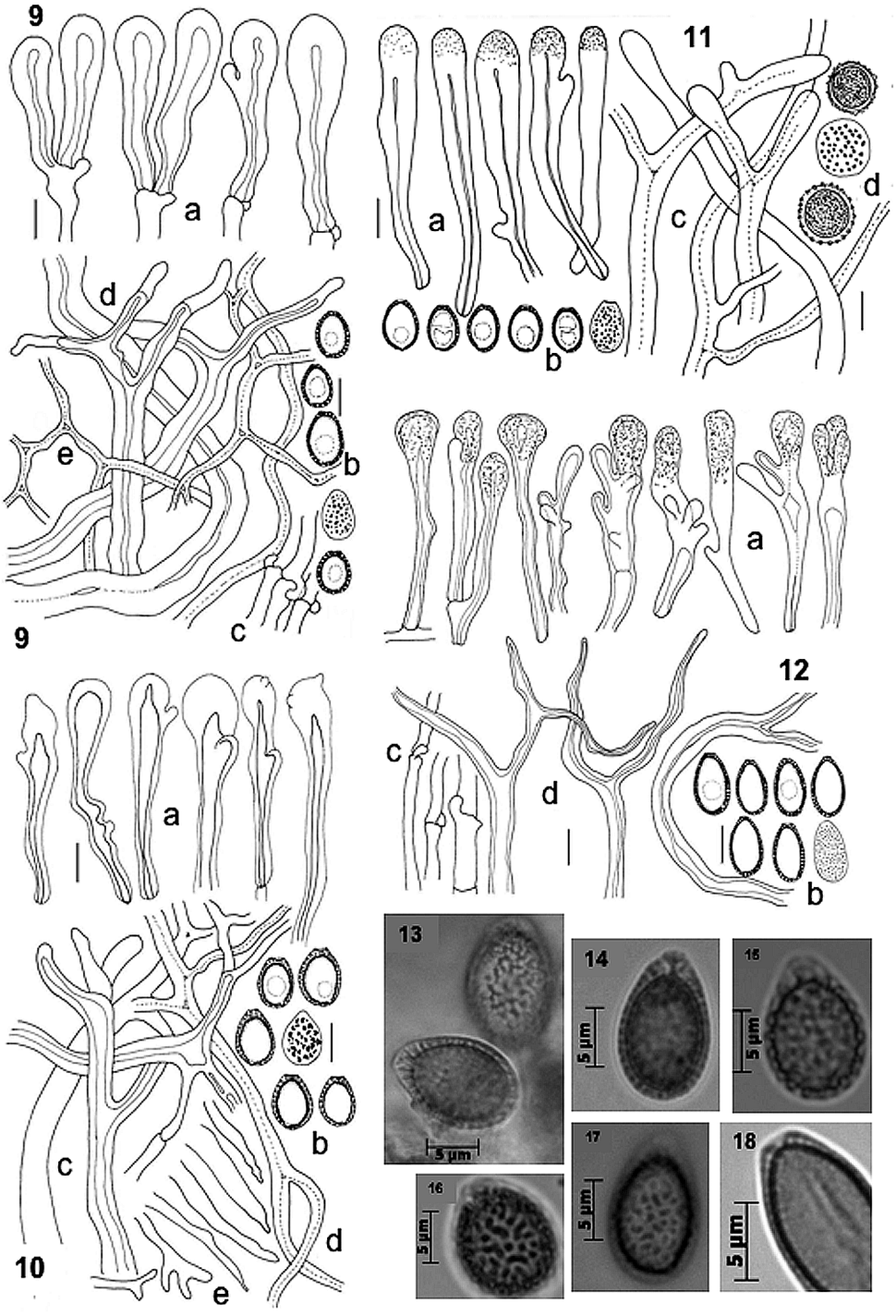
Specimens examined. Hidalgo, Mpio. of Tenango de Doria, 64 km S of Tenango de Doria, alt. 1600 m, on *Quercus* sp., 24 Jul 1969, *S. & J. Peck s.n.* (SP 124133, ex-BCI 3079). Jalisco, Mpio. of Ajijic, edge of Laguna de Chapala, close to Ajijic, alt. 1540 m, on *Salix* sp., 22 Dec 1979, *Guzmán 17888* (IBUG); Mpio. of Zapopan, 8 km NW of Tesistán, alt. 1670 m, 8 Jul 1980, *Nieves 27-A* (IBUG).

Other specimens examined. USA, New York, Bedford Park, on *Quercus* trunk, s.date, s.coll., (NY, lectotype).

Habitat. Mainly solitary; subtropical vegetation; on living trees (i.e., *Salix* and *Quercus*) or on dead deciduous wood.

Distribution. Recorded from Argentina, Mexico, and USA.

Remarks. The more distinctive features of the species are the basidiomata color, the spongy-corky consistency, duplex context with resinous bands that at times may be difficult to observe, and basidiospores with short, thick, and subfree pillars. The Mexican specimens are in accordance with the



Figures 9–18. 9. *Ganoderma sessiliforme*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. E. Binding hyphae. 10. *G. subincrustatum*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Skeletal hyphae. D. Binding hyphae. E. Terminal hyphae of the hymenium. 11. *G. weberianum*. A. Cuticle cells. B. Basidiospores. C. Skeletal hyphae of crustohymenodermis. D. Chlamydospores. 12. *G. zonatum*. A. Cuticle cells. B. Basidiospores. C-D. Hyphal system of crustohymenodermis: C. Generative hyphae. D. Skeletal hyphae. 13–18. Basidiospores. 13. Subreticulate pillars, *G. colossus* (*Suárez 81*). 14. Subacute apex, *G. oregonense* (*Acosta 653*). 15. Thick pillars, *G. perturbatum* (*Grupo Ecológico Forestal Tonatiuh s.n.*). 16. Partially anastomosed pillars, *G. perturbatum* (Holotype). 17. Relativelly free pillars, *G. oregonense* (*Guzmán 28886*). 18. Thin pillars, *G. zonatum* (*Cervantes 1*). Bar = 8 µm.

lectotype and with the description of Gottlieb and Wright (1999).

Steyaert (1972, 1980) based on the morphology of the basidiospores suggested that the species was a taxonomic synonym of *G. resinaceum*, opinion that was followed by Bazzalo and Wright (1982) and Ryvarden (2000, 2004). Nevertheless, *G. resinaceum* is different in the light reddish-brown without resinous bands context and almost cylindrical cuticle cells with a diffuse granulated apex.

Ganoderma sessile has been cited from many localities in USA and Mexico, but because it has previously been treated as a synonymy of G. *resinaceum* the distribution is uncertain. Gottlieb and Wright (1999) cited it from Argentina. It is one of the most commonly cited species from Mexico (e.g., Guzmán, 1977); nevertheless, the majority of the specimens in Mexican herbaria labeled as *G. sessile* correspond to *G. oerstedii* or *G. subincrustatum*. *Ganoderma sessile s.str.* is rare in Mexico and the collections cited above are the first confirmed records.

Ganoderma sessiliforme Murrill, Bull. New York. Bot. Gard. 8: 149, 1912.

For a complete description see Torres-Torres *et al.* (2012).

Figures 9, 21

Specimens examined. Morelos, near Cuernavaca, on dead wood, 24-27 Dec 1909, *E. & L. Murrill 392* (NY, lectotype of *G. sessiliforme*); Mpio. of Tepoztlán, Tepoztlán, El Parque, Estación del Ferrocarril, s. date, *Guzmán 2078* (ENCB).

Habitat. Mainly gregarious; tropical forest with *Quercus*; on dead wood.

Distribution. Recorded from Argentina, Brazil, India, and Mexico.

Remarks. The more important distinctive features of this species are the thin, flabelliform, conchate pileus, light context without resinous bands, basidiospores with short, thick, and subfree pillars, and short cuticle cells. The studied specimens, including the type, are in accordance with the description of Gottlieb and Wright (1999), who recorded it from Argentina. Ryvarden (2000) suggested this species as a synonym of *G. resinaceum*; nevertheless, the last one has light reddish-brown context, longer cuticle cells, and longer basidiospores with free pillars. *Ganoderma sessiliforme* was described in 1912 from Mexico and mentioned again in 1999 from Brazil (Gottlieb and Wright, 1999; Torres-Torres *et al.*, 2012), and recently by Raymundo *et al.* (2013) from Sonora. This is the third record for Mexico from the same region as the type. Bhosle *et al.* (2010) recently cited it from India.

Ganoderma subincrustatum Murrill, North Amer. Flora 9: 122, 1908.

Figure 10

Basidiomata 7.5-10 × 12-12.5 cm, average 1.5 cm thick, up to 2.3 cm thick in the base, perennial, substipitate to stipitate, with a contracted base, single to imbricate, woody. Pileus flabelliform, rounded-flabelliform to circular, concave to infundibuliform; surface glossy, in some changing to dull, with a laccate crust, not cracking, not easily removed, easy to penetrate with fingernail, concentrically sulcate; reddish-brown (9F8, 8F8) to burn-sienna (7D8) close to the base, gradually changing to henna (7E8), deep yellow (5B8) toward the margin in some specimens, with age fully dark reddish-brown; margin whitish or lighter than pileus, thick. Stipe 1.5-4.3 × 1.5-2 cm, short to large and thick, cylindrical, lateral to central, solid, reddish-black, darker than pileus. Context 1.1-1.7 cm thick, average 0.5-0.7 cm, fibrous-corky, not completely homogeneous, concentrically zonate, a narrow apricot (5B6) zone close to the pileus, and otherwise dark-brown (7F7), with discontinuous resinous bands from the base to half or more of the basidiomata, with whitish mycelium close to the base. Pores 4-6 per mm, whitish, yellowish-white (3A2) to pale yellow (4A2, 4A3) when fresh, darkening to ochraceous or yellowish-brown (6C5) when bruising; tubes 0.4 cm long, lighter to concolorous with lower part of the context. Hyphal system trimitic. Generative hyphae 3-5.5 µm diam., non-septate; apex of the hyphae visible in the tube lumen, rounded to tapering, or submoniliform. Skeletal hyphae 3-8 µm diam., solid to thick-walled, septate or aseptate,

non-branched to arboriform. Binding hyphae 3-5.5 µm diam., solid, non-septate. Pileipellis a crustohymeniderm, cells 32-80 (-96) × 5.5-14.5 µm diam., narrow clavate to clavate, generally with one or two protuberances or branches, thick-walled, first reddish in group, negative to occasionally slightly amyloid in Melzer's reagent after 36 h. Basidiospores 9.6-12.4 × 7.2-8.4 µm, Q = 1.3-1.58, ellipsoid, few broadly ellipsoid, apex truncate, with apical germ pore; exosporium with inter-walled pillars up to 0.6 µm thick, partially anastomosed.

Specimens examined. Jalisco, Mpio. of Gómez Farías, Rancho La Calavera, 16 Jul 1980, *Nieves 56* (IBUG); Mpio. of Guadalajara, Calzada Independencia and Sierra Madre, alt. 1500 m, on tree, 6 Jul 1999, *López-Damián 49* (IBUG); Mpio. of Zapopan, Parque Los Colomos, alt. 1500 m, 21 Sep 1989, *Vargas 316* (IBUG). Nuevo León, Mpio. of Sabinas Hidalgo, La Cuchilla, to 5 km NW of Sabinas, alt. 300 m, 13 Jul 1986, *González-Velásquez 556* (ENCB). Quintana Roo, Mpio. of Cancún, 4 km E from the deviation to Puerto Morelos, 22 Aug 1988, *Valenzuela 6429* (ENCB). Veracruz, Mpio. of San Juan Evangelista, San Juan Evangelista, alt. 60 m, on wood, 12 Sep 1960, *Rojas* s.n. (ENCB), San Juan Evangelista, S of Acayucan, alt. 60 m, on tree, 15 Nov 1961, *Guzmán 2873* (ENCB); Mpio. of Martínez de la Torre, El Guineo, between Martínez de la Torre and Arroyo Fierro, alt. 250 m, in soil, 13 Jun 1970, *Ventura 1312* (ENCB).

Other specimens examined. Jamaica, Hope Garden, on log wood stump, 26 Oct 1902, *Earle 176* (NY, holotype).

Habitat. Solitary or gregarious; in evergreen tropical forest, deciduous tropical forest, *Pinus-Quercus* forest, *Pinus-Eucalyptus* artificial forest, xerophytic bush, or subtropical secondary vegetation; on living trees, on dead wood, or on the ground as parasite of roots.

Distribution. Recorded from Argentina and Jamaica, and now from Mexico.

Remarks. *Ganoderma subincrustatum* is recognized by the gradual change of the pileus color, the concave to infundibuliform and generally rounded-flabelliform to circular pileus, the not completely homogeneous context without resinous bands in the periphery, and the basidiospores with anastomosed pillars. Moreover, the generative hyphae in the hymenium have a distinctive tapering apex, very characteristic in the examined specimens and also in *G. applanatum*. Macromorphologically, it is similar to *G. oerstedii* and *G. pulverulentum* by the color of pileus surface and context.

Ganoderma subincrustatum, together with *G. oerstedii* and one species not yet identified, were among the most common species in the urban tropical and subtropical zones in Mexico, especially as a parasite of many kinds of trees. It was also found as parasite in tropical, subtropical, and *Pinus-Quercus* forests. The specimens were labeled and deposited in the Mexican herbaria reviewed as *G. lucidum*, *G. resinaceum*, *G. sessile*, or *Ganoderma* sp. *Ganoderma subincrustatum* was considered a synonym of *G. resinaceum* by Bazzalo and Wright (1982); on the other hand, Ryvarden (1985) suggested that could be *G. lucidum s.l.* Gottlieb and Wright (1999) recorded it from Argentina as an independent taxon of *G. resinaceum*. The species was not considered by Steyaert (1972, 1980), Corner (1983), and Ryvarden (2004). Because of the morphology of the basidiomata and the anastomosed pillars of the basidiospores, we consider that it is an independent species. This species was recorded by Guzmán (1975) from Colima and Morelos, Mexico.

Ganoderma weberianum (Bres. et Henn. ex Sacc.) Steyaert, Persoonia 7(1): 79, 1972.

For a complete description see Torres-Torres *et al.* (2012).

Figures 11, 22

Specimens examined. Jalisco, Mpio. of Cuautitlán, Cuautitlán, 9 Aug 2004, *Cuevas s.n.* (IBUG); Mpio. of San Sebastián del Oeste, entre La Taberna de la Ermita y El Otatal, alt. 1250 m, 16 Sep 1995, *Sánchez-Jacome 892* (IBUG); Mpio. of Talpa, km 1.6-1.8 desviación a La Cumbre, camino Talpa-La Cuesta, alt. 1500-1600 m, 24 Sep 2004, *Guzmán-Dávalos 9569* (IBUG), alt. 1680 m, 1 Oct 2005, *Torres-Torres 690* (IBUG).

Habitat. Mainly gregarious; *Pinus-Quercus* forest; on wood.

Distribution. Recorded from Africa, Australia, Brazil, Indonesia, Malaysia, Mexico, New Guinea, Samoa Island, Singapore, and Taiwan.

Remarks. The remarkable features of *G. weberianum* are a pale context that changes to yellow when cut in fresh condition, with shiny and thick resinous incrustations, frequently with chlamydospores, and relatively narrow and very thick-walled to solid, almost cylindrical cuticle cells. Furthermore, the pileus is very hard as in subgenus *Elfvingia* and the laccate crust is difficult to indent with the fingernail. The examined specimens are in accordance with the descriptions of Steyaert (1972) and Corner (1983), except they mentioned the inter-pillars in the basidiospores barely visible. Steyaert (1972) described two forms of *G. weberianum*: one with thin and long cuticle cells (30 × 7-8 µm) and without or with few chlamydospores, and the other with thick and short cuticle cells (20 × 10-12 µm) and abundance of chlamydospores. Nevertheless, according to his pictures, the relationship wide/long indicates the cuticle cells are longer than he described. On the other hand, Corner (1983) described narrow and long cuticle cells and abundant chlamydospores. The Mexican materials have narrow and long cuticle cells as in Corner specimens but scarce and smaller chlamydospores; Corner (1983) described them as 12-19 × 12-16 µm.

Wang *et al.* (2005) considered *G. microsporum* R.S. Hseu as synonym of *G. weberianum*; however, the first one has smaller basidiospores (6-9 × 4.5-6.5 µm), longer cuticle cells, and absence of chlamydospores in the context (Hseu *et al.*, 1989). The occurrence of chlamydospores is variable in the genus and should be treated with care. Although *G. weberianum* has been reported from Asia (Steyaert, 1972), it was not considered by Núñez and Ryvarden (2000). In Mexico, it was recorded from Quintana Roo and Yucatán (Guzmán, 1983). Bandala *et al.* (1993) mistakenly listed this species as cited by Valenzuela and Chacón-Jiménez (1991) from Tamaulipas, but the last authors did not mention this taxon.

Ganoderma zonatum Murrill, Bull. Torrey bot. Club 29: 606, 1902.

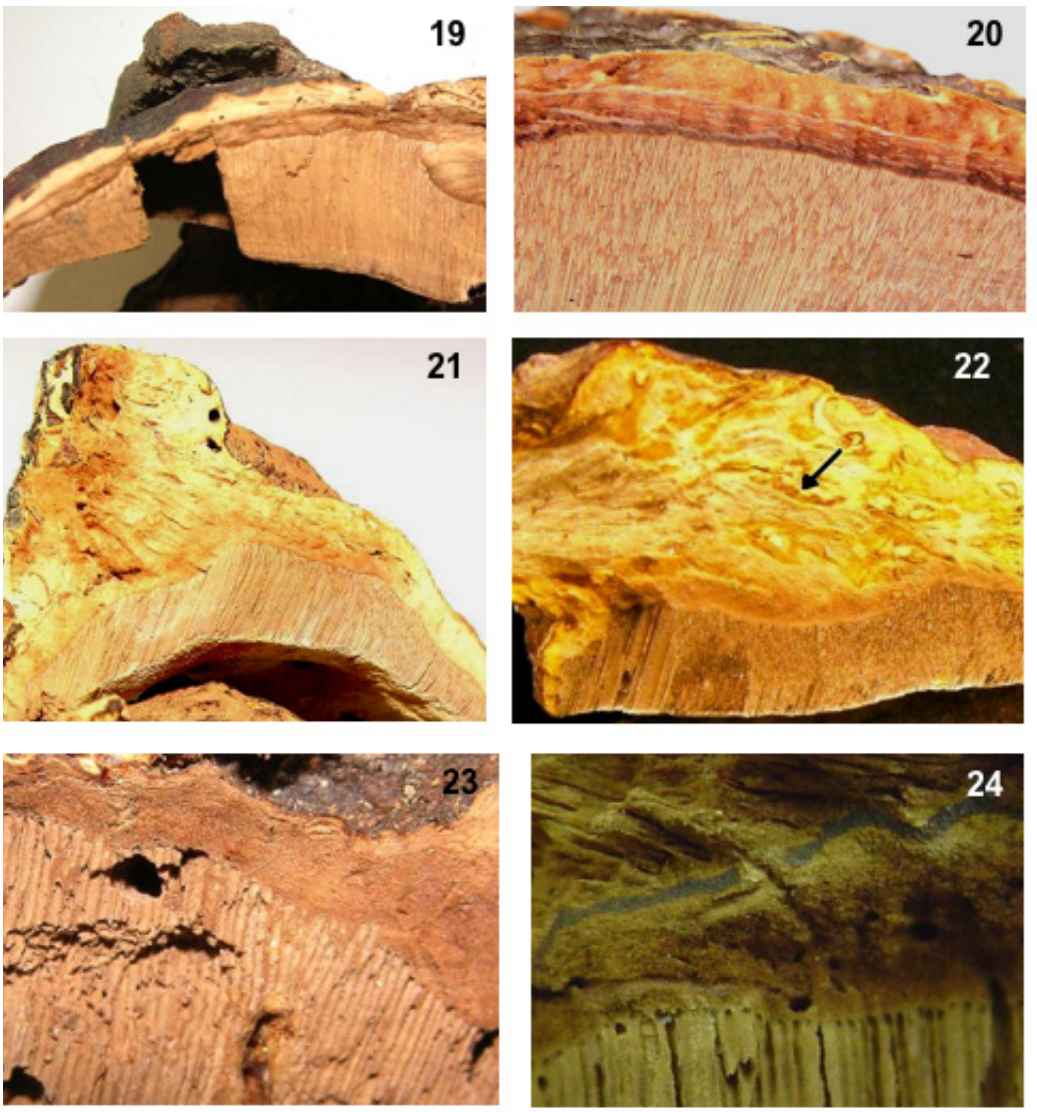
Figures 12, 18

Basidiomata 4-7 × 5-8 cm, up to 3 thick in the base, perenne, sessile to substipitate, sometimes effused-reflexed, single, woody but very light in weight. Pileus dimidiate to semicircular, broadly attached, surface shiny, with a laccate crust, cracked and removed when cut or aged, easy to penetrate with fingernail, slightly concentrically sulcate; reddish-brown (8F8, 9F8), becoming lighter than deep orange (7E7) toward periphery, generally homogeneous except in the margin; margin yellowish-white, or as the pileus but lighter, thick, obtuse, sulcate, with margins of previous season one over the other. Context up to 1.5 cm thick at the base, 0.9 cm average, corky-fibrous, almost homogeneous, zonated, henna-brown (7E8) to dark-brown (7F8), with a golden-yellow (5B7) to deep yellow (4A8) thin fringe below the laccate crust, without resinous bands. Pores 3-5 per mm, yellowish-white (3A2), darkening to brown (6D8) when bruising; tubes up to 1.5 cm thick, indistinctively stratified, concolorous with the context. Hyphal system dimitic. Generative hyphae 2-3 µm diam., with conspicuous clamps. Skeletal hyphae 2-8 µm diam., solid to thick-walled, arboriform, with few branches. Pileipellis a crustohymeniderm, cells 40-80 × 5.5-18.5 µm, clavate, with two to three lateral protuberances and branches, generally without protuberances in the apex, thick-walled, at times multistratified, with incrustations, content immediately black with Melzer's reagent, cells strongly amyloid after 12 h. Basidiospores (11.2-) 12-14.4 × 5.6-7.6 (-8.4) µm, Q = (1.57-) 1.67-2.15, oblong, apex truncate, with apical germ pore; exosporium with inter-walled pillars less than 0.4 µm thick, free pillars.

Specimens examined. Jalisco, Mpio. of Zapopan, Parque los Colomos, alt. 1500 m, 13 Sep 1986, *Cervantes 1* (IBUG). Nayarit, Mpio. of Compostela, highway 200 Las Varas-La Peñita de Jaltemba, km 8 deviation to Chacala, 0 m, 20 Nov 1986, *Vargas 13* (IBUG); Mpio. of Las Varas, 25 km W of Los Ayalas Beach, Apr 1986, *Fanti 514* (IBUG).

Other specimen examined. USA, Florida, 1914, *Underwood s.n.* (NY, holotype).

Habitat. Single; artificial forest of *Pinus* and deciduous tropical forests; on dead wood.



Figures 19–24. 19. Duplex context of *G. sessile* (*Lectotype*). 20. Relatively homogeneous context with very evident resinous bands of *G. tuberculosum* (*Holotype*). 21. Relatively homogeneous context of *G. sessiliforme* (*Holotype*). 22. Relatively homogenous context and resinous incrustations of *G. weberianum* (*Guzmán-Dávalos 9569*). 23. Homogeneous context of *G. resinaceum* (*Guzmán 11647*). 24. Resinous bands in the context of *G. sessile* (*S. & J. Peck s.n.*).

Distribution. Recorded from Africa, Argentina, Java, Mexico, and USA. This species has a wide tropical and subtropical distribution.

Remarks. The species is easily recognized because in the edge of the pileus there are many imbricate margins and the basidioma, although not spongy, is very light in weight. Also, its oblong basidiospores are very characteristic. Murrill (1902) described basidiospores 8-10 × 4-6 µm, smaller than the ones observed in Mexican specimens, but subsequent authors studied the type and described them as 10-15 × 5-8 µm (Overholts, 1953; Bazzalo and Wright, 1982; Gottlieb and Wright, 1999; Ryvarden, 2000, 2004), which are in accordance with the studied specimen. Furthermore, we also examined the lectotype and observed basidiospores (11.2-) 12-13 (-14) × 5.6-7.2 (-8) µm. In the Mexican materials the color of the pileus surface is more or less homoge-

neous and the surface remains shiny, while in the type the surface is dull and presents color zonations [reddish-brown (8F8, 9F8), deep orange (7E7) and golden-yellow (5B8)]. The specimens recorded from Argentina by Bazzalo and Wright (1982) are substipitate and have rugose basidiospores; maybe they correspond to a different species. *Ganoderma zonatum* was recorded from Baja California Sur and Puebla (Guzmán, 1972); here is the first record for Jalisco and Nayarit, on different substratum (hardwood), previously was recorded growing only on palms.

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