Record of New Species of *Ganoderma* in Maharashtra India

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**Abstract:** Thirty four species of *Ganoderma* out of 100 samples from more than 20 different hosts were obtained in the present study. The species were identified on the basis of external and internal morphology of specimens. The results indicated that 20 species including *G. africanum, G. amazonense, G. boninense, G. chalceum var. pleistrichum, G. concinnum, G. dejongii, G. donkii, G. fulvum, G. lobatoideum, G. lobatum, G. luteicinctum, G. microsporum, G. mirabile, G. ostreatum, G. pfeifferi, G. pseudoboletus, G. trenggananse, G. trulliforme, G. vanheurnii and G. williamsianum* are new to India.

**Key words:** Phellinus, mushroom, canker rot, heart rot, maharashtra

**INTRODUCTION**

The genus *Ganoderma* with the type species *G. lucidum* was established by Karsten in 1881.

Taxonomical studies of the genus *Ganoderma* had been extensively done throughout the world (Bazzalo and Wright, 1982; Buchanan and Wilkie, 1995; Coleman, 1927; Corner, 1947, 1983; Gottlieb and Wright, 1999a, b; Moncalvo and Ryvarden, 1997; Murrill, 1902, 1903; Ryvarden, 2000; Smith and Sivasithamparam, 2000; Stalpers, 1978; Steyaert, 1967a, b, 1972, 1980).

There are 322 species listed in the CABI Bioscience Fungus names database. The database of Stalpers and Siegelius available on CBS Website lists 316 names in *Ganoderma* (http://www.punjabenvironment.com/bd_list.htm).

In India Bakshi (1971) contributed to study of this genus. He prepared a key to Indian species. Bilgrains *et al.* (1991) recorded seven species. Bhosle and Vaidya (2006) added ten new species to the Indian list of *Ganoderma* species. Twenty species are recorded for the first time from India in the present study.

The aim of present investigation was to study of *Ganoderma* species, which are the Root Rot Pathogens and cause responsible damages to trees in the forest, in park and in urban situating every year in Maharashtra state of India.

**MATERIALS AND METHODS**

The present study was carried out during 2004-2006 in Maharashtra state of India.

*Ganoderma* samples were collected in the sexual stages on different hosts like: *Azadirachta indica, Delonix regia, Tamarindus indica*, etc., from various regions of Maharashtra state like Anjira Baneshwar, Dapoli-Dabhul road, etc. The specimens were examined for external and internal morphology.

For external morphology the material was observed for colour, texture, type of attachment to host, pore morphology, disseminations character; margin, hymenial and pileal surface of basidiocarp.

For internal morphology, thin hand sections were taken from fruiting body passing through hymenium, which was done by chopping method. Semi-permanent slides prepared in lactoglycerine were maintained by sealing with nail polish for amyloid and non-amyloid reaction, spores were treated with Melzer’s reagent (chlooriodine solution), which turns blue. For Xanthocronic reaction 10% KOH solution was used (Beneke, 1958).

The slides were observed under Bausch and Lomb compound microscope having a combination of 10x eyepiece and 10x, 45x and oil immersion (i.e., 100x), objectives.

Photographs were taken using digital camera. Measurements of hyphae, basidia cystidia, setae, spores, cutis element etc. were taken using objective micrometer or calibrated ocular. Dimension of microscopic characters are given in micrometer (μm) eyepiece.

**RESULTS AND DISCUSSION**

Thirty four species of *Ganoderma* were identified in the present study (Table 1). Among them 20 species are new to Maharashtra India.
Table 1: *Ganoderma* species, their host, collection location and code

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
<th>Location</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>G. africanum</em></td>
<td>Delonix regia, unknown tree</td>
<td>Pune University, Anjirne</td>
<td>GA 94, GA 419</td>
</tr>
<tr>
<td><em>G. amazonense</em></td>
<td>Tectona grandis</td>
<td>Karad</td>
<td>GA 149</td>
</tr>
<tr>
<td><em>G. boninense</em></td>
<td>Delonix regia</td>
<td>Pune University</td>
<td>GA 97</td>
</tr>
<tr>
<td><em>G. chalceum</em></td>
<td>Areca catechu, Asandra indica,</td>
<td>Guhagar, Anjirne, Banschwar,</td>
<td>GA 338, GA 395</td>
</tr>
<tr>
<td><em>G. chalceum</em> var.</td>
<td>Tectona grandis</td>
<td>Pune University</td>
<td>GA 128, GA 82,</td>
</tr>
<tr>
<td><em>pleiotrichium</em></td>
<td>Tamarindus indica</td>
<td>Pune University</td>
<td>GA 79, GA 116</td>
</tr>
<tr>
<td><em>G. concinnum</em></td>
<td>Delbergia sisso</td>
<td>Pune University</td>
<td>GA 88</td>
</tr>
<tr>
<td><em>G. dejongii</em></td>
<td>Ficus benjamina, Mangifera indica</td>
<td>Shivwardhan, Dapoli-Hame road</td>
<td>GA 182, GA 360</td>
</tr>
<tr>
<td><em>G. donkii</em></td>
<td>Areca catechu</td>
<td>Dapoli-Hame Road</td>
<td>GA 362</td>
</tr>
<tr>
<td><em>G. fulvum</em></td>
<td>Areocarpus integriofolia, Areca catechu</td>
<td>Anjirne, Dabhhol</td>
<td>GA 378, GA 357</td>
</tr>
<tr>
<td><em>G. lipisense</em></td>
<td>Areca catechu, Casuarina equisetifolia</td>
<td>Anjirne, poultry trainee center-Pune</td>
<td>GA 378, GA 7</td>
</tr>
<tr>
<td><em>G. lobataeform</em></td>
<td>Delonix regia</td>
<td>Pune University</td>
<td>GA 377</td>
</tr>
<tr>
<td><em>G. lobatum</em></td>
<td>Areca catechu, Delonix regia</td>
<td>Anjirne, Pune University</td>
<td>GA 93, GA 378</td>
</tr>
<tr>
<td><em>G. lucidum</em></td>
<td>Delbergia melanoxylon, Cacalopika coriaria</td>
<td>Pune University, Thumshini</td>
<td>GA 74, GA 160</td>
</tr>
<tr>
<td><em>G. marteaceum</em></td>
<td>Tamarindus indica</td>
<td>Pune University</td>
<td>GA 8, GA 178</td>
</tr>
<tr>
<td><em>G. microasperum</em></td>
<td>Areocarpus integriofolia</td>
<td>Dapoli</td>
<td>GA 229</td>
</tr>
<tr>
<td><em>G. mirabile</em></td>
<td>Ficus bengalensis, Delonix regia</td>
<td>Dapoli, Keyna, Anjirne</td>
<td>GA 60, GA 250,</td>
</tr>
<tr>
<td><em>G. multicornum</em></td>
<td>Delonix regia</td>
<td>on stumps and Areca catechu</td>
<td>GA 417</td>
</tr>
<tr>
<td><em>G. orbiforium</em></td>
<td>Delonix regia</td>
<td>Pune University</td>
<td>GA 44</td>
</tr>
<tr>
<td><em>G. ostreadum</em></td>
<td>Mangifera indica (dead tree), Mangifera indica</td>
<td>Singhpol, Anjirne</td>
<td>GA 111, GA 428</td>
</tr>
<tr>
<td><em>G. pfefferi</em></td>
<td>Mangifera indica</td>
<td>Anjirne</td>
<td>GA 416</td>
</tr>
<tr>
<td><em>G. philippi</em></td>
<td>Mangifera indica, Unknown dead tree</td>
<td>Anjirne, Dabhhol</td>
<td>GA 351, GA 409</td>
</tr>
<tr>
<td><em>G. praelongum</em></td>
<td>Areca catechu</td>
<td>Anjirne</td>
<td>GA 372</td>
</tr>
<tr>
<td><em>G. pseudobutia</em></td>
<td>Cocos nucifera</td>
<td>Guhagar</td>
<td>GA 330</td>
</tr>
<tr>
<td><em>G. rectacaeum</em></td>
<td>Delonix regia</td>
<td>Pune University</td>
<td>GA 36</td>
</tr>
<tr>
<td><em>G. sessiliforme</em></td>
<td>Unknown</td>
<td>Pune University</td>
<td>GA 325</td>
</tr>
<tr>
<td><em>G. stipitatum</em></td>
<td>Tamarindus indica, Delonix regia, Unknown</td>
<td>Pune University, Empress Park-Pune</td>
<td>GA 10, GA 94, GA 419</td>
</tr>
<tr>
<td><em>G. subincrustatum</em></td>
<td>Delbergia melanoxylon</td>
<td>Empress park-Pune</td>
<td>GA 12</td>
</tr>
<tr>
<td><em>G. testaceum</em></td>
<td>Areocarpus integriofolia</td>
<td>Guhagar</td>
<td>GA 333</td>
</tr>
<tr>
<td><em>G. tornatum</em></td>
<td>Areocarpus integriofolia, Cocos nucifera, Gliricida sepilum</td>
<td>Dapoli-Hame Road, Empress Park-Pune, Dapoli-dabhol road.</td>
<td>GA 185, GA 187, GA 45</td>
</tr>
<tr>
<td><em>G. tordansanum</em></td>
<td>Delbergia melanoxylon</td>
<td>Empress park-Pune</td>
<td>GA 11</td>
</tr>
<tr>
<td><em>G. tridifforme</em></td>
<td>Delonix regia, on dead tree of Ficus sp.</td>
<td>Lonawala, Dapoli</td>
<td>GA 171, GA 210</td>
</tr>
<tr>
<td><em>G. vanheurnii</em></td>
<td>Ficus benjamina, Tamarindus indica</td>
<td>Pune University-Pune, Shivwardhan</td>
<td>GA 376, GA 84</td>
</tr>
<tr>
<td><em>G. williamsonii</em></td>
<td>Areca catechu</td>
<td>Dapoli-dabhol road</td>
<td>GA 334</td>
</tr>
<tr>
<td><em>G. zonatum</em></td>
<td>Areca catechu</td>
<td>Guhagar</td>
<td>GA 335</td>
</tr>
</tbody>
</table>

An artificial key was prepared, to distinguish the collected species. For the segregation and assignment of correct taxonomic identity to the samples, keys of different authors viz., Bakshi (1971), Ryvarden and Johansen (1980), Steyaert (1972, 1980), Gilberston and Ryvarden (1986), Gottlieb and Wright (1999a, b) and Ryvarden (1995, 2000) were used.

1'. Fileus non laccaete, generally astipitata ............ 2
2. Fileus laccaete, stipitate ................................ 13
2'. Cutsis anamixidormis type .............................. 3
2". Cutsis other than anamixidormis type ................. 9
3. Poure 3 mm^-1 ........................................... 4
3'. Poure 4 mm^-1 ........................................... 5
4. Context 10-12 mm thick, reddish brown ... G. lobatum
4'. Context 3 mm thick, brown ....................... G. lobataeform
5. Poure 4 mm^-1 ........................................... 6
5'. Poure 5 mm^-1 ........................................... 7
6. Spore ovoid, basidioicap sense-rich, por greyish ......... G. donkii

6'. Spore subglobose, basidioicap flabelliform ....... G. testaceum
7. Spore colour dark brown ......................... G. dejongii
7'. Spore colour yellow ......................... 8
8. Spore colour yellow, pore 6 mm^-1 angular .......... G. fulvum
8'. Spore colour yellow, pore 5-6 mm^-1, rounded ...... G. williamsonii
9. Cutsis trichodermis type ......................... 10
9'. Cutsis non trichodermis type .................. 12
10. Max. tube size ≤10 mm, context dark brown .......... G. vanheurnii
10'. Max. tube size ≤10 mm, context redish brown ... 11
11. Max. tube size 12 mm, tube dirty black ........ G. tornatum
11'. Max. tube size 13 mm, tube light brown ......... G. lipisense
12. Cutsis formed by somewhat elevate hyphal endings, pore light-Brown; 4-5 mm^-1 .......... G. amazonense
12'. Cutsis somewhat similar to anamixidormis type, pore creamish, 6 mm^-1 .......... G. philippi
Description of new species

**Ganoderma africanum** (Lloyd) Doidge Protoleque Botthalia 5: 511. 1950.


Basidiocarp: Laccate, annual, sessile, imbricate, eccentric, corky, Irregular, 20×16×5 cm. Upper surface: conceave, laccate, 3 concentric zone, waved, flexible, sulcate, rugose,


Basidiocarp: Non-laccate, annual, sessile, latrally woody, dimidiate, semi circular, about 15 cm in diam. Upper surface: Applanate. Margin: thick, lobed, brown in growing specimens white. Context: 3-4 mm thick brown in colour. Tube: 9 mm long, grey brown. Pores: 5-7 mm⁻¹, round. Cutis type: Cutis anamixidemins type, made up mostly of subparallel, brown hyphae, loosely interwoven. Hyphal system: Dimitic, Generative hyphae: 2.5 μm, Skeletal hyphae: 3.57-5.36 μm. Basidiospores: Ovoid, truncate at maturity, smooth, dark brown, 7.1-7.9×5.5-5.5 μm. Spore index: 1.42-1.44.


Basidiocarp: Non-laccate, lobed, sessile, flabelliform 10 cm in radius, concentrically sulcate. Upper surface: Non-laccate, reddish brown, zonation inconspicuous. Margin: Round to subacute, lobate, white to greyish colour. Hyphal surface: Yellowish pink towards the margin. Context: Reddish brown and becoming darker near the tubes. 10-12 mm long. Tube: Dark reddish brown 4 mm long. Pores: 3-4 mm⁻¹ angular. Cutis type: Cutis Anamixidemins type with clavate elements, blackish brown, shiny, underlaid of a brownish yellow zone with a dark brown layer thick, parallel to the cutis below the latter. Hyphal: hyaline, thin walled, nodose-septate, frequently branched, 2-6 μm diameters. Basidiospores: Oval, truncate, smooth, brown, 7.6-9×5.2-7 μm. Spore index: 1.28-1.42.

Basidiocarp: Laccate, annual, sessile, solitary, laterally, corky, Irregular, 5×3.5×3 cm. Upper surface: concave,

**Ganoderma mirabile** (Lloyd) Humph., Mycol. 30: 332. 1938.


**Ganoderma pseiffleri** Bres., Bull. Soc. Mycol. Fr. 5: 70. 1889.


**Ganoderma trengganiense** Corner. Beih. 75: 141. 1983.
Basidiocarp: Laccate, annual, sessile, imbricate, laterally, corky, crustose, Irregular, 19×17×4 cm. Upper surface: convex, 4 concentric zone, laccate, waved, brittle, sulcate, rugose, dark brown. Margin: lobed, sterile, sharp, layered, cream, 2.5 mm thick. Pore surface: cream. Pore: angular, 5 mm⁻¹ Tube: 10 mm long, light brown. Context: 3 mm thick, chocolate colour.
Cutis type: Cutis Claviform. Hyphal system: Dimitic without flagelliform binding processes, not enwrapped closely interwoven. Generative hyphae: 2.6 μm, Skeletal hyphae: 3.57-4.28 μm, walls 0.5-1 μm thick, with intercalary cells and narrow branches near the distal end. Branches continuing as skeletal cells without septation. Basidiospores: Oval, yellow, 11-12 x 8.5-9.9 μm. Spore index: 1.20-1.29.


Basidiocarp: Laccate, annual, sessile, solitary, lateral, corky, irregular, 6.5 x 3.8 x 1.8 cm. Upper surface: flat, lute, waved, flexible, sulcate, rugose, red brown. Margin: entire, sterile, sharp, light brown, >1 mm thick. Pore surface: light brown. Pore: rounded, 6 mm. Tube: 5 mm long, creamish. Context: 2 mm thick, light brown in colour. Cutis type: Hypenniomerium form with spheropodulcinate elements. Hyphal system: Trimitic, Generative hyphae: 3.1 μm, Skeletal hyphae: 2.5-3.57 μm, Binding hyphae: 3.5-5.3 μm. Basidiospores: Truncate, smooth, oval, light brown, 11-13 x 7-9 μm. Spore index: 1.4-1.57.


Basidiocarp: Non laccate, sessile, annual, solitary, ungulate, up to 5 cm diameter, 1.5-2.0 cm in thick. Upper surface: Convex, dull brown to red brown, shallow concentric grooves. Margin: generally thick rounded, yellow to grayish. Tube: up to 10 mm long, grayish to brown. Pores: 4-6 mm angular. Context: thin 2 mm in thick dark brown in colour. Cutis type: Cutis anamixdermis type, horny, thick, dissepiments. Hyphal system: Trimitic, with hyaline, thin walled, clamped generatives, with septa restricted to clamps, Skeletal hyphae: long with a thick, golden wall, without clamps. Binding hyphae: bovista type, without clamps, aseptate, with branches, 1-3 μm. Basidiospores: Oval to sub globose, truncate at maturity, smooth, light brown, 10.1-11.9 x 5.2-6. Spore index: 1.9-1.98.


Basidiocarp: Non laccate, annule, sessile, semi circula, laterally woody, dimidiate, irregular, up to 15 cm diameter. 15 to 60 mm thick. Upper surface: Dull brown or hairy brown, with many narrow grooves. Margin: Thin, brown, 2 mm thick. Tubes: 6-12 mm long, one layered, brown. Pores: 5-6 mm and rounded. Context: very thin, 2-3 mm thick, brown. Cutis type: Cutis anamixdermis type. Basidiospores: Ovoid, truncate at maturity, smooth, yellow, 5.36-7.8 x 4.2-6.1 μm. Spore index: 1.25-1.29.

Morphological characters of reproductive stage such as laccate and non-laccate, type of basidiocarp (stipitate/sessile, imbricate, concave, number of concentric zones, etc.), Margin shape (lobed, fertile/sterile, rounded/acute) and colour (brown, etc.), Pore (colour, Pore mm⁻¹, angular/rounded), Hyphal system (trimitic/dimittic), Tube size and colour, Contex, Cutis type and spore characters where consider for identification of the species in the present study, which are confirmative with the species of the *Ganoderma* described by authors in the references viz., Bakshi (1971), Corner (1983), Elliott and Broschat (2001), Gilberston and Ryvarden (1986), Gottlieb and Wright (1999a, b), Lloyd (1915) Monocava and Ryvarden (1997), Ryvarden and Calonge (1976) Ryvarden and Johansen (1980), Ryvarden (1995, 2000), Stuplers (1978) and Steyaert (1972, 1980).

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**REFERENCES**


