



## Two new records of hydroid fungi from the Western Ghats of India

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### Abstract

During inventory of macrofungi in the forests of Western Ghats, two hitherto unrecorded rare hydroid taxa, *Gyrodontium sacchari* (Spreng.) Hjortstam (Agaricomycetes, *Boletales*, *Coniophoraceae*) and *Hericium cirrhatum* (Pers.) Nikol. (Agaricomycetes, *Russulales*, *Hariciaceae*) were recovered on decaying wood. Both are reported from North-Eastern India, thus the present report constitutes the first report for the Western Ghats of India. This communication embodies brief systematic accounts with illustrations, substrates, distributions and economic value of these hydroid fungi.

**Key words** – forest – *Gyrodontium sacchari* – *Hericium cirrhatum* – macrofungi – wood

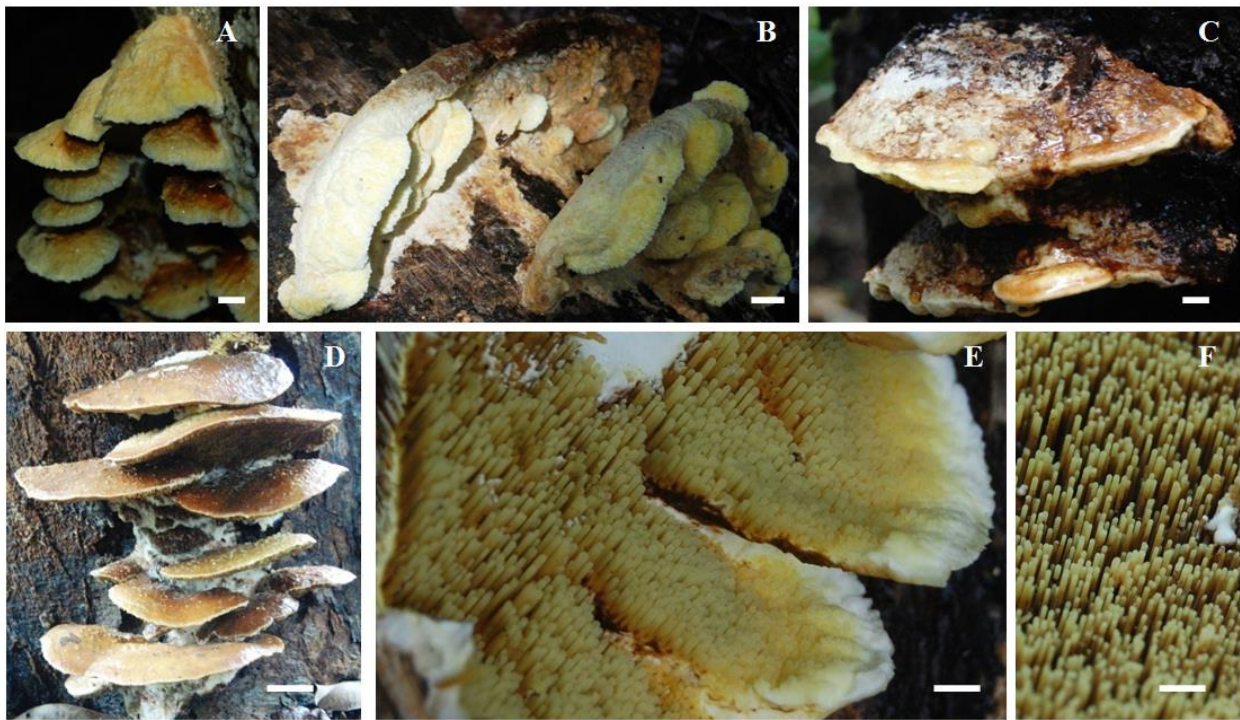
### Introduction

The hydroid fungi are commonly known as tooth fungi as they produce spores on pegs or spines or tooth-like projections underneath the fruit body. Index Fungorum (2016) documented nearly 900 species of hydroid fungi worldwide. *Gyrodontium sacchari* has been originally reported from Guadeloupe as *Hydnum benningsii* Bers. a generic type species in 1890. Subsequently it was recorded from Argentina, Bahia State, Belize, Brazil, Costa Rica, Cuba, Ecuador, French Guiana, Mexico and Panama (see Robledo et al. 2014). Hembrom et al. (2014) recorded this fungus for the first time in India in the West Bengal during 2013. The hydroid nature of hymenophore of the genus *Hericium* was shown by Persoon (1794) and described as *Hydnum cirrhatum*. Nikolajeva (1950) transferred this species to the genus *Hericium*. The genus *Hericium* is of particular interest due to peculiarity in morphology of fruit body possessing woolly surface. Because of specific woolly texture, some of them are commonly called bear's head mushroom (*H. americanum*), monkey's head mushroom (*H. cirrhatum*) and lion's mane or goat's beard mushroom (*H. erinaceus*). Their common names is also due to nature spines like coral-spine mushroom (*H. coralloides*), spine-face or tiered-tooth mushroom (*H. cirrhatum*). The present study provides systematic account of *Gyrodontium sacchari* and *Hericium cirrhatum* recovered from the Western Ghats with notes on their distribution, edibility and economic value.

### Systematic account

*Gyrodontium sacchari* (Spreng.) Hjortstam, 1995, *Mycotaxon* 54: 186 Fig. 1A–F; 2A–F  
Syn.: *Hydnum sacchari* Spreng., 1820, *K. Sevenska Vetensk-Acad. Handl.* 46: 51.

Description – Large creamy-brown brackets with spongy to puffy upper surface on eruption (Fig. 1A and B) possessing fertile cylindrical pegs underneath (Fig. 2B, C and D). Solitary or in



**Fig. 1** – *Gyrodontium sacchari*. A–B. developing basidiomata. C–D. solitary and tuft of maturing basidiomata. E–F. side view and tips of developing pegs underneath basidiomata. Scale bar = 1 cm.

tufts (Fig. 1C and D), annual, lignicolous, rare, odor mealy or almond-like, taste not distinctive, edible based on tribal knowledge and measures 3.2–20.2 cm diam.  $\times$  0.5–2.3 cm thick.

Basidiomata initially small, drooping, dirty-white to yellowish-cream or yellowish-brown on eruption (Fig. 1A and B), becoming irregular to bracket-shaped to lobed or tufted with wavy margin (Fig. 1D and 2A). Upper surface is grayish-brown/smoky-brown/creamy-brown/orange-brown (Fig. 1C, 2A and 2E), slimy to smooth, spongy to puffy, fleshy when moist, smoky-grey on drying, warty to rough and leathery. The lower part initially yellowish-green (Fig. 1E) or greenish-brown (Fig. 1F) and becoming brownish-green on maturity (Fig. 2B, C and D). Fertile hymenium bears cylindrical, smooth, thick or thin, soft, blunt pegs (Fig. 2D), 5–16 mm tall  $\times$  1 mm thick, crowded and spread over the under surface (Fig. 2B). Sessile or occasionally knob-like with short stem, flesh creamish to greenish-brown and soft. Basidia elongated and 2–4 spored. Spores oval to ellipsoidal, smooth, greenish-yellow or yellowish-brown and measures 3.4–4.7  $\times$  2.6–3  $\mu$ m (Fig. 2F).

**Substrate** – On the rotting fallen trunk and standing dead palm *Caryota urens* in Sampaje Reserve Forest of the Western Ghats (12°28'N, 75°37'E; 608 m asl) (July 31, 2013) (Table 1). On standing dead *C. urens* and base of live *Terminalia catappa* tree in Arboretum of Mangalore University Campus, Konaje (12°48'N, 74°55'E; 87.2 m asl) (September 20, 2015) (Table 1).

**Distribution** – It was first reported from India in the Acharya Jagadish Chandra Bose Indian Botanical Garden, West Bengal during June 26th, 2013 (Hembrom et al. 2014). The present study from the Western Ghats and subsequently from the west coast of India constitutes the second report (Table 2). It has a wide distribution in different ecosystems in five continents specifically from the Argentina, Bahia State, Belize, Brazil, Caribbean, Costa Rica, Cuba, Ecuador, Ethiopia, French Guiana, Guadeloupe, Mexico, Panama, Tanzania and Zimbabwe (Valenzuela et al. 2012, Robledo et al. 2014). It has been traced mainly in the old-growth forests (especially on fallen dead angiosperm wood and in base of living trees), however in Brazil it was reported inside a tree hole of a living tree (Robledo et al. 2014). Interestingly, it was also found associated with monocots like fallen palm in Belize and leaves of sugarcane in Guadeloupe (Valenzuela et al. 2012, Robledo et al. 2014).

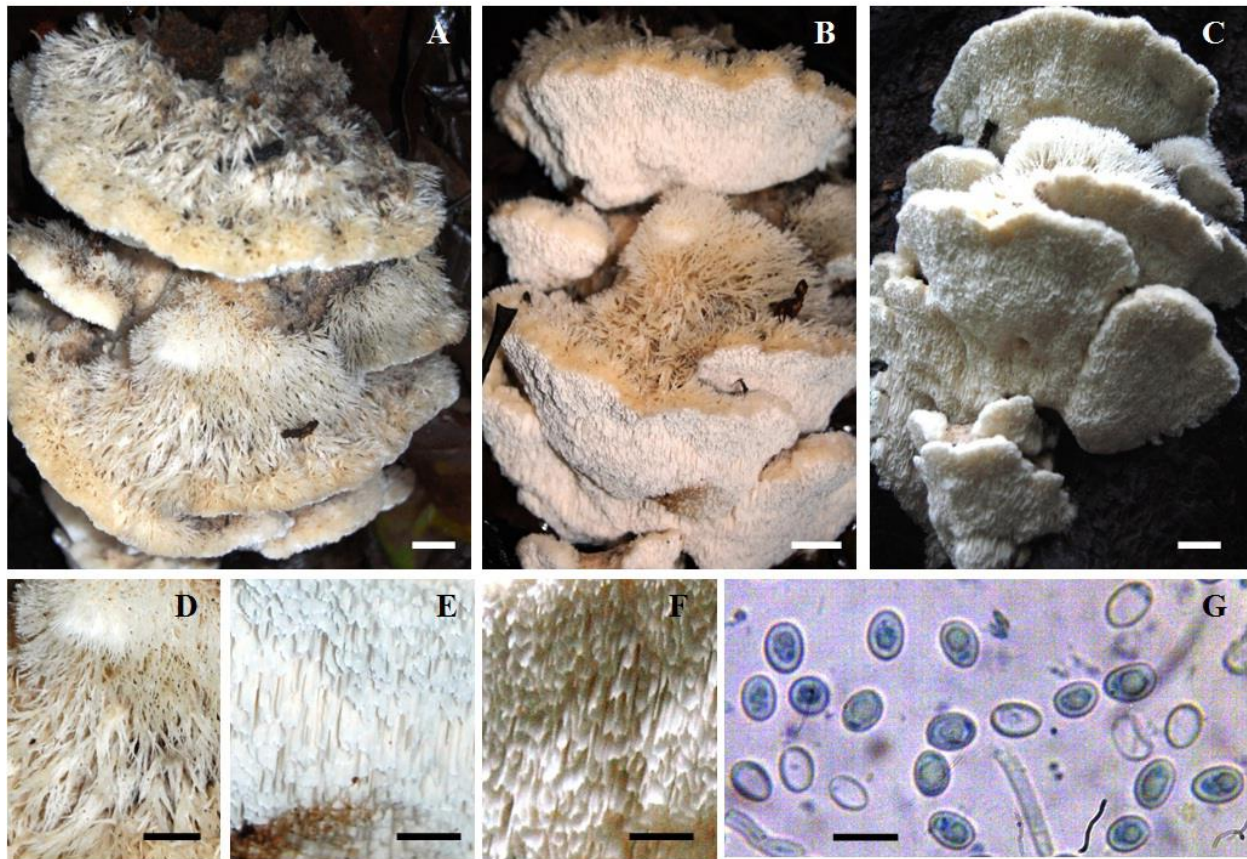




**Fig. 2** – *Gyrodontium sacchari*. A. top view of mature basidiomata. B–D. details of pegs underneath mature basidiomata. E. basidiomata nearing decay. F. mature basidiospores. Scale bar: A–E = 1 cm, F = 10  $\mu$ m.

**Table 1** Comparison of characteristics of *Gyrodontium sacchari* and *Hercium cirrhatum*

	<i>Gyrodontium sacchari</i>	<i>Hercium cirrhatum</i>
<b>Nutritional mode</b>	Wood and monocot stem saprotroph	Wood saprotroph
<b>Type of wood decay</b>	White rot	White rot
<b>Host</b>	Wild palm <i>Caryota urens</i> (Western Ghats); wild palm <i>C. urens</i> and <i>Terminalia catappa</i> (west coast)	Endemic tree <i>Euodia lunuankenda</i>
<b>Substrate</b>	Fallen or standing dead dicot and monocot trees	Live tree crevices
<b>Location</b>	Sampaje forest reserve (Western Ghats); Arboretum (west coast)	Makutta forest reserve (Western Ghats)
<b>Fruiting season</b>	July-October (Western Ghats); August-October (west coast)	July-August (Western Ghats)
<b>Optimum temperature</b>	23–27°C (Western Ghats); 25.5–31.5°C (west coast)	22–24°C (Western Ghats)
<b>Fruit body texture</b>	Slimy and spongy to puffy	Hairy and fleshy
<b>Texture on drying</b>	Leathery	Corky
<b>Fertile region of hymenophore</b>	Greenish-brown crowded pegs	Whitish tiered teeth with pinkish tinge
<b>Spore color</b>	Yellowish-brown	Hyaline
<b>Edibility character and odor</b>	Mealy or almond-like odor; Congregation of fruit flies and ants	Almond-like odor; Congregation of fruit flies and ants
<b>Associated macrofungi</b>	<i>Caryota urens</i> : <i>Lentinus</i> spp., <i>Pleurotus</i> spp. and <i>Royporus spathulatus</i> ; <i>Terminalia catappa</i> : <i>Ganoderma</i> spp. and <i>Xylaria</i> spp.	<i>Pleurotus</i> spp.



**Fig. 3** – *Hericium cirrhatum*. A. top view of mature basidiomata with woolly nature. B. side view of mature basidiomata. C. lower view of mature basidiomata. D. details of woolly upper surface. E. and F. tiered teeth underneath basidiomata. G. mature basidiospores. Scale bar: A–F = 1 cm, G = 10 µm.

*Hericium cirrhatum* (Pers.) Nikol. *Acta Inst. Bot. Acad. Sci. USSR Plant Crypt., Fasc. II* 6, 343 (1950) Fig. 3A–G

Syn.: *Hydnum cirrhatum* Pers., 1794, *Neues Mag. Bot.* 1: 109; *Hydnum corrugatum* Fr., 1818, *Observ. Mycol. (Havniae)* 3: 269; *Creolophus cirrhatus* (Pers.) P. Karst., 1879, *Meddn Soc. Fauna Flora Fenn.* 5: 42; *Steccherinum cirrhatum* (Pers.) Teng, 1963, *Thung-Kuo Ti Chen-Chan (Fungi of China)*: 763.

Description – Large white bracket-like caps with hairy-bristly upper surface and fertile flattened tiered teeth underneath. Solitary or in tufts (Fig. 3A, B and C), annual, lignicolous, rare, odor almond-like, taste not distinctive, edible and measures 2.2–10.9 cm diam. × 0.5–3.3 cm thick.

Basidiomata at first small pinkish-white eruption with fine hairs, on ageing becomes irregular to bracket-shaped, hairy and on maturity irregularly semicircular to lobed or bracket-like to shell-shaped with wavy margin (Fig. 3A, B and C). Upper surface sterile, light-brown to white, hairy-bristly and on ageing short-spined to warty (hairs get trimmed off due to heavy showers) (Fig. 3D). The lower pinkish-white fertile hymenium bears deadaleoid to lamellate, deeply incised, pointed, flattened teeth 5–18 mm tall, surface finely sulcate, tiered, crowded, spread over (Fig. E and F) and sometimes decurrent directly onto substrate. Sessile and laterally attached to substrate. Flesh whitish and soft. Basidia elongated, club-shaped and 2–4 spored. Spores whitish, smooth, oval and measures 9.8–11.2 × 7.2–8.2 µm (Fig. 3G).

Substrate – In the crevices of live *Euodia lunuankenda* tree trunk in Makutta reserve forest (12°8'N, 75°47'E; 897 m asl) (July 24, 2012) (Table 1).



**Table 2** Distribution and substrate preference of *Gyrodontium sacchari* and *Hericium* spp. in India

Species	Location	Substrate	Reference
<i>Gyrodontium sacchari</i>	Botanical Garden, West Bengal	Dead log of <i>Casuarina</i> sp.	Hembrom et al. (2014)
	Sampaje, Western Ghats of Karnataka	Dead stem of palm <i>Caryota urens</i>	Present study
	Konaje, West coast of Karnataka	Dead log of <i>Terminalia catappa</i> tree	
<i>Hericium bharengense</i>	Upper Bhareng, Sikkim	Logs of <i>Tsuga dumosa</i>	Das et al. (2011)
<i>H. cirrhatum</i>	Yuksom, Sikkim	Wood of <i>Alnus nepalensis</i> ; Trunk of <i>Quercus</i> sp.	Das & Sharma (2010)
	Makutta, Western Ghats of Karnataka	Crevice of endemic tree <i>Euodia lunuankenda</i>	Present study
<i>H. clathroides</i>	Chamba, Himachal Pradesh	Dead tree of <i>Quercus incane</i>	Thind & Khara (1975)
<i>H. coralloides</i>	Darjeeling; West Bengal	?	Berkeley (1851)
	Mussoorie Hills, Uttarakhand	?	Bagchee et al. (1954)
	Pahalgam, Jammu-Kashmir	Log in coniferous forest	Thind & Khara (1975)
	Doda, Jammu- Kashmir	Dead wood of <i>Quercus leucotrichophora</i>	Zutshi & Gupta (2013)
<i>H. erinaceus</i>	Sikkim	?	Berkeley (1851)
	Mussoorie Hills, Uttarakhand	?	Bagchee et al. (1954)
	Narkanda, Simla	Log of coniferous tree	Thind & Khara (1975)
	Nainital, Uttarakhand	Base of <i>Quercus incane</i>	
	Pauri, Uttarakhand; Shimla, Himachal Pradesh	Cracks of live but decaying <i>Quercus leucotrichophora</i>	Semwal et al. (2014)
	Western Ghats of Karnataka	Unknown tree canopy	Karun & Sridhar (2016)
<i>H. yumthangense</i>	Yumthang, Sikkim	Wood of <i>Abies densa</i>	Das et al. (2013)

Distribution – Six species of *Hericium* have been reported from the Indian Subcontinent on woody substrates mainly from the Himalayan region: *Hericium bharengense* K. Das, Stalpers & Eberhardt; *H. cirrhatum* (Pers.) Nikol; *H. clathroides* (Pall.) Pers.; *H. coralloides* (Scop.) Pers.; *H. erinaceus* (Bull.) Pers.; *H. yumthangense* K. Das, Stalpers & Stielow (Thind & Khara 1975, Das & Sharma 2009, Das et al. 2011, 2013, Zutshi & Gupta 2013, Semwal et al. 2014) (Table 2). *Hericium erinaceus* was also known from the reserve forest of the Western Ghats during July 2012 (Karun & Sridhar 2016). *Hericium cirrhatum*, *H. coralloides* and *H. erinaceus* were recorded from Asia, North America and Europe (see Boddy et al. 2011).

## Discussion

Economic importance – Macrofungi are of promising interest due to their nutritional, therapeutic and bioactive components. Being mainly saprotrophic on wood, *G. sacchari* and *H. cirrhatum* are important especially in the old-growth forest ecosystem. *Gyrodontium sacchari* isolated from *Pinus densiflora* and *Quercus* sp. in Korea produced cellulase, xylanase and ligninase on agar media higher than many reference strains (Park et al. 2015). Fernando et al. (2015) has reported potent antioxidant activities of *G. sacchari*. Tribals of the Western Ghats (e.g. Kudia, Kuruba and Yerava) consume majority of macrofungi growing on *C. urens* (e.g. *Pleurotus* spp., *Royporus spathulatus* and *Lentinus* spp.) including *G. sacchari*. In the present study, fruit fly (*Drosophila*) and ants were congregated on fruit bodies of *G. sacchari*. Based on tribal knowledge, such insect association of feeding indicates its edibility. Moreover, *G. sacchari* has pleasant mealy

or almond odor, which is one of the main characteristic features of edible mushrooms in the Western Ghats.

Most of the young *Hericium* spp. are edible, however, there is no information about edibility of *H. cirrhatum*. Tribals of the Western Ghats designated this fungus as ‘Karadi-Kum’ (meaning: ‘bear-head mushroom’) with pleasant almond odor and it is delicacy for them. Besides edibility, *Hericium* spp. are also known for their therapeutic potential especially in stimulation or synthesis of nerve growth factor (NGF) and several health-promoting principles including those used in treatment of dementia (e.g. metabolites of *H. erinaceus*: Kawagishi and Zhuang 2008, Ma et al. 2010, Friedman 2015, Thongbai et al. 2015). It is also known that *H. erinaceus* possess polysaccharide belonging to  $\beta$ -glucan group showing potent antitumor activities (Seok et al. 2009).

Conservation – The Italian Botanical Society has proposed 23 species of macrofungi as rare and or endangered, which also encompass *G. sacchari* (IUCN, 1994). The wild palm supports growth of *G. sacchari* in the Western Ghats and west coast is *Caryota urens* (also called toddy or civet palm) used to extract toddy, they produce nuts similar to areca nut (*Areca catechu*) used for chewing during scarcity of nuts of *A. catechu*. Civet cats are known to raise their young ones in this palm and they are mainly dependent on pulp of fruits helping in seed as well as fungal dissemination. As *Caryota urens* serve as a potent host for *G. sacchari*, special care need to be exercised for its preservation. In the southwest coast of India, *G. sacchari* is widely associated with live as well as dead horticulture tree *Terminalia catappa* (almond tree).

*Hericium coralloides* and *H. erinaceus* are designated under ‘vulnerable’ (VU) category of Red List in many European countries (Boddy et al. 2011). Most of the *Hericium* spp. are edible and needs conservation measures during mass collection from wild. Being edible and medicinally versatile, several strategies and priorities of conservation of *Hericium* spp. have been offered by Boddy et al. (2011). In the Western Ghats, *H. cirrhatum* was found on the dead wood of endemic live trees of *Euodia lunuankenda* and this host is extensively used to manufacture plywood and matchsticks. Besides, *H. cirrhatum* was recovered on the tree canopy of unknown tree during July 2012 (Karun & Sridhar 2016). It is likely Western Ghats harbor some more *Hericium* spp. warrants further exploration.

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