**Three *Hericium* Pers. from Ratanmahal Wildlife Sanctuary of Gujarat, India.**

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**Abstract**

A survey was undertaken during 2010-2011 to detect the various white rot fungi in Ratanmahal wildlife sanctuary of Gujarat. Detailed macroscopic and microscopic study of fungal samples was identified as *Hericium abietis* (Weir ex Hubert) K. Harrison, *Hericium cirrhatum* (Pers.) Nikol. *Hericium erinaceus* (Bull. ex Fr.) Pers. The two species of *Hericium* was reported for the first time from the Eco-regions of Gujarat. For the first time *Hericium abietis* was reported from India. All the three species of *Hericium* was used as food by tribal of Gujarat, so the conservation was done.

**Introduction**

The edible mushroom *Hericium* was first described as genus by Persoon (1794). it is a part of the *Hydnum* genus due to the hydnoid nature of hymenophore (Fries 1822, Miller 1933). It belong to the order Hericiales and Hericiaceae family (Donk 1964), but according to Index Fungorum the Hericiales was merged with the Russulales order (Kirk et al. 2001). it comprises 34 species with 66 taxon names was listed in Index Fungorum (Index Fungorum 2021), 71 species names was listed in Mycobank (2022) and 23 species records in Notes of Genera in Basidiomycota (He et al. 2019). The mega-diverse country of the world is India, being underexplored for *Hericium* macro-fungi, except some sporadic noteworthy mycologists’ contributions (Berkeley 1851; Bagchee et al. 1954;, Thind & Khara 1975; Das & Sharma 2010; Das et al. 2011, 2013; Zutshi & Gupta 2013, Semwal et al. 2014, Karun & Sridhar 2016). The genus *Hericium* shows a peculiar morphology in fruit body like woolly surface. So they are commonly called as bear's head mushroom (*H. americanum*), monkey's head mushroom (*H. cirrhatum*) and lion's mane or goat's beard mushroom (*H. erinaceus*) and based on the nature of spines they are also called coral-spine mushroom (H. coralloides), spine-face or tiered-tooth mushroom (*H. cirrhatum*) (Karun & Sridhar 2016). The basidiomata is white and fleshy, growing on dead trees or dried woods, the basidiomata are similar to fragile iced thorns which either hang from a branch, supporting the framework or as a tough unbranched cushion of tissue (Kuo 2014). In the present study the distribution, identification and conservation of some species of Hericium from Rathanmahal wildlife Sanctuary, Gujarat, India was reported.

**Materials and Methods**

**Study area**

Ratanmahal Wildlife Sanctuary is an area of 55.65 Sq. Km consisting of dry deciduous forest. The total existing sanctuary area lies between the river panama and orsang. It’s location is Panchmahals district, Limkheda taluka. Ratanmahal is 45 km from Baria. It is situated between 74º 37' to 70º 11' East longitude and between 22º 32' to 22º 35' North latitude. The flora of Ratanmahal forest is 543 species of plants, out of which 119 species are trees, 40 species are shrubs, 238 species are herbs, 48 species are grasses, 87 species are climbers, 2 species are partial parasites and 9 species are orchids. Amongst all tree species, Teak was found to have the maximum density and comprised 19.6 % of the total trees cover composition. The next dominant species is the Badaro, constituting 15.7 % of the total composition. The climate is subtropical arid, which turns to humid during the monsoon, i e during July to October. Gradually it becomes exceedingly dry and cold during November to February followed by a long hot summer the hottest month being May and June. Mean annual temperature of the sanctuary is 25.3 ºC with a maximum of 44.9 ºC and minimum of 6.1 ºC. annual rain fall is about 980 mm and rain fall occurs between June and September

**Collection and Phenotypical identification**

The sporophore was collected from Eco-regions of Gujarat like, India, during the rainy season (July–September) of the years 2015 to 2019. Field characters like habit, host, name of locality and other macro-morphological characteristics were recorded for sample specimens. For Phenotypical identification of sporophore, different Macroscopic features like abhymenial, hymenial surfaces, context, and pore tubes of species were examined. Microscopic features like hyphae, basidiospores and pilear crust were observed by preparing crush mounts and free-hand sections in water, 5% KOH solution, and staining was done with cotton blue (1%, in lactophenol), Congo red (1%, in distilled water), phloxine (1%, in distilled water), and Melzer’s reagent (Arya et al., 2008, Nagadesi and Arya,2012, 2016, Nagadesi 2019,Nagadesi et al 2014).

**Results and Discussion**

***Hericium abietis* (Weir ex Hubert) K. Harrison. Canad. Jour. Bot. 42: 1208. 1964. Plate 1 Fig. C,D**

Sporophore up to 5 x 2.5 cm, solid tubercle; white to yellowish, buff when young, yellowish when bruised. sessile large, solid, massive, tubercle attached laterally to the wood by rooting strands, context firm, pallid; spines up to 1.2 cm long, very short and stout when young, pointed on ends in tufts. The basal mycelium is interwoven with rhizomorphic strands; hyphae on surface of basal tubercle nonamyloid, clamped, 2.65-3.75 µm wide, cells long, walls thin. No KOH reaction when dried; Melzer's reagent gave amyloid reaction to tramal context, branches, and spines. Hymenium and subhymenium nonamyloid, dull yellow in Melzer's; subhymenium compact, 20.85-30.65µm thick, consisting of a layer of thin-walled generative hypha 3.65-4.75 µm in diameter. Hyphae in basidiocarp amyloid, flexuous, often bifurcating broadly, interwoven, variable in width, clamped at the septa, thick-walled, with wider lumen. Spores 4.65-5.56 x 4.25 - 4.75µm, subglobose, white, smooth, amyloid with thickwalls, dextrinoid; Basidia 5-7 x 25-30 µm, with walls irregular wavy; cystidia flexuous, clavate. Gloeocystidia 8-12 µm; oleiferous hyphae 200 µm, thick-walled, exposed in hymenium, moniliform, usually burst in Melzer's reagent and exuding oily contents. Odor and taste mild.

**Specimen examination**

India, Gujarat state, Ratanmahal wildlife sanctuary, on dead bamboo wood causing a white rot, 15th August 2010, coll. N. Praveen Kumar, (Acc no: MSUB Bot 120),

This fungus causes a white pocket rot in *Abies grandis* (Dougl.) Lindl., *A. lasiocarpa* (Hook.) Nutt., *A. procera* Rehd., *Picea engelmannii* Parry ex Engelm., *Tsuga heterophylla* (Raf.) Sarg., *Pseudotsuga menziesii* (Mirb) Franco in the Pacific Northwest. In Alaska, it is causing a rot in western hemlock, and *Picea sitchensis* (Bong.) Carr.(Englerth 1947). In Canada of British Columbia it causing a long pitted trunk rots in western hemlock and true fir (Bier 1949). Foster and Foster (1951) also reported it as a cause of a rot of western hemlock. In the present study it is causing white rot on dead Bamboo.

***Hericium cirrhatum* (Pers.) Nikol. Acta Inst. Bot. Acad. Sci. USSR Plant Crypt., Fasc. II 6, 343 (1950) Plate 1 Fig. E**

Sporophore: Large white bracket-like caps with hairy-bristly upper surface and fertile flattened tiered teeth underneath. Solitary or in tufts (Plate I Fig. E), 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 (Plate I Fig. E). Upper surface sterile, light-brown to white, hairy-bristly and on ageing short-spined to warty (hairs get trimmed off due to heavy showers) (Plate I Fig. E). 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 (Plate I Fig. E) 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 (Plate I Fig. E).

**Specimen examination**

India, Gujarat state, Ratanmahal wildlife sanctuary, on dead and living tree of *Madhuca indica* wood causing a white rot, 15th August 2010, coll. N. Praveen Kumar, (Acc no: MSUB Bot 125),

***Hericium erinaceus* (Bull. ex Fr.) Pers. Mycol. Europ. 2: 153. 1825. Plate 1 Fig. A,B,**

Basidiocarp an ovoid, solid, up to 5 cm wide, attached laterally; upper surface a tangle of coarse agglutinated strands of mycelium; white becoming yellowish and finally brownish. Margin of pileus indefinite, but marked by the bases of long pendent spines. Context fleshy, tough, watery, concolorous; Spines 1.5-4.2 cm long, pendent, beard-like, covering the sides. These are formed in a line as though the rows of spines originated in sequence during the enlargement of the tubercle. Stipe represented by a tough rooting attachment arising within the woody substrate. When KOH was applied to dried material there was no reaction; with Melzer's reagent, context surface and spores were amyloid, context usually amyloid but may not show any darkening in some sections. Spores 5.5-6.8 x 4.5-5.6 µm, subglobose, finely roughened to smooth; basidia 25-40 x 5.25-7.65 µm, 4-spored; gloeocystidia arising in subhymenium, up to 7.75 µm wide, with dense contents exuding as oily appearing droplets in KOH. Hyphae of the trama 3.65-20 µm in diameter, inflated or not, thick-walled, at times the lumen almost closed, interwoven, giving rise to gloeocystidia in the spines. Interweaving hyphae 3.65-10 µm thick with some clamps, branched and thick-walled. odor and taste mild.

**Specimen examination**

India, Gujarat state, Rajpipla forest, on dead wood causing a white rot, 15th September 2011, coll. N. Praveen Kumar, (Acc no: MSUB Bot 128),

*Hericium erinaceus* is a rare species native to North America, commonly found in East Asia and India (Das et al. 2011), rarely found in Europe. It is considered as being associated with a heart rot of oaks, occasionally on other frondose species, and is usually found growing from knotholes or cracks on living trees. It is recorded on Fagus in a number of states, on Acer spp. (Washington), Eucalyptus (California) and Platanus (Virginia). In 2003, it was red-listed in 13 of the 23 European countries because its natural habitats are beginning to disappear (Thongbai et al. 2015). In the present study it is causing white rot in dead wood of Rajpipla forest area.

**Distribution** – Eidgt species of *Hericium* have been reported from the Indian Subcontinent on woody substrates mainly from the Himalayan region (Thind & Khara 1975, Das & Sharma 2009, Das et al. 2011, 2013, Zutshi & Gupta 2013, Semwal et al. 2014, Das et al. 2013) (Table 2). *Hericium erinaceus* was also known from the reserve forest of the Western Ghats during July 2012 (Karun & Sridhar 2016). In the present study it is reported from reserved forest of Rajpipla area of Gujarat. *Hericium cirrhatum, H. coralloides* and *H. erinaceus* were recorded from Asia, North America and Europe (Boddy et al. 2011). In the present study it was recorded from the India country of Asian continent

**Plate I**



**E**

**A**

**D**

**C**

**B**

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No | Species  | Location | Habitat | Reference |
| 1 | Hericium abietis | Rathanmahal, Gujarat | Bamboo | Present study |
| 2 | Hericium bharengense | Upper Bhareng, Sikkim | Logs of Tsuga dumosa | Das et al. (2011) |
| 3 | H. cirrhatum.  | Yuksom, Sikkim  | Wood of Alnus nepalensis; Trunk of Quercus sp  | Das & Sharma (2010)  |
|  |  | Makutta, Western Ghats of Karnataka | Crevices of endemic tree Euodia lunuankenda | Karun and Sridhar (2016) |
|  |  | Rthanmahal, Gujarat | Living tree of Madhuca indica | Present study |
| 4 | H. clathroides  | Chamba, Himachal Pradesh | Dead tree of Quercus incane | Thind & Khara (1975) |
| 5 | H. coralloides  | Darjeeling; West Bengal | unknown | Berkeley (1851) |
|  |  | Mussoorie Hills, Uttarakhand ?  | unknown | Bagchee et al. (1954) |
|  |  | Pahalgam, Jammu-Kashmir  | Log in coniferous forest | Thind & Khara (1975) |
|  |  | Doda, Jammu- Kashmir  | Dead wood of Quercus leucotrichophora | Zutshi & Gupta (2013) |
| 6 | H. erinaceus  | Sikkim | Unknown | Berkeley (1851) |
|  |  | Mussoorie Hills, Uttarakhand  | Unknown | Bagchee et al. (1954) |
|  |  | Narkanda, Simla  | Log of coniferous tree | Thind & Khara (1975) |
|  |  | Nainital, Uttarakhand | Base of Quercus incane | Thind & Khara (1975) |
|  |  | Pauri, Uttarakhand;  | Cracks of live but decaying | Semwal et al. (2014) |
|  |  | Shimla, Himachal Pradesh | On wood of Quercus leucotrichophora | Semwal et al. (2014) |
|  |  | Western Ghats of Karnataka  | Unknown tree canopy | Karun & Sridhar (2016) |
|  |  | Rajpipla, Gujarat | Imported wood log | Present study |
| 7 | Hericium rajendrae | Himalayan, Jammu- Kashmir | Unlnown wood | Upendra Singh and Kanad Das in 2019 |
| 8 | H. yumthangense  | Yumthang, Sikkim | Wood of Abies densa | Das et al. (2013) |

**Conservation –** *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 present study also the *Hericium* sp was used by tribal of Gujarat as food so it is edible. 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 (Karun & Sridhar 2016) in the present work the *H. cirrhatum* was dead and living tree of *Madhuca indica* and this plant is used for making tribal drink alcohol in Gujarat

**Medicinal uses -** Most of the young *Hericium* spp. are edible, *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).

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