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Five new additions of wood decaying Polypores to India

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Five species of Polypores i.e *Antrodia heteromorpha* (Fr.:Fr.) Donk, *Fomitiporia hartigii* (Allesch. & Schnabl) Fiasson & Niemelä *Heterobasidion australe* Y.C. Dai & Korhonen, *Niveoporofomes spraguei* (Berk. & M.A. Curtis) B.K. Cui and *Oxyporus millavensis* (Bourdot & Galzin) Ryvarden & Melo have been described and illustrated on the basis of macromorphological and micromorphological characters. The polypore taxa were collected during the rainy season in the Doda, Kishtwar and Udhampur of Jammu Division (Union Territory of Jammu and Kashmir) from the years 2014-2017. All the described five polypores species are reported first time from India. It is worth to mention that the genus *Niveoporofomes* is also recorded first time from India. Of the five species, the basidiomes of *Antrodia heteromorpha* were collected from angiospermic as well as gymnospermic host, *Oxyporus millavensis* was found only on *Pyrus malus* and the rest of species were found on gymnospermic host.

Key words : *Agaricomycetes*, Brown rot, North Western Himalaya, Poroid fungi, White rot

INTRODUCTION

During the fungal surveys conducted in Doda, Kishtwar and Udhampur of Jammu Division (Union Territory of Jammu and Kashmir) some interested polypore taxa were collected from the years 2014-2017 in the months of July to September. The poroid fungi or polypores (*Agaricomycetes*, *Basidiomycota*) are featured by macroscopic basidiome with poroid hymenial surface. These fungi are unique in having unilateral hymenium, which forms the fertile layer surrounding the tubes that open on the hymenial surface in the variable forms of pores. The pilear surface in case of pileate members ranges from smooth to tuberculate to warted to scurpouse to tomentose to velutinate to hirsute to hispid. The colour of hymenial and abhymenial shows variation from shades of yellow to orange to grey to red.

Polypores contribute very significantly to forest ecosystem because of the secretion of enzymes laccase and cellulase which degrade the lignin and cellulose of wood respectively. Some of these fungi contains important bioactive compounds, thus are

useful in medicinal system (Wachtel-Galor *et al.* 2011; Susanna and Narine, 2016; Gáper *et al.* 2016). Jammu Division of Union Territory of Jammu and Kashmir is located between 32°17' and 37°05'N and 72°31' and 80°20' E. The altitude varies from 300 m - 4200 m above mean sea level.

The area shares border with Kashmir, Ladakh, Punjab and Himachal Pradesh. Of the total forest cover of Union Territory about 27.41% is recorded in Jammu Division. The forests of Jammu division ranges from subtropical evergreen forests to subtropical Pine forests to himalayan moist forests to himalayan dry temperate forests to subalpine forests alpine forests. The diverse nature of vegetation, geography and climate in Jammu division offers the better combination of conditions for the germination and growth of polypore taxa. In present case, five species viz. *Antrodia heteromorpha* (Fr.:Fr.) Donk, *Heterobasidion australe* Y.C. Dai & Korhonen, *Fomitiporia hartigii* (Allesch. & Schnabl) Fiasson & Niemelä *Niveoporofomes spraguei* (Berk. & M.A. Curtis) B.K. Cui and *Oxyporus millavensis* (Bourdot & Galzin) Ryvarden & Melo are illustrated and described as first reports from India.

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MATERIALS AND METHODS

The polypore basidiomes were collected during the excursions carried out in various parts of district Doda of Jammu Division in the rainy months (July–September) of years 2014–2017. These basidiome were separated carefully from their substratum using a hammer and chisel. The macromorphological details i.e. nature of the basidiocarp, mode of attachment, hymenial and abhymenial surface, margins, etc. were recorded. A piece of the fertile portion of the basidiome was used for getting the spore print on a micro slide. After drying (in sun or on an electric drier), the collected basidiomes were packed in ziplock airtight bags. The micro morphological characters were studied by making preparations in water, 3%/5%/10% KOH, 1% phloxine, 1% congo red and 1% cotton blue (in distilled water/lactophenol). The cyanophilous and amyloid reaction of different microscopic structures were studied in 1% cotton blue and Melzer's reagent (Iodine 0.5 g, Potassium iodide 1.5 g, Chloral hydrate 20.0 g and distilled water 20.0 ml) respectively. The line diagrams of the microscopic structures were drawn with the help of a camera lucida mounted on a compound microscope at 100X, 400X, and 1000X magnification. Finally the specimens were identified on the basis of comparison of the description with the literature and online repository Roy and Das, 1996; Leelavathy and Ganesh, 2000; Sharma, 2012; Ryvarden and Melo, 2014; Mycobank, 2022). The identified specimens were finally submitted to the Herbarium, Department of Botany, Punjabi University, Patiala (PUN) using standard packing protocol.

RESULTS AND DISCUSSION

Antrodia heteromorpha (Fr.:Fr.) Donk, Persoonia 4: 339, 1961.

≡ *Deadalea heteromorpha* Fr., Observationes mycologicae 1: 108 (1815).

Basidiome annual, resupinate, soft when fresh, becomes hard and tough on drying, easy to separate from the substrate; up to 0.5 mm in cross section; *Hymenial surface* poroid, white when fresh, changing to pale yellowish on drying; margin concolorous, adnate, entire, sterile up to 2 mm; *Pores* angular to sinuous, 2–3 per mm; dissepiments lacerate, up to 60 µm in thickness; Tube layer white, up to 2 mm deep. *Subiculum* homogenous, white

to brownish grey, up to 2 mm in thickness; Hyphal system dimitic. *Generative hyphae* hyaline, thin-walled, clamped, branched up to 3 µm in width. *Skeletal hyphae* subhyaline, thick-walled, aseptate, unbranched, up to 4 µm in width; *Hyphal* arrangement sub hymenium constituted of loosely to moderately compact generative hyphae. *Trama* composed of moderately compact generative and skeletal hyphae. *Context* formed of moderately compactly arranged, branched generative hyphae and skeletal hyphae. *Basidia* sub-clavate, thin-walled, tetrasterigmate, clamped at the base, 20.3–31×6.3–7.5 µm; *sterigmata* up to 2 µm in length. Basidiospores cylindrical to oblong ellipsoid, hyaline, thin-walled, smooth, 7–12×2.5–4.7 µm, no reaction in Melzer's reagent and cotton blue (Fig. 1 a–f)

Material examined: Jammu and Kashmir, Jammu, Doda, Chinta, on angiospermous wood, Brij Bala 11204 (PUN), September 21, 2015; Kishtwar, Chatroo, on *Cedrus deodara* stump, Brij Bala 11226 (PUN), August 21, 2017.

Notes: *Antrodia heteromorpha* differs in having cylindrical to oblong ellipsoid basidiospores. It is described as new to India. It is distributed mainly in Czech Republic, Norway, Finland, Russia, Italy, France, Spain, Northern Asia and North America (Spirin *et al.* 2013; Mycobank, 2022).

Fomitiporia hartigii (Allesch. & Schnabl) Fiasson & Niemelä, Karstenia 24: 25 (1984).

≡ *Polyporus hartigii* Allesch. & Schnabl, Fungi Bavarici Exsiccati Cent. I: no. 48 (1890).

Basidiome perennial, pileate, sessile, broadly attached, solitary, corky hard when fresh, woody hard and medium in weight after drying; pilei unguulate, up to 12×9×6 cm.; Abhymenial surface tomentose, sulcate, faintly zonate, somewhat cracked, brown when fresh, not changing much on drying; margin concolorous, entire, velvety, obtuse; *Hymenial surface* poroid, brown to rusty brown when fresh, not changing much on drying; margin concolorous, sterile up to 0.2 mm; *Pores* angular to round, 4–6 per mm; dissepiments entire, up to 300 µm in thickness; *Tube layer* light brown, indistinctly stratified, two layered, each layer up to 1.5 cm thick, separated by thin layer of context. *Context* homogenous, brownish orange, up to 3 cm thick; *Hyphal system* dimitic. *Generative hyphae* hyaline, thin-walled, simple-septate, branched, up to 2.8

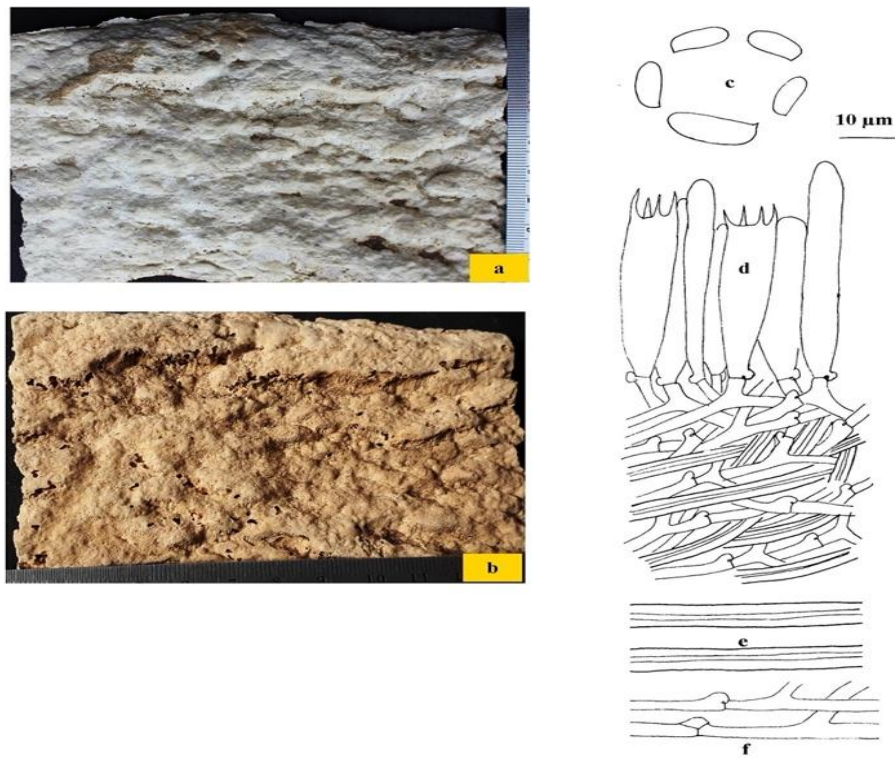


Fig. 1 (a-f). *Antrodia heteromorpha*: a-b. Basidiome showing hymenial surface (fresh and dry); c. Basidiospores; d. Basidia; e. Skeletal hyphae; f. Generative hyphae

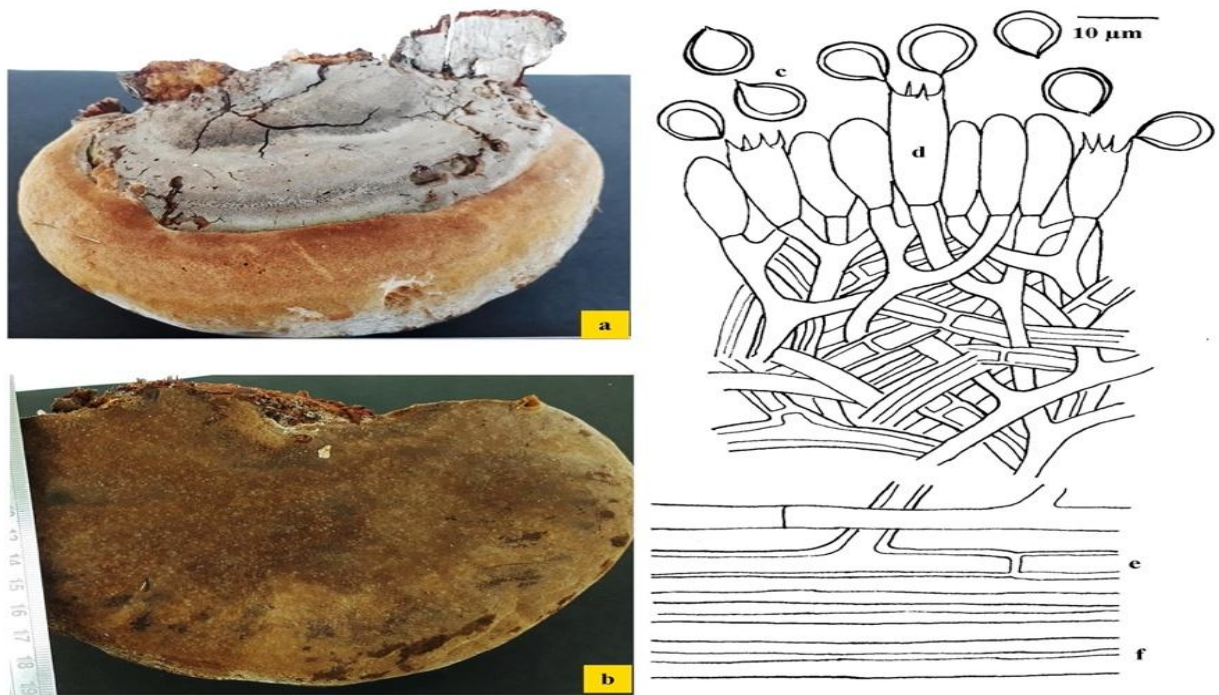


Fig. 2(a-f). *Fomitiporia hartigii*: a-b. Basidiome showing abhymenial and hymenial surface; c. Basidiospores; d. Basidia; e. Generative hyphae; f. Skeletal hyphae

μm in width. *Skeletal hyphae* pale-yellowish, thick-walled, aseptate, unbranched, up to $6.2 \mu\text{m}$ in width; Hyphal arrangement: subhymenium composed of thin-walled, loosely interwoven and irregularly branched generative hyphae. *Trama* consists of both moderately interwoven and irregularly branched generative hyphae and skeletal hyphae. *Context* formed of loosely interwoven skeletal hyphae and occasionally with generative hyphae. *Basidia* subclavate to subcylindrical, thin-walled, simple-septate at the base, tetrasterigmate, $15\text{-}25 \times 5\text{-}7 \mu\text{m}$; *sterigmata* up to $2.5 \mu\text{m}$ in length; *Basidiospores* subglobose to globose, hyaline to subhyaline, thick-walled, smooth, no reaction in Melzer's reagent and cotton blue, $6\text{-}10 \times 5.5\text{-}9.5 \mu\text{m}$ (Fig. 2 a-f).

Material examined: Jammu and Kashmir, Doda, on way from Dugban to Shunushir, on *Abies pindrow* stump, Brij Bala, 11181 (PUN) August 17, 2017.

Notes: It is unique in having perennial basidiome with angular to round pores, indistinctly stratified tube layers, homogenous context and hyaline to subhyaline, subglobose to globose basidiospores. It is a new record for India and is earlier described from Auckland, Arizona, British Columbia, California, Columbia, Indonesia, New Mexico, Western Australia and China (Mycobank, 2022).

Heterobasidion australe Y.C. Dai & Korhonen, *Mycoscience* 50 (5): 353-356 (2009).

Basidiome perennial, pileate, imbricate, sessile, narrowly attached, laterally fused, easy to separate from the substrate, leathery when fresh, corky hard after drying; pilei semicircular, applanate, up to $7.5 \times 4 \times 0.9 \text{ cm}$; Abhymenial surface glabrous, concentrically zonate, wrinkled, reddish brown towards the proximal end and white towards the distal end when fresh, dark brown towards the proximal end and pale yellowish towards distal end on drying; margin white when fresh, changing to pale yellowish on drying, acute, entire, curved inside on drying; *Hymenial surface* poroid, glabrous, white when fresh, changing to pale yellowish on drying; margin concolorous, sterile up to 2 mm ; *Pores* round, 4-5 per mm; dissepiments entire, up to $70 \mu\text{m}$ in thickness; *Tube layer* orange white, stratified, two layered, up to 3 mm deep in each layer; *Context* homogenous, greyish white, up to 3 mm in thickness.; *Hyphal system* dimitic.

Generative hyphae hyaline, thin-walled, simple-septate branched, to $3.5 \mu\text{m}$ in width. *Skeletal hyphae* subhyaline to pale-yellowish, thick-walled, aseptate, dextrinoid, unbranched, up to $6.5 \mu\text{m}$ in width. Hyphal arrangement: subhymenium usually distributed with loosely arranged generative hyphae. *Trama* chiefly composed of loosely to moderately compact generative and skeletal hyphae. *Context* formed of moderately loose to compactly arranged generative and skeletal hyphae. *Basidia* clavate to sub-clavate, thin-walled, tetra sterigmate, simple-septate at the base, $18\text{-}27 \times 5\text{-}9 \mu\text{m}$; sterigmata up to $3.5 \mu\text{m}$ in length; *Basidiospores* broadly ellipsoid to subglobose, hyaline, echinulate, guttulate, spore wall stained in cotton blue, no reaction in Melzer's reagent, $5\text{-}7.8 \times 4.5\text{-}7.5 \mu\text{m}$ (Fig. 3 a-h).

Material examined: Jammu and Kashmir, Doda, Bhandarwah, Nalthi, on *Pinus roxburghii* stump, Brij Bala 11233(PUN), September 28, 2015.

Notes: *Heterobasidion australe* is peculiar in having perennial basidiome, homogenous context with thin crust and smaller broadly ellipsoid to subglobose, echinulate, cyanophilous basidio spores. It is known only from its locality in southern China (Dai and Korhonen, 2009). This is the first report of *H. australe* from India.

Niveoporofomes spraguei (Berk. & M.A. Curtis) B.K. Cui, M.L. Han & Y.C. Dai, *Fungal Diversity* 80: 360 (2016).
= *Polyporus spraguei* Berk. & M.A. Curtis, *Grevillea* 1 (4): 50 (1872).

Basidiome annual, pileate, imbricate, sessile, broadly attached, tough, persistent and woody hard when fresh, not changing much on drying; pilei semicircular, unguulate, up to $11 \times 9 \times 5 \text{ cm}$. Abhymenial surface glabrous, sulcate, rugose, faintly zonate to azonate, crustose, deposited with gelatinous layer, orange when fresh, changing to dark orange to reddish brown after drying; margin concolorous, entire, obtuse, wavy. *Pilear crust* up to 2 mm in thickness, agglutinated, formed of thin-walled generative hyphae, thick-walled binding hyphae and loosely interwoven, unbranched, skeletal hyphae. *Hymenial surface* poroid, white when fresh, changing to pale yellowish on drying; margin concolorous, sterile up to 5 mm . *Pores* round, 3-6 per mm; dissepiments lacerate, up to $250 \mu\text{m}$ in thickness. Tube layer white when fresh, changing

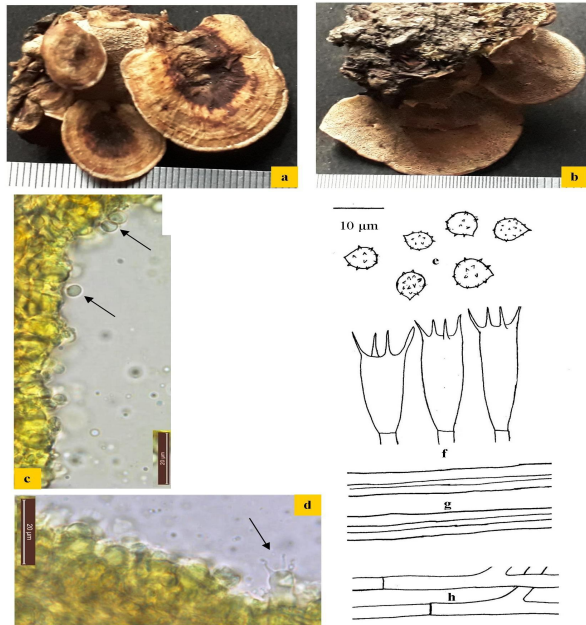


Fig. 3(a-h). *Heterobasidion australe*: a-b. Basidiome showing abhymenial and hymenial surface; c-d. Photo **Figs 7-12.** *Fomitiporia hartigii*: 7-8. Basidiome showing abhymenial and hymenial surface; 9. Basidiospores; 10. Basidia; 11. Generative hyphae; 12. Skeletal hyphae micrograph showing c. basidiospores, d. basidium; e. Basidiospores; f. Basidia; g. Skeletal hyphae; h. Generative hyphae

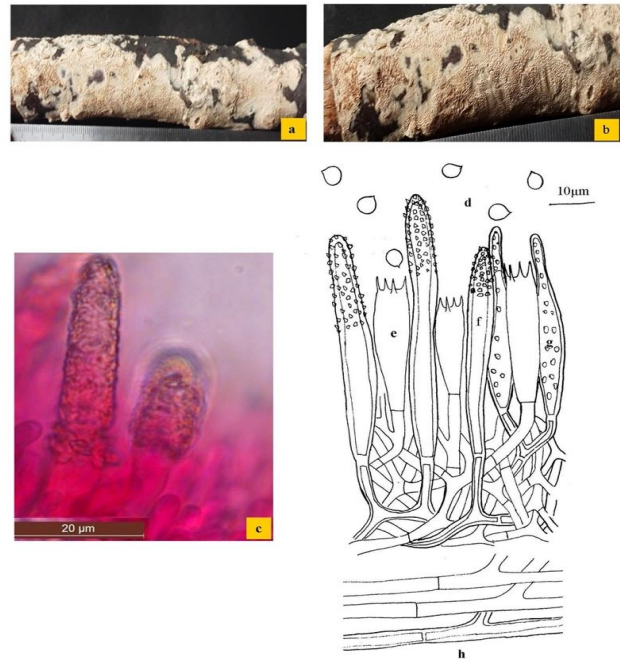


Fig. 5(a-h). *Oxyporus millavensis*: a. Basidiome showing hymenial surface (fresh); b. Basidiome showing hymenial surface (dry); c. Photomicrograph showing cystidia; d. Basidiospores; e. Basidia; f. Cystidia; g. Gloeocystidia; h. Generative hyphae

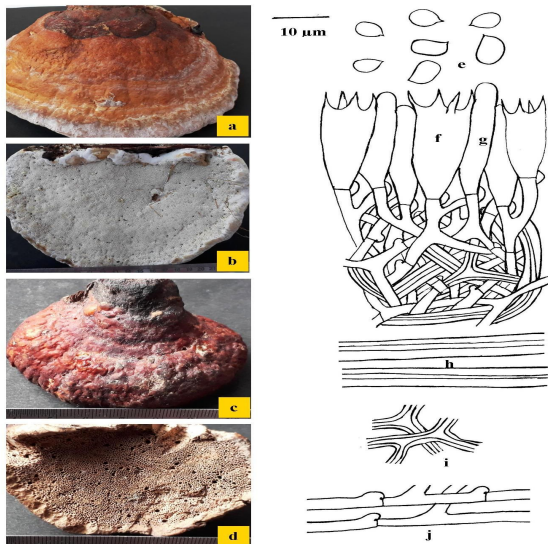


Fig. 4(a-j). *Niveoporofomes spraguei*: a-b. Basidiome showing abhymenial and hymenial surface (fresh); c-d. Basidiome showing abhymenial and hymenial surface (dry); e. Basidiospores; f. Basidia; g. Cystidiolae; h. Skeletal hyphae; i. Binding hyphae; j. Generative hyphae

to pale yellowish on drying, up to 1 cm deep. *Context* homogenous, white when fresh, changing to pale yellowish on drying, azonate, up to 4 cm in thickness. *Hyphal system* trimitic. *Generative hyphae* hyaline, thin-walled, clamped, branched,

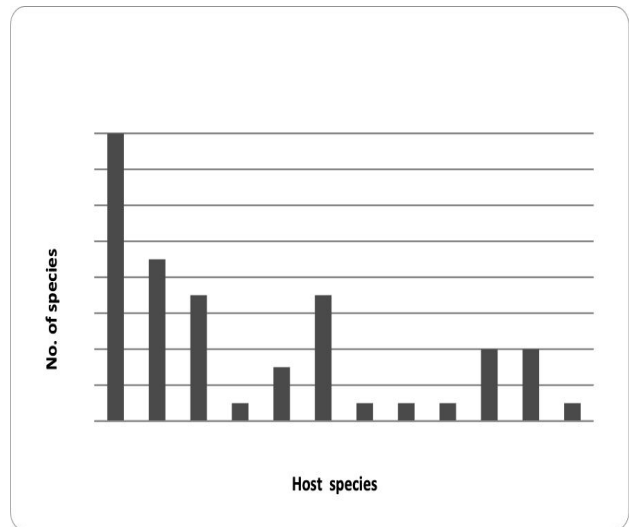


Fig. 6: Host distribution of Polypores species (From Left to right) i. *Cedrus deodara* ii. *Abies* sp. iii. *Pinus excelsa* iv. *Pinus roxburghii* v. unidentified gymnospermous wood vi. *Quercus* sp. vii. *Berberis aristata* viii. *Platanus orientalis* ix. *Pyrus malus* x. unidentified angiospermous wood xi. unknown hosts xii. both angiospermic and gymnospermic host

irregularly oriented, up to 4 µm in width. *Binding hyphae* hyaline to subhyaline, thick-walled, aseptate, branched, up to 5.8 µm in width. *Skeletal hyphae* pale-yellowish, thick-walled, aseptate, unbranched, up to 6.2 µm in width. Hyphal

arrangement: subhymenium constituted of loosely to moderately compact, irregularly oriented generative and binding hyphae. *Trama* usually composed of loosely to moderately compact generative and binding hyphae. *Context* chiefly formed of compactly arranged, generative hyphae and skeletal hyphae. *Cystidioles* fusoid, thin-walled, smooth, clamped at the base, originates in the hymenium, $19.7\text{-}23.7 \times 3.4\text{-}4 \mu\text{m}$; almost enclosed in the hymenium. *Basidia* sub-clavate, thin-walled, tetrasterigmate, clamped at the base, $17.5\text{-}24.5 \times 7\text{-}10 \mu\text{m}$; sterigmata up to 3.5 in length. *Basidiospores* ovoid to broadly ellipsoid, thin-walled, smooth, no reaction in Melzer's reagent and cotton blue, $3\text{-}7.5 \times 3\text{-}4.5 \mu\text{m}$ (Fig. 4 a-j).

Material examined: Jammu and Kashmir, Udhampur, Sanasar, on *Abies pindrow*, Brij Bala 11352 (PUN), September 14, 2016; Doda, Bhaderwah, jai on *A. pindrow*, Brij Bala (PUN) 11216, August 18, 2017; Kishtwar, Paddar, on *A. pindrow*, Brij Bala 11356 (PUN), August 21, 2017.

Notes: *N. spraguei* is a new record of polyporoid fungi for India. It is distinguished in having annual basidiocarp which is usually persistent and tough, trimitic hyphal system, fusoid cystidioles and ovoid to broadly ellipsoid basidiospores. It is distributed mainly in Europe and America (Ryvarden and Melo, 2014 ; Mycobank, 2022).

Oxyporus millavensis (Bourdot & Galzin) Ryvarden & Melo, Poroid Fungi of Europe: 293, 2014
 ≡ *Poria mucida* ssp. *millavensis* Bourdot and Galzin, Bull. Soc. Mycol. Fr.40, 238, 1925.

Basidiome annual, resupinate, adnate, effused, soft when fresh, becomes coriaceous after drying, easily separable from the substrate; up to 2 mm thick in cross-section. *Hymenial surface* poroid, white when fresh, changing to pale yellowish on drying; margin concolorous, adnate, entire, sterile up to 2 mm. *Pores* angular, 2-3 per mm; dissepiments entire, up to 50 μm in thickness. *Tube layer* pale yellowish, up to 1 mm deep. *Subiculum* homogenous, orange white, up to mm 1 thick. *Hyphal system* monomitic. *Generative hyphae* hyaline to pale yellowish, thin- to thick-walled, simple-septate, branched, up to 4 μm in width. *Hyphal arrangement:* subhymenium and trama formed of moderately compact, frequently branched generative hyphae. *Subiculum*

composed of moderately to compactly arranged generative hyphae. *Cystidia* clavate, thick-walled, simple-septate at the base, apically encrusted, originate in the subhymenium, $58\text{-}87 \times 5\text{-}9.5 \mu\text{m}$; projecting up to 12 μm from the hymenium. *Gloeocystidia* clavate, thick-walled, pale-yellowish, simple-septate, originate in the subhymenium, $60\text{-}87 \times 5\text{-}6 \mu\text{m}$; projecting up to 35 μm from the hymenium, contents stained in sulphovanillin. *Basidia* sub-clavate, thin-walled, simple-septate at the base, tetrasterigmate, $16\text{-}33.5 \times 5\text{-}8$; *sterigmata* up to 2 μm in length. *Basidiospores* subglobose, hyaline, thin-walled, smooth, no reaction in Melzer's reagent and cotton blue, $4.5\text{-}6 \times 4\text{-}5 \mu\text{m}$ (Fig. 5 a-h)

Material examined: Jammu and Kashmir, Jammu, Doda, Bhaderwah, Attalgarh, on *Pyrus malus* branch, Brij Bala 11314 (PUN), September 27, 2014.

Notes: *Oxyporus millavensis* differs from *Oxyporus latemarginatus* in having gloeocystidia and subglobose basidiospores. It is a new report for India. The earlier reports of *O. millavensis* are from Czech Republic, France, Estonia, Norway, Russia and Turkmenistan (Ryvarden and Melo, 2014).

The diversity in climatic parameters, topography and altitude range of forests of Union Territory of Jammu and Kashmir attracted the mycological taxonomists from different parts of India. As a result, the earlier workers (Bala *et al.*, 2020 and Bala, 2022) recorded the 49 species of polypores from the Union Territory of Jammu and Kashmir. Presently, 5 new records for India are reported and thus, increasing the number of polypore species in Union Territory of Jammu and Kashmir from 49 to 54. These 54 species are classified under 23 genera, 9 families and 4 orders. It is pertinent to mention that genus *Niveoporo fomes* is recorded first time from India.

Polypore species are mainly saprobic and a very few are parasitic in their nutrition. These fungi absorb the nutrients from the wood by degrading the lignin, cellulose and hemicelluloses. Thus, they contribute a significant role in recycling of nutrients. Polypores grows both in association with angiospermous as well as gymnospermous host. Of these, 54 species described and illustrated from the study area, 36 species have been found growing in association with gymnospermous host [*Cedrus deodara* (16), *Abies sp.* (9), *Pinus excelsa* (7), *Pinus roxburghii* (1) and unidentified

gymnospermous wood (3)], 14 species have been found growing in association with angiospermous host [*Quercus sp.* (7), *Berberis aristata* (1), *Platanus orientalis* (1), *Pyrus malus* (1) and unidentified angiospermous wood (4)] and the remaining 4 species have been found with unknown stumps and one species have been found both on angiospermic as well as gymnospermic host (Fig. 6).

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