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Cover: Dorsal view of Mantis Shrimp *Cloridina ichneumon* (Fabricius, 1798) & *Gonodactylus demanii* (Henderson, 1893). © Fisheries Research Station, Junagadh Agricultural University, Sikka.



Genus *Gymnopilus* (Agaricales: Strophariaceae): additions to the agarics of India

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Abstract: The present study deals with the diversity of the genus *Gymnopilus* collected from Kashmir Himalaya. Frequent fungal forage were undertaken during spring, summer, and autumn seasons as a result of which a systematic account of various taxa of the genus *Gymnopilus* was compiled. In the present paper six species of the genus are taxonomically described and identified as *G. decipiens*, *G. aeruginosus*, *G. fuscusquamulosus*, *G. crocias*, *G. junonius*, and *G. liquiritiae*. Out of all described species *G. decipiens* is reported for the first time from India while the other four are reported for the first time from northern India. In addition, only *G. aeruginosus* is reported for the first time from Bangiward, southern Kashmir. Detailed morpho-anatomical characters of these species with habitat photographs, line drawings of macro and microscopic features are given. An identification key to the described species are also given.

Keywords: Clamp connections, Cystidia, Dextrinoid basidiospores, habitat, Kashmir Himalaya, line drawings, macrofungi.

Editor: Anonymity requested.

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Author contributions: MK—developed the research idea and also helped in identification of the agaric species. NAW—led the manuscript writing with inputs from MK and NAM. All the authors approved final draft of the manuscript for submission.

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INTRODUCTION

Jammu & Kashmir has different climate varying from tropical deciduous forests to temperate and coniferous forests which provide compatible habitat for the growth of macrofungal species. The macrofungal richness of the union territory is directly related to its diverse weather patterns and expansive forest communities. The genus *Gymnopilus* P. Karst under the order Agaricales includes interesting and important saprotrophic, usually lignicolous inhabiting fungi occurring all over the world (Holec 2005). The important characters of the genus are the bright coloured yellow, ferruginous, or purple fruiting bodies, adnexed to decurrent lamellae, along with cortinoid to membranaceous veil and a rusty-brown spore print. Microscopically, the genus is identified by the rough basidiospores having a verrucose to rugulose ornamentation lacking a germ pore or plage and mostly dextrinoid wall, gill edges are sterile with cheilocystidia, which are more or less ventricose below and possess subcapitate to capitate apex and clamp connections present on almost all kinds of hyphae (Kühner 1980; Singer 1986). The size and shape of the basidiospores and cystidia are considered important characters for differentiation among the species (Rees et al. 2004).

Gymnopilus was considered a member of Cortinariaceae by Hesler (1969) & Singer (1986) and under Strophariaceae by Kühner (1984) & Guzmán-Dávalos et al. (2003). Presently, this genus is placed under the family Strophariaceae purely on the basis of non-ectomycorrhizal associations. According to (Høiland 1990) this genus may be linked to a hypothetical primitive, saprophytic ancestor of both Cortinariaceae and Strophariaceae. In this line the first family developed the ectomycorrhizal mode of life while the second maintained the saprophytic mode. According to the review, globally *Gymnopilus* is represented by 200 species (Kirk et al. 2008) while MycoBank (<https://www.mycobank.org/>) documents 289 legitimate species. In India, 30 species of the genus were recorded (Berkeley 1851; Sathe & Rahalkar 1975; Manjula 1983; Natrajan & Raman 1983; Dhancholia et al. 1991; Chadha & Sharma 1995; Natarajan et al. 2005; Farook et al. 2013; Kaur et al. 2015; Upadhyay et al. 2017).

MATERIALS & METHODS

Study Area

Jammu & Kashmir is the second largest union territory of India, located in the extreme north of the country. The

area is geographically divided into two regions namely Kashmir valley and Jammu region. The Kashmir valley lies between the coordinates 34.166N & 74.500E, is situated between Pir Panjal range & Zaskar range; and has a total area of 15,948 km² (Qazi 2005). Northern and southern Kashmir, presently selected as the areas of investigation harbour a rich floristic diversity. Due to the varied climatic and topographic conditions, the area is considered a hot spot of fungal diversity.

Morpho-anatomical observations

Collections of agarics were made on routine mycological field visits to the forests of northern and southern Kashmir. Basidiomes were collected with care using a sharp knife, waste newspapers, hand lens, camera, paper & pen, field notes regarding locality, GPS position, altitude, date of collection, collection number, habit, habitat, substrate, and their association with the surrounding forest vegetation. The basidiomes collected for the purpose of taxonomic studies were fresh and healthy and wherever possible in the field, the whole range of developmental stages were collected. The collected species were taken to the laboratory for further analysis such as microscopic observations, drying, and packing. The study also examines the data with respect to the seasonal availability, habit, habitat, edibility status and the range of distribution of studied taxa as described in Table 1.

The morphological characters and chemical tests were carried out in the field as well as in the laboratory as per the standard protocol given by Atri et al. (2005, 2017), further the colour names and codes were followed as given by Kornerup & Wanscher (1978).

Macro-morphological characters were observed from fresh specimens considering all the available basidiomes. A small portion of the cap, stipe and volva were preserved in liquid preservative (25% rectified alcohol + 5 % formalin + 70 % distilled H₂O (Hawksworth et al. 1983). The microscopic details were studied by cutting free hand sections of the revived parts (revived with KOH) of the dried specimen and staining them either in cotton blue or Congo red and the internal details of the pileus cuticle, stipe cuticle, hymenophore trama and various cystidial elements were observed. The basidiospores were studied from the spore print as well as from the crush mounts of the lamellae and their reaction with Melzer's reagent were checked. The basidiospore quotient (Q) was calculated by ratio of mean length divided by mean breadth of 30 as per Singer (1986). Properly dried and preserved specimens of the described species were deposited in the

Table 1. The data of described species regarding localities, seasonal availability, habitat, edibility status, and the allotted herbarium numbers.

Name of the species	Locality of the species along with altitude	Date, Month & Year of collection	Growing habit	Habitat	Edibility	Herbarium numbers
<i>G. decipiens</i>	PanzullaTakya (1,807 m)	17 May 2013	Groups	Growing on soil around burnt stalk of <i>Pinus</i>	Poisonous	PUN 9290
<i>G. aeruginosus</i>	Bangiward (2,700m)	19 August 2015	Solitary	Growing on wood of <i>Cedrus deodara</i>	Hallucinogenic	PUN 9068
<i>G. liquiritiae</i>	Pahalgam (2,650m)	5 August 2014	Caespitose	Growing on burnt and rotten wood of <i>Cedrus deodara</i>	Unknown	PUN 9070
<i>G. junonius</i>	Naugam (2,100 m)	22 June 2015	Groups	Growing on burnt wood of <i>Pinus</i>	Inedible	PUN 9292
<i>G. fuscusquamulosus</i>	Naugam (2,125 m) Bangiward (2,700m)	06 August 2014 20 August 2015	Caespitose	Growing on dead wood stump of <i>Cedrus deodara</i> and on dry peat moss of <i>Pinus wallichiana</i>	Poisonous	PUN 9291 9069
<i>G. crocias</i>	Dazna Rafiabab (2,215 m)	08 August 2014	Caespitose	Growing on humicolous soil around the scattered needles of <i>Pinus</i>	Unknown	PUN 9289

Key to the investigated species of the genus *Gymnopilus*

- 1 Cuticle half peeling; Stipe annulate with rhizomorphs usually present at the base of the stipe *G. decipiens*
- Cuticle fully peeling; Stipe exannulate without any rhizomorphs present at the base of the stipe 2
- 2 Cap with a bluish tinge; Pileal veil appendiculate *G. aeruginosus*
- Cap without any bluish tinge; Pileal veil absent 3
- 3 Gill edges sterile; Caulocystidia present *G. liquiritiae*
- Gill edges heteromorphous; Caulocystidia absent..... 4
- 4 Gill edges serrate; Cap with areolate cracking exposing the flesh below *G. junonius*
- Gill edges smooth; Cap without areolate cracking 5
- 5 Basidiome growing on dead wood stump of *Cedrus deodara*; Flesh changing; Taste acrid *G. fuscusquamulosus*
- Basidiome growing on humicolous soil; Flesh unchanging; Taste mild *G. crocias*

Herbarium, Department of Botany, Punjabi University, Patiala (Punjab) India, under the Accession No. PUN as given in Table 1.

RESULTS

The taxonomic descriptions of six species of genus *Gymnopilus*—*decipiens*, *aeruginosus*, *liquiritiae*, *junonius*, *fuscusquamulosus*, and *crocias*—are provided as per the sequence of segregation in the identification key given below.

TAXONOMIC STUDY

Gymnopilus decipiens (Sacc.) P.D. Orton, *Transactions of the British Mycological Society* 43(2): 176 (1960). (Image 1–4)

[Mycobank No. 331590; Legitimate]

Basidiome up to 4.0 cm in height, pileus up to 3.6 cm broad, convex to applanate with uplifted margin; umbo absent; margin irregular, splitting at maturity,

non-striate; surface pale orange (5A3); moist; scaly, scales squamulose, light orange (5A4) to brownish-orange (5C6), cover the entire pileus, more concentrated towards the centre; cuticle half peeling; context up to 0.4 cm thick, creamy white, unchanging; odour mild. Pileal veil absent. Lamellae free to adnexed, distant, unequal, not in series; moderately broad (up to 0.3 cm); pale orange (5A3) to greyish orange (5B5), unchanging; gill edges serrate, white; lamellulae present. Stipe central, up to 4.0 cm long, up to 0.3 cm broad above, 0.2 cm broad at middle and up to 0.4 cm broad at the base, unequal in diameter with a slightly bulbous base; surface creamy white, light yellow (4A4) towards apex, light orange (5A4) in the middle, orange (5B8) to brownish-yellow (5C8) towards base, unchanging; scaly, scales appressed fibrillose, brownish-yellow (5C7); hollow; rhizomorphs present at the base of the stipe; annulate, annulus scaly, attached, evanescent. Spore print brownish-orange (7C4).

Basidiospores 7.47–9.13 x 4.15–5.81µm, Q = 1.8, ellipsoidal, dextrinoid, ornamented, outer wall thick,

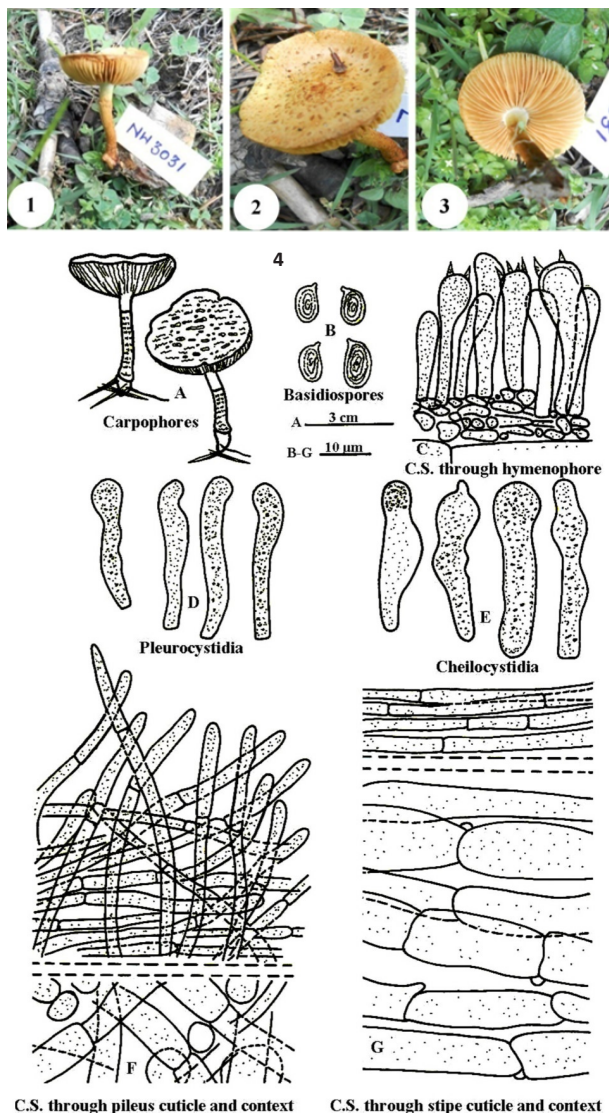


Image 1–4. *G. decipiens* (Sacc.) P.D. Orton: 1—Basidiome growing solitary in their natural habitat and the rhizomorphs are clearly visible at the base of the stipe | 2—Cap surface covered with light orange to brownish-orange squamulose scales | 3—Under view of cap showing distinct, free to adnexed lamellae | 4—Camera lucida drawings (A–G).

rough, thickly granular; apiculate, apiculus 0.83–1.66 μm long, excentric. Basidia 25.0–34.86 $\times$ 5.0–6.64 μm , claviform, granular; bisterigmate to tetrasterigmate, sterigmata 2.5–4.15 μm long, granular. Pleurocystidia 20.0–36.52 $\times$ 4.15–6.64 μm , cylindric to capitate, densely granular. Cheilocystidia 21.58–39.84 $\times$ 6.64–10.0 μm , claviform, capitate, lageniform to lecythiform, densely granular; gill edges heteromorphous. Hymenophoral trama regular. Pileipellis hyphal, ixocutis, made up of 1.66–5.0 μm broad, horizontally tangled septate, hyphae giving rise to scattered turf of 2.5–4.15 μm broad, septate, granular, projecting hyphae; pilocystidia absent;

context made up of 6.64–9.13 μm broad, granular, septate, hyphae intermingled with 5.81–13.28 μm broad, granular, cellular elements. Stipe cuticle hyphal, made up of longitudinally arranged, 4.15–5.0 μm broad, septate, hyphae; context hyphal, made up of, 8.3–12.45 μm broad, septate, hyphae. Clamp connections present throughout the context.

Collection examined: Jammu & Kashmir, Baramulla, Panzulla Takya (1,807 m) 34.486N & 74.350E, growing in groups on soil around burnt stalk of *Pinus*, in mixed coniferous forest, Naseema Aqbar Wani, PUN 9290, 17 May 2013.

Edibility: O'Reilly (2016) listed it as a poisonous mushroom.

Distribution and Ecology: *Gymnopilus decipiens* was found growing solitary or in small groups on burnt soil and on burnt pine stumps from England by Orton (1960). Høiland (1990) reported this species growing on burnt dry sandy soil in open pine forest in the month of July from Norway. Holec (2005) reported this species from European countries and Czech Republic. This species was also found growing on hardwood stumps, burnt wood, and forest fire sites in the months of June to November from Britain, England, Scandinavia, France, and Italy by O'Reilly (2016). The present collection has been found growing in groups on soil around burnt stalk of *Pinus*, in mixed coniferous forests in the month of May from Jammu & Kashmir.

Remarks: The morphology and microscopic details of the above examined collection are in full conformity with the details given for *Gymnopilus decipiens* (Sacc.) P.D. Orton, by Orton (1960) and Høiland (1990). But in the recent work collection the encrustations and pigmentation pattern are lacking in the projecting hyphae of the turf of pileus cuticle which should be present as per Orton (1960). The species is recorded for the first time from India.

***Gymnopilus aeruginosus* (Peck) Singer, Lilloa 22: 560, 1951. (Images 5–7)**

[Mycobank No. 298026; Legitimate]

Basidiome up to 7.0 cm in height. Pileus up to 8.0 cm broad, convex; umbonate, umbo acute with a bluish tinge; surface light yellow (4A4), orange or deep orange (6B6) near margin with reddish tinge; scaly, scales, appressed fibrillose, deep orange (6A6); margin, involute, not splitting at maturity; dry; cuticle fully peeling; context up to 0.2 cm thick, brown, unchanging; taste bitter observed from dry specimen, odor mild. Pileal veil appendiculate, dry. Lamellae up to 0.5 cm broad, adnate to adnexed, close, unequal, non furcate,

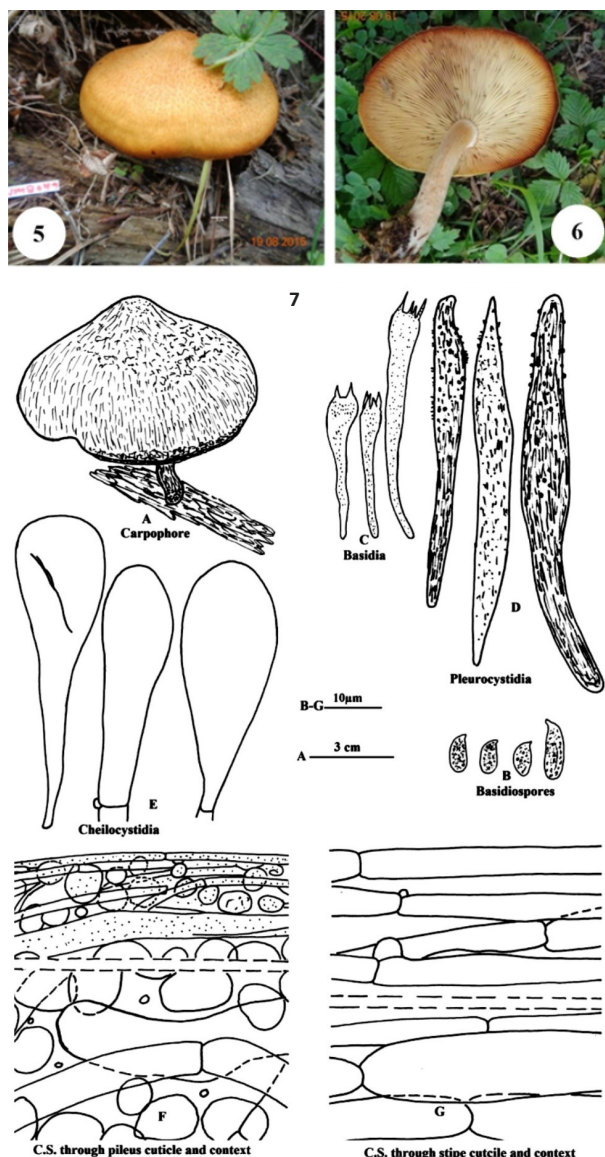


Image 5–7. *G. aeruginosus* (Peck) Singer: 5—Basidiome in solitary habit with acute umbo with light yellow, orange to deep orange surface and reddish tinge near margin | 6—Under view of Basidiome with dentate lamellae edges and excentric stipe | 7—Camera Lucida drawings (A–G).

creamy white, changing to deep orange or dark brown (7F8); lamellulae present. Gill edges dentate. Stipe excentric, up to 6.5 cm long, up to 0.6 cm broad, equal in diameter; surface off white with orange (5A6) shade; scaly, scales fibrillose, floccose near apex; changing to yellow on handling; white mycelium present at base; first solid then hollow; exannulate. Spore print greyish orange (6B3).

Basidiospores $6.4\text{--}9.6 \times 3.2\text{--}4.0 \mu\text{m}$; $Q = 1.7$, ellipsoidal to oblong, single thick walled, ornamented, ornamentation very fine, punctuate, granular; amyloid;

apiculate, apiculus up to $0.8 \mu\text{m}$ long. Basidia $24.0\text{--}40.0 \times 2.4\text{--}4.8 \mu\text{m}$, clavate, narrow, granular, tetrasterigmate, sometimes bi-sterigmate; sterigmata $1.6\text{--}3.3 \mu\text{m}$ long, granular, apices pointed. Pleurocystidia $80.0\text{--}118.4 \times 5.6\text{--}6.4 \mu\text{m}$, clavate, ventricose with beaked, pointed to rounded tips, thickly granular, encrusted, filled with yellow shiny content, protruding beyond the basidia, deeply seated. Cheilocystidia $48.0\text{--}72.0 \times 14.4\text{--}24.0 \mu\text{m}$, broadly clavate, hyaline, rarely clamped at the base, abundant. Hymenophoral trama regular. Gill edge sterile. Pileus cuticle hyphal, ixocutis, made up of $2.0\text{--}3.32 \mu\text{m}$ broad, narrow, septate, granular hyphae; context hyphal, made up of $2.0\text{--}10.52 \mu\text{m}$ broad, septate, irregularly placed, hyaline, hyphae, intermixed with clavate to globose sphaerocysts. Stipe cuticle hyphal, made up of $3.2\text{--}9.6 \mu\text{m}$ broad, longitudinally placed, hyaline, septate, clamped hyphae; caulocystidia absent; context hyphal, made up of $8.0\text{--}13.6 \mu\text{m}$ broad, longitudinally placed, hyaline, inflated hyphae.

Collection examined: Jammu and Kashmir, Bangiward (2,700m), 33.670N & 75.074E , growing solitary on wood of *Cedrus deodara* in coniferous forest, Nazir Ahmad Malik, PUN 9068, 19 August 2015.

Edibility: *Gymnopilus aeruginosus* is a hallucinogenic species (Arora 1986).

Distribution and Ecology: Arora (1986) found *Gymnopilus aeruginosus* growing gregarious in caespitose habit on logs, stumps, woodchip or sawdust on hardwood and conifers during spring and winter in the Pacific Northwest. Sharma et al. (2019) has reported this species from the plains of Jammu. In the present study *G. aeruginosus* has been found growing solitary on stumps of *Cedrus deodara* in coniferous forest.

Remarks: The macroscopic and microscopic observation of present collection matches and fits well the description provided for *Gymnopilus aeruginosus* (Peck) Singer by Arora (1986) and Barnhart (1994). The present PUN 9068 falls under the section *Gymnopilus* of subgenus *Gymnopilus* (Hesler 1969) and is characterized by acute umbo with bluish tinge, broadly convex cap with orange or deep orange (6B6), involute margin, deep orange (6A6) appressed fibrillose scales, bitter taste observed from dry specimen, pleurocystidia are shiny encrusted, cheilocystidia are rarely clamped at the base and pileus context is intermixed with clavate to globose sphaerocysts. However, the microscopic observations both from dry as well as wet specimen does not reveal the presence of caulocystidia on the stipe as described by Barnhart (1994) for this species. *Gymnopilus aeruginosus* has been recorded from India (Gogoi & Parkash 2015) while Sharma et al. (2019)

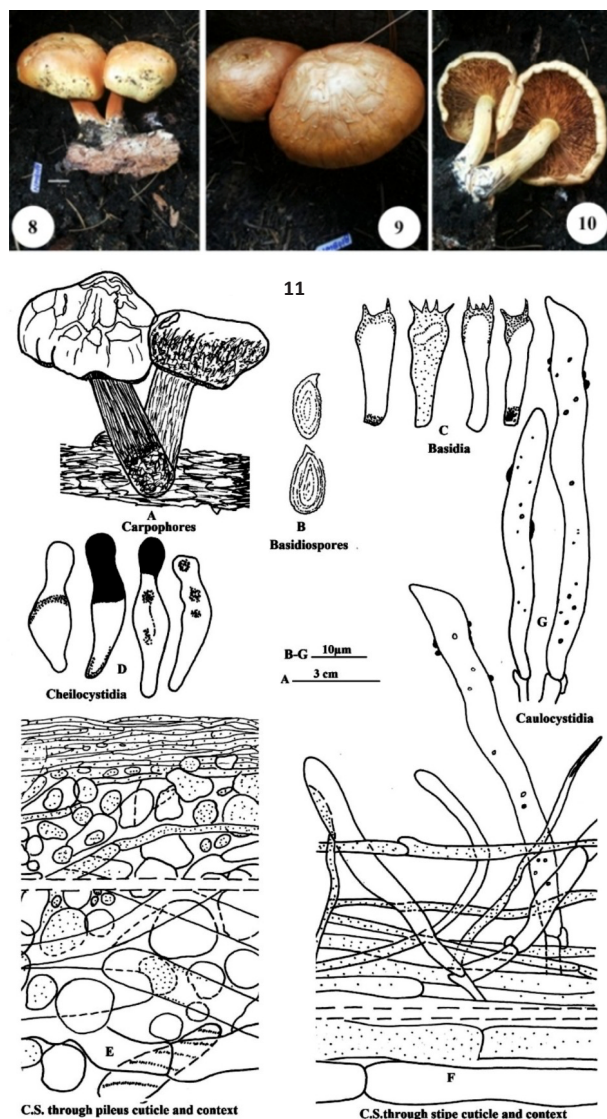


Image 8–11. *G. liquiritiae* (Pers.) P. Karst.: 8—Basidiomata caespitose on burnt and rotten wood of *Cedrus deodara* with rusty brown powdery mass both on cap and stipe surface | 9—Cap surface bearing squamose scales | 10—Underview of cap showing involute margin and dentate, wavy lamellae edges | 11—Camera lucida drawings (A–G).

reported this species from the Jammu plains. Presently this species is reported for the first time from the Kashmir Himalaya.

Gymnopilus liquiritiae (Pers.) P. Karst., *Bidr. Finl. Nat. Folk* 32: 400, 1879. [MycoBank No. 415197; Legitimate] (Images 8–11)

Basidiomata 6.5–8.0 cm in height. Pileus 4.0–6.5 cm broad, hemispherical when young, obtuse convex at maturity; surface orange (5A6), light yellow (4A9) near margin with light rusty tinge; scaly, scales appressed

fibrillose, squamose, reddish-brown (8D8), rusty brown powdered depositions present; cracked; margin regular, involute at maturity; dry; glabrous; cuticle fully peeling; context up to 0.8 cm thick, brown, unchanging; odor mild, taste bitter. Pileal veil absent. Lamellae up to 0.8 cm broad, adnexed, crowded, unequal, brownish orange (7C6), yellowish shade near stipe, lamellulae present. Gill edges dentate, wavy. Stipe central, 5.0–7.0 cm long, up to 1.5 cm broad, equal in diameter; surface orange (5A6) with light orange (5A₄) tinge, stains after handling; rusty brown powdery mass covering the entire stipe; white mycelium with yellow tinge present at base; solid; exannulate.

Basidiospores $8.8\text{--}11.2 \times 4.8\text{--}6.4 \mu\text{m}$; $Q = 1.7$, ellipsoidal to amygdaliform, thick double walled, rough, ornamented, verrucose; amyloid; apiculate, apiculus $0.8 \mu\text{m}$ long. Basidia $18.26\text{--}23.24 \times 5.0\text{--}8.3 \mu\text{m}$, clavate to subcylindrical, granular, bi to tetrasterigmate; sterigmata $1.66\text{--}3.32 \mu\text{m}$ long, granular, apices pointed. Pleurocystidia absent. Cheilocystidia $16.6\text{--}25.0 \times 5.0\text{--}8.3 \mu\text{m}$, lecythiform, capitate, rarely granular, abundant. Hymenophoral trama regular. Gill edge sterile. Pileus cuticle hyphal, ixocutis made up of $1.66\text{--}2.5 \mu\text{m}$ broad, narrow, compact hyphae, consisting yellowish content; context hyphal, made up of $5.0\text{--}11.62 \mu\text{m}$ broad, septate, irregularly placed, hyaline, gelatinized, hyphae, intermixed with clavate, inflated cells. Stipe cuticle hyphal, ixocutis, made up of $1.66\text{--}2.49 \mu\text{m}$ broad, longitudinally placed hyphae, giving rise to irregular turf of hyaline to granular filled with yellowish black content, clamped hyphae caulocystidia; caulocystidia $72.0\text{--}96.0 \times 6.4\text{--}8.0 \mu\text{m}$ broad, elongated, granular, encrusted, clamped at the base, rare; context hyphal made up of $5.0\text{--}11.62 \mu\text{m}$ broad, longitudinally placed hyphae with inflated to beaked hyphal ends, hyaline to granular hyphae.

Collection examined: Jammu & Kashmir, Pahalgam (2,650 m), 34.076N & 75.425E, growing in caespitose habit on burnt and rotten wood of *Cedrus deodara* in pure *Cedrus* forest, Nazir Ahmad Malik, PUN 9070, 5 August 2014.

Edibility: Unknown.

Distribution and Ecology: *Gymnopilus liquiritiae* is a widely distributed species growing in caespitose habit on wood of conifer. Guzman-Davalos & Guzman (1991) have found this species growing in cespitose habit on dead wood of *Pinus* and *Quercus* in the forests of Mexico. Natarajan & Raman (1983) found this species on living or dead wood in South India. The present Indian collection has been found growing in caespitose habit on burnt and rotten wood of *Cedrus deodara* in pure *Cedrus*

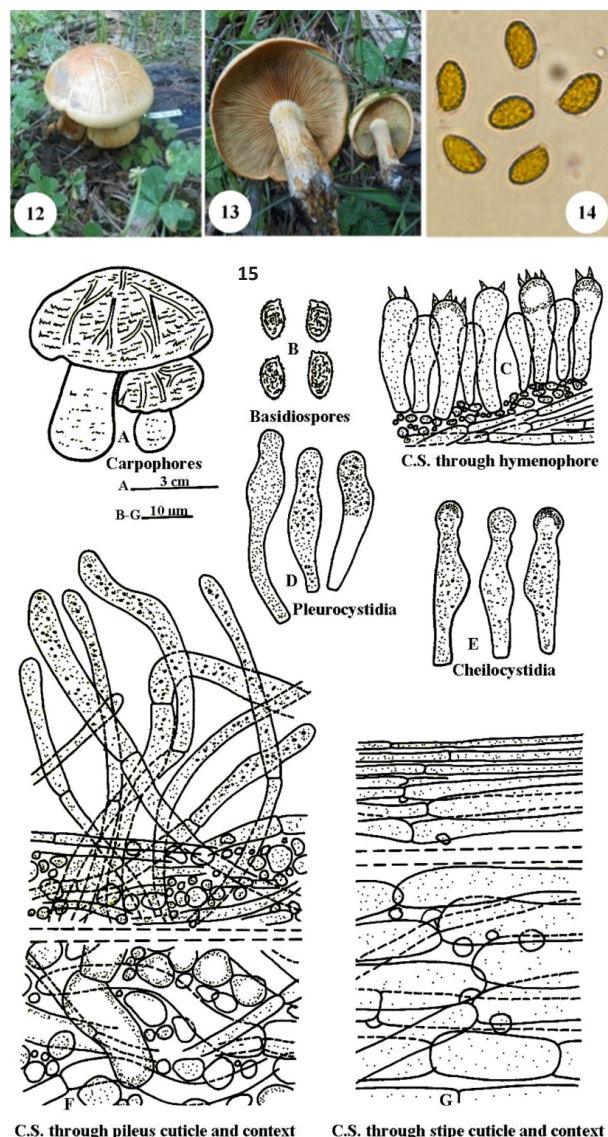


Image 12–15. *G. junonius*(Fr.) P.D. Orton: 12—Basidiomata growing in groups on burnt wood of *Pinus* and the cap surface with prominent areolate cracking | 13—Underview of cap showing pale orange to brownish orange lamellae with serrate edges | 14—Microphotograph of verrucose, dextrinoid basidiospores | 15—Camera lucida drawings (A–G).

forests during August at an altitude of 2,650 m.

Remarks: The present collection due to the absence of annular ring on the stipe falls under the section *Gymnopilus*, further on the basis of morphological and internal details it matches well with *G. liquiritiae* (Pers.) P. Karst. as described by Arora (1986), Natarajan & Raman (1983) and Barnhart (1994). This PUN 9070 is characterized by reddish-brown (8D8) scales on hemispherical to convex cap, bitter taste, pileus surface consists clavate, inflated cells and presence of elongated caulocystidia with clamps at base on stipe.

This collection was compared with an allied species viz. *G. penetrans* (Fr.) Murrill and *G. flavidellus* Murrill which has a whitish veil that makes it differ from the present collection. Present PUN 9070 grows on burnt and rotten wood but *G. sapineus* (Fr.: Fr.) Maire does not grow on burnt wood or debris, hence makes it differ from the present collection. Holec (2005) reported similar species from the Czech Republic and described as a *G. picreus* (Pers.: Fr.) P. Karst but Bon & Roux (2002) described similar species as *G. liquiritiae*. *G. liquiritiae* is first time reported from northern India.

***Gymnopilus junonius* (Fr.) P.D. Orton,** *Transactions of the British Mycological Society* 43(2): 176 (1960). (Images 12–15) [Mycobank No. 331593; Legitimate]

Basidiomata 3.2–7.0 cm in height. Pileus 3.0–6.2 cm broad, convex, with inrolled margin; umbonate, umbo broad; margin irregular, splitting at maturity, non striate; surface greyish-orange (5B5) at centre, light orange (5A4) towards margin; moist; areolate cracking, flesh exposed beneath the cracks; glabrous; scaly, scales appressed fibrillose especially when young, cuticle half peeling; context up to 0.4 cm thick, creamy white to pale yellow (3A3), unchanging; odor mild. Pileal veil absent. Lamellae adnate to decurrent, subdistant, unequal, not in series; moderately broad (up to 0.6 cm); pale orange (5A3) to brownish-orange (6C4), unchanging; gill edges serrate, floccose white, gills forming striations on the stipe apex; lamellulae present. Stipe central to eccentric, 2.4–5.5 cm long, up to 1.6 cm broad above, up to 2 cm broad at the base, short stout, equal in diameter throughout with a bulbous base; surface pale orange (5A3) towards apex, brownish orange (5C6) towards base; solid; scaly, scales fibrillose; white mycelial mat present at the base of the stipe; annulate, annulus patchy, evanescent in mature basidiomata.

Basidiospores 7.47–9.13 × 4.98–5.81 µm, Q = 1.5, ellipsoid, dextrinoid, ornamented, warts low, rough, thick; apiculate, apiculus up to 0.83 µm long. Basidia 20.0–28.22 × 5.81–7.5 µm, clavate, granular; bisterigmate to tetrasterigmate; sterigmata 2.5–4.2 µm long, granular. Pleurocystidia 25.0–40.0 × 5.8–7.5 µm, clavate to lecythiform with rounded capitate apex, densely granular, non encrusted. Cheilocystidia 30.0–36.5 × 6.64–7.5 µm, lecythiform with rounded capitate apex, densely granular, non encrusted; gill edges heteromorphous. Hymenophoral trama regular. Pileus cuticle hyphal, ixocutis, made up of 1.66–4.15 µm broad, horizontally tangled hyphae giving rise to a scattered turf of 3.32–6.64 µm broad, septate, thickly granular, projecting hyphae; pilocystidia absent; context

made up of 2.5–10.0 μm broad, granular, septate, hyphae intermingled with 3.32–11.62 μm broad, granular, cellular elements. Stipe cuticle hyphal, made up of longitudinally arranged, 2.5–4.15 μm broad, septate hyphae; context hyphal, made up of, 5.0–13.3 μm broad, septate, hyphae. Clamp connections present throughout.

Collection examined: Jammu & Kashmir, Kupwara, Naugam (2,100 m), 34.424N & 74.450E, growing in groups on burnt wood of *Pinus*, in mixed coniferous forest, Naseema Aqbar Wani, PUN 9292, 22 June 2015.

Edibility: Due to its very bitter taste it is recommended as inedible by Orton (1960).

Distribution and Ecology: Orton (1960) reported *Gymnopilus junonius* growing solitary to caespitose on deciduous trees, coniferous stumps or on ground mostly attached to buried wood from Great Britain and Ireland. Orton (1960) reported it growing in clusters on logs and stumps of hardwoods and conifers during early to midwinter from Great Britain. Arora (1986) found this growing usually in clusters but occasionally solitary on old pine stumps and trees on *Eucalyptus* during early spring and fall, winter, and favors conifers from North America. Phillips (2001–2016) found this species growing on stumps or logs of deciduous trees during late summer to early winter from America and Europe. This species has also been reported by Kuo (2018) growing in caespitose clusters on decomposed hardwoods and conifers from the western coast in North America during summer and spring. Natarajan & Raman (1983) found this species growing in groups on decaying wood of *Eucalyptus* trees from September to November from Tamil Nadu. The presently examined collection has been collected from coniferous forests of Jammu and Kashmir growing in groups on burnt wood of *Pinus* in the month of June.

Remarks: The morphology and microscopic details of the above examined collection are in full conformity with the details given for *Gymnopilus junonius* (Fr.) P.D. Orton, by Orton (1960), Arora (1986), Phillips (2001–2016) and Kuo (2018). This species is characterized in possessing large sized convex cap, evanescent annulus, gills forming striations on the stipe apex, gill edges floccose white, cheilocystidia and pleurocystidia present, spore size similar and in their habitat the present species too was found growing on burnt wood as reported by Orton (1960). The present collection was also compared with an allied taxa *G. odini* (Fr.) Bon & P. Roux, but due to the smaller size of basidiospores and the shape of cheilocystidia given by Orton (1960) it was ruled out. *G. junonius* was earlier reported from southern India

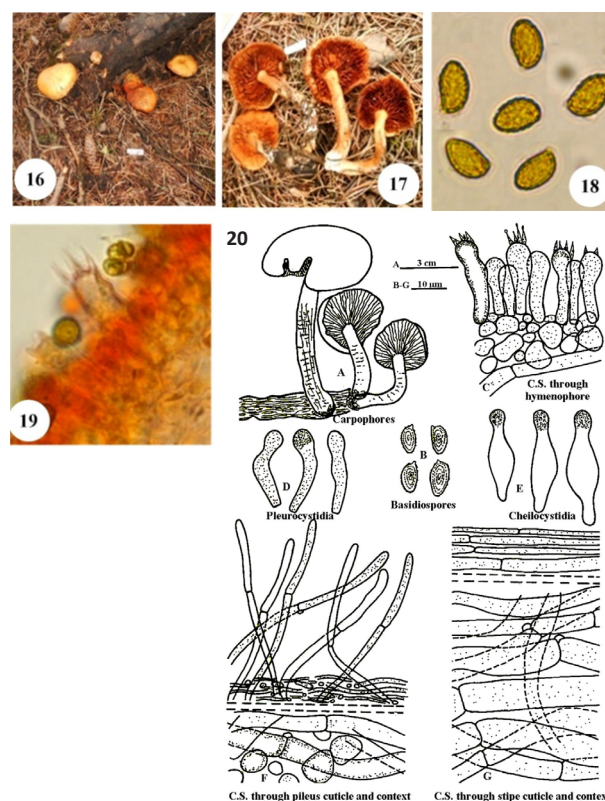


Image 16–20. *G. fuscusquamulosus* Hesler: 16—Basidiomata growing on dead wood stump of *Cedrus deodara* | 17—Underview of cap showing adnexed to adnate, orange to brownish-orange lamellae | 18—Microphotograph of verrucose basidiospores | 19—C.S. through lamellae showing tetrasterigmate basidia | 20—Camera Lucida drawings (A–G).

by Natarajan & Raman (1983) and Mohanan (2011). Presently, it has been recorded for the first time from north ernIndia.

***Gymnopilus fuscusquamulosus* Hesler, *Mycologia Memoirs* 3: 78, 1969. [Mycobank No. 314786; Legitimate] (Images 16–20)**

Basidiomata 9.5–10.5 cm in height. Pileus up to 5.5–6.5 cm broad, convex to plano-convex; umbonate, umbo broad; margin irregular, splitting at maturity, non striate; surface pale yellow (4A4) to reddish orange (7B8) to light brown (7D6); dry; cuticle fully peeling; context up to 0.2 cm thick, creamy white, changing; odor mild; taste acrid. Pileal veil absent. Lamellae adnexed to adnate, distant, unequal, not in series; moderately broad (up to 0.7 cm); orange (6A6) (6B7) to brownish-orange (7C6), unchanging; gill edges smooth; lamellulae present. Stipe central to eccentric, 9.5 cm long, up to 0.8 cm broad above, up to 1.0 cm broad at the base, equal in diameter throughout with a slightly bulbous base; surface light orange (5A5) to brownish-orange (7C5), unchanging;

scaly, scales appressed fibrillose, white mycelial mat present at the base of the stipe; solid; exannulate.

Basidiospores $7.47\text{--}9.13$ (9.96) $\times$ $4.15\text{--}4.98$ μm , $Q = 1.8$, ellipsoidal, dextrinoid, ornamented, verrucose, beaded, thick-walled, rough; apiculate, apiculus up to 0.83 μm long, excentric. Basidia $18.26\text{--}34.86 \times 5.0\text{--}6.64$ μm , clavate, granular, without clamp connections at the base; tetrasterigmate, rarely bisterigmate; sterigmata $4.15\text{--}6.64$ μm long, granular. Pleurocystidia $20.0\text{--}33.2 \times 5.0\text{--}6.64$ μm , clavate to lecythiform with capitate apex, granular, not much protruding out of the basidial layer, densely granular towards apices. Cheilocystidia $25.0\text{--}34.86 \times 7.5\text{--}9.13$ μm , lageniform to lecythiform with rounded capitate apices, thickly granular, filled with yellowish content towards the apex; gill edges heteromorphous. Hymenophoral trama regular. Pileus cuticle hyphal, ixocutis, made up of $1.66\text{--}2.5$ μm broad, horizontally tangled septate hyphae giving rise to sparsely populated regular turf of $1.66\text{--}3.32$ μm broad, septate, clamped, projecting hyphae; pileocystidia absent; context made up of $4.15\text{--}13.3$ μm broad, densely granular, septate, clamped, hyphae intermingled with $5.0\text{--}11.62$ μm broad, granular, cellular elements. Stipe cuticle hyphal, made up of longitudinally arranged, $2.5\text{--}3.32$ μm broad, septate hyphae; caulocystidia absent; context hyphal, made up of $6.64\text{--}11.62$ μm broad, septate, hyphae. Clamp connections present throughout.

Collection examined: Jammu & Kashmir, Kupwara, Naugam (2,125 m) 34.424N & 74.450E , growing in caespitose clusters on dead wood stump of *Cedrus deodara*, in coniferous forest, Naseema Aqbar Wani, PUN 9291, 06 August 2014; Jammu & Kashmir, Bangiward (2,700 m), 33.670N & 74.450N , growing in caespitose on dry peat moss on *Pinus wallichiana* tree in coniferous forest, Nazir Ahmad Malik, PUN 9069, 20 August 2015.

Edibility: It is poisonous, hence inedible as reported by Pushpa & Purushothama (2012).

Distribution and Ecology: *Gymnopilus fuscusquamulosus* was found growing on the roots of Buckeye and Rhododendron in the month of June from North America and North Carolina by Hesler (1969). Natarajan & Raman (1983) found this species growing in groups on wood in the month of October from southern India. Pushpa & Purushothama (2012) collected this species from Karnataka. The presently examined collection was made from Jammu & Kashmir growing in caespitose clusters on dead wood stump of *Cedrus deodara* and on dry peat moss of *Pinus wallichiana* tree in the month of August.

Remarks: The present collection falls under section *Gymnopilus*, as the annular ring on the stipe is lacking.

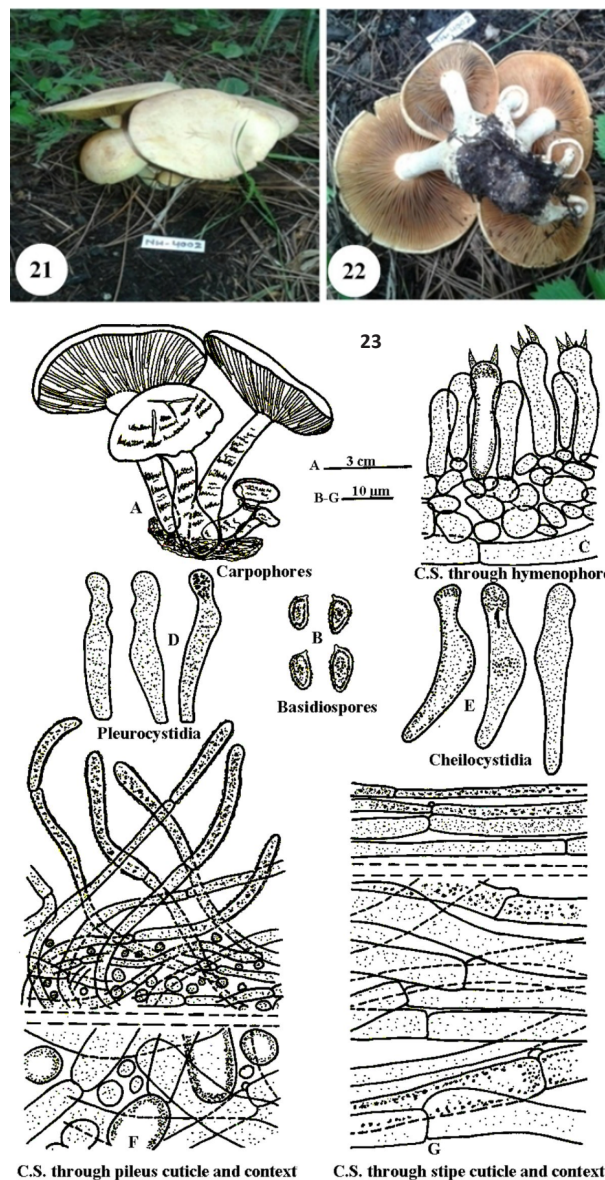


Image 21–23. *G. crocias* (Berk. & Broome) Singer: 21—Basidiomata growing in caespitose clusters on humicolous soil around the scattered needles of *Pinus* in their natural habitat | 22—Under view of cap adnexed, furcate lamellae | 23—Camera lucida drawings (A–G).

Further this matches well with the description provided for *Gymnopilus fuscusquamulosus* Hesler by Hesler (1969), Natarajan & Raman (1983) and Pushpa & Purushothama (2012). *G. fuscusquamulosus* has been earlier reported from India by Natarajan & Raman (1983) from Tamil Nadu and by Pushpa & Purushothama (2012) from Karnataka. Presently, it has been recorded for the first time from northern India.

Gymnopilus crocias (Berk. & Broome) Singer, *Sydowia* 9(1–6): 412 (1955). [Mycobank No. 298031; Legitimate]

(Images 21–23)

Basidiomata 5.7–7.4 cm in height. Pileus 3.7–6.5 cm broad, convex to applanate with inrolled margin; umbo absent; margin irregular, splitting at maturity, non striate; surface orange white (5A2) to pale orange (5A3); dry; scaly, scales appressed fibrillose, cuticle half peeling; flesh up to 0.5 cm thick, creamy white, exposed below the cracking, unchanging; taste mild. Pilealveil reduced to cortinoid zone in young basidiomata. Lamellae adnexed, close to subdistant, unequal, not in series; moderately broad (up to 0.6 cm); greyish-orange (6B3) to brownish-orange (6C3), unchanging, furcate; gill edges smooth; lamellulae present. Stipe central to eccentric, 4.5–6.2 cm long, up to 0.6 cm broad above, up to 1.0 cm broad at the base, equal in diameter throughout with a bulbous base; surface creamy white, pale orange (6A3) towards apex and base, unchanging; scaly, scales appressed fibrillose, white; white mycelial mat present at the base of the stipe; solid; annulate, annulus patchy, evanescent in mature basidiomata.

Basidiospores 6.64–8.3 x 4.15–4.98 μm , $Q = 1.6$, elliptical, dextrinoid, ornamented, verrucose, wall rough, thick; apiculate, apiculus up to 0.83 μm long, eccentric. Basidia 21.58–36.25 x 5.0–6.64 μm , clavate, granular; bisterigmate to tetrasterigmate, rarely bisterigmate; sterigmata 3.32–5.0 μm long, thickly granular. Pleurocystidia 25.0–34.86 x 5.0–6.64 μm , clavate to lecythiform with rounded capitate apex, thickly granular. Cheilocystidia 26.56–34.86 x 5.0–7.5 μm , subcapitate to lecythiform, densely granular towards the apex, abundant; gill edges heteromorphous. Hymenophoral trama regular. Pileus cuticle hyphal, ixocutis, made up of 1.66–2.5 μm broad, horizontally tangled septate, hyphae giving rise to a regular turf of 1.66–4.15 μm broad, septate, granular, heavily encrusted projecting hyphae, few hyphae with transverse thick encrustations; pileocystidia absent; context made up of 4.5–10.8 μm broad, clamped, granular, septate, hyphae intermingled with 6.64–11.62 μm broad, granular, cellular elements. Stipe cuticle hyphal, made up of longitudinally arranged 2.5–4.15 μm broad, septate, densely granular, hyphae; context hyphal, made up of loosely arranged, 5.81–11.62 μm broad, septate, hyphae. Clamp connections present throughout.

Collection examined: Jammu & Kashmir, Baramulla, Dazna Rafiabab (2,215 m) 34.366N & 74.466E, growing in caespitose clusters on humicolous soil around the scattered needles of *Pinus*, in coniferous forest, Naseema Aqbar Wani, PUN 9289, 08 August 2014.

Edibility: Unknown.

Distribution and Ecology: *Gymnopilus crocias* was

found growing on dead wood in the month of February from Thwaites by Pegler (1986). The presently examined collection was collected from Jammu & Kashmir, growing in caespitose clusters on humicolous soil around the scattered needles of *Pinus* in the month of August at an altitude of 2,215 m.

Remarks: The details of the presently examined collections agree well with the description of *Gymnopilus crocias* (Berk. and Broome) Singer given by Pegler (1986). *Gymnopiluscrocias* is easily recognized by convex to applanate cap with in-rolled margin, veil reduced to a cortinoid zone in young basidiomata, spore size similar, shape of cheilocystidia and pleurocystidia similar and the gill edges are hetromorphous with crowded cheilocystidia. Further, the clamp connections are present on both pileus and stipe cuticle. From India, this species has been found reported from Kerala by Mohanan (2011). Presently, it has been recorded for the first time from northern India.

CONCLUSION

Amongst the six keyed out species of the genus *Gymnopilus* documented in this manuscript *G. decipiens* and *G. aeruginosus* are the first time reports from India while as *G. fuscosquamulosus*, *G. crocias*, *G. junonius*, and *G. liquiritiae* are reported for the first time from northern India. Based on the results obtained from this study, it is clear that there are still a lot of macrofungal species that have not been explored yet. So it is advisable to do more investigations on the other locations of the Kashmir valley in order to complete the list of the macrofungi from the area.

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