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Noteworthy species of genus *Melanoleuca* (*Trichlomataceae*, *Agaricales*) from India

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ABSTRACT

Three species of genus *Melanoleuca* Pat. viz. *M. excissa* (Fr.) Singer, *M. paedida* (Fr.) Kühner & Maire and *M. subalpina* (Britzelm.) Bresinsky & Stangl. were collected from Jammu and Kashmir, India and are taxonomically described. An identification key based upon the morphoanatomical characters is also provided. All the three species included in this paper are reported for the first time from India.

Key Words: *Melanoleuca*, amyloid, gelatinized pileus cuticle.

INTRODUCTION

Melanoleuca Pat. is a well defined genus of family *Trichlomataceae* falling under order *Agaricales* (Kirk *et al.*, 2008) and suborder *Phuteineae* (Dentinger *et al.*, 2015). This genus is characterized in possessing a collybioid to tricholomatoid habit, color of the pileus varying in the shades of grey and brown; lamellae are mostly white to pale yellowish in color: adnexed, sinuate, adnate to subdecurrent in their attachment. Microscopically, the basidiospores are mostly ellipsoid, amyloid with prominent ornamentations: cheilocystidia and pleurocystidia are mostly lageniform to fusoid ventricose, sometimes with apical encrustations and clamp connections are lacking in this genus (Pegler and Young, 1973; Singer, 1986; Boekhout, 1988, 1999; Bon, 1991; Vesterholt, 2008). Kirk *et al.* (2008) documented fifty species of this genus while the latest MycoBank record (<http://www.mycobank.org/2018>) lists 338 validly published species of *Melanoleuca*. From India this genus is represented by only four species (Upadhyay *et al.*, 2017). Out of these, *M. melaleuca* (Pers.) Murrill was documented by Dhancholia *et al.* (1991) from Uttrakhand, *M. subrimosa* Murrill by Mohanan (2011) from Kerala and *M. subpulverulenta* (Pers.) Singer and *M. roseobrunnea* Murrill by Watling and Gregory (1980) from Jammu and Kashmir.

MATERIAL AND METHODS

The fungal forays were undertaken from time to time to various places in Kashmir during spring and summer for the collection of gilled mushrooms. These collections were worked out as per the standard methodology given by Atri *et al.*, (2005, 2017). The concepts of the classification and generic names followed are as given by Kirk *et al.*, (2008) and MycoBank (2018). The color terminology of Kornerup and Wanscher (1978) has been followed to describe the color of the various carpophores parts. Following Singer (1986) the basidiospore quotient (Q) was calculated by ratio of mean length divided by mean breadth of numerous basidiospores. The specimens were dried and deposited in the Herbarium, Department of Botany, Punjabi University, Patiala (Punjab) India, under the Accession No. PUN.

TAXONOMIC OBSERVATIONS

The taxonomic descriptions of the presently investigated species of genus *Melanoleuca*, namely *M. excissa* (Fr.) Singer, *M. paedida* (Fr.) Kühner & Maire and *M. subalpina*

(Britzelm.) Bresinsky & Stangl are given in the ongoing account as per the sequence of their segregation in the identification key given below.

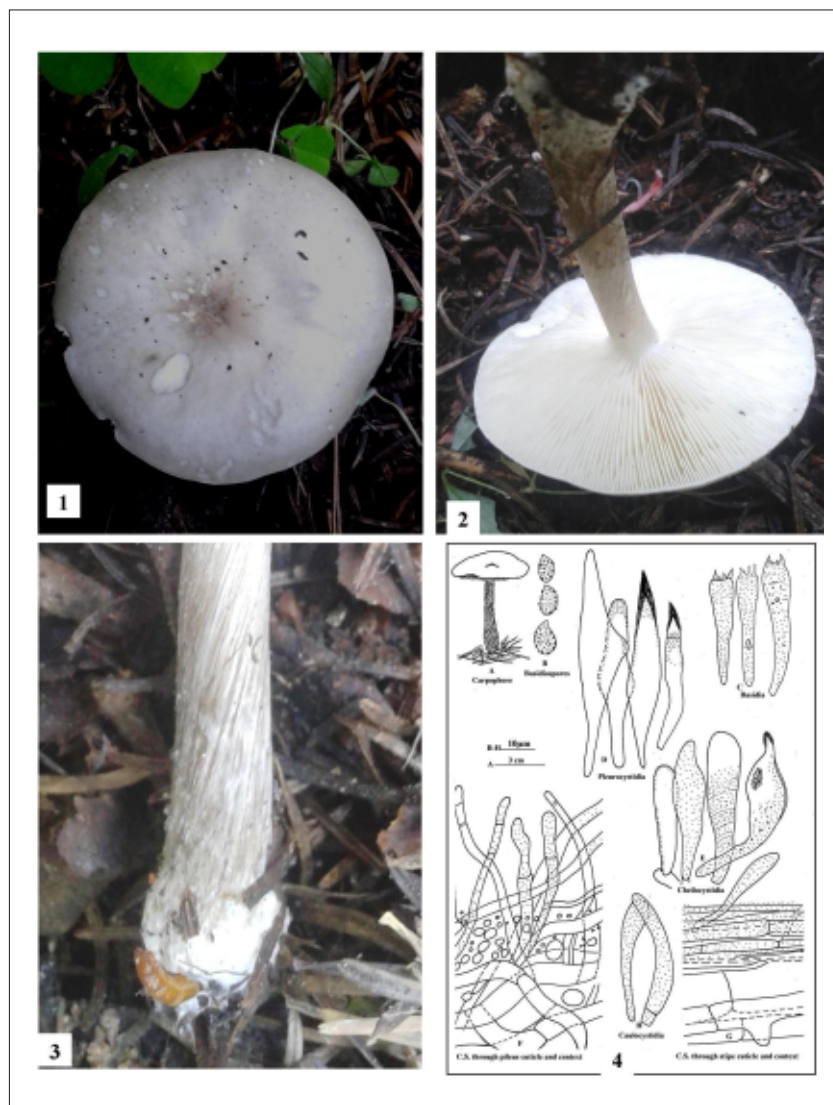
Key to the investigated species of the genus *Melanoleuca*

- 1 Stipe twisted rope like; basidia with siderophilous granules; gill edges sterile.....*M. excissa*
- 1' Stipe not twisted; basidia without siderophilous granules; gill edges heteromorphous.....2
- 2 Sporophores growing in groups or scattered on *Picea* cones; cap applanate; cuticle fully peeling; pleurocystidia and cheilocystidia stinging hair like.....*M. paedida*
- 2' Sporophores growing solitary or scattered on needles of *Pinus*; cap infundibuliform; cuticle half peeling; pleurocystidia and cheilocystidia lageniform to fusoid ventricose.....*M. subalpina*

Melanoleuca excissa (Fr.) Singer, *Cavanillesia* 7: 125, 1935. **Figs. 1-4**

Sporophores 4.8-8.0 cm in height. Pileus 3.0-5.0 cm broad, applanate, umbonate, umbo acute; surface grey (20B₁), reddish grey (7B₂) at the centre, dry; margin regular; cuticle fully peeling; flesh up to 0.2 cm broad, white, unchanging; taste and odor mild. Lamellae up to 0.5 cm broad, adnate to sub decurrent, crowded, unequal, white (2A₁), unchanging, lamellulae present in 1-4 lengths. Gill edges smooth. Stipe central, 5.0-7.0 cm long, 0.5-1.0 cm broad, tapering upwards with a bulbous base, twisted, rope like, white (2A₁) to grey (7B₂), unchanging, scaly, scales appressed fibrillose, white, hollow, exannulate.

Basidiospores 6.4-8.0 × 4.8-5.6 (6.4) μm (excluding ornamentation), Q = 1.3, broadly ellipsoid, rough walled, granular, ornamented, ornamentation verrucose 0.8-1.6 μm high; amyloid; apiculate, apiculus 0.83 - 1.6 μm long. Basidia 33.0-41.5 × 5.0-8.3 μm, clavate, granular, siderophilous granules present, tetrasterigmate; sterigmata 1.6-3.32 μm long. Pleurocystidia 49.0-75.0 × 8.3-13.28 μm, fusoid, ventricose to lageni form with pointed to broad inflated tips, apically incrustated, secondary septa present, abundant; cheilocystidia 33.2-50.0 × 5.81-11.6 μm, clavate to lageniform with rare apical incrustations, rarely clamped, thickly granular, not crowded. Hymenophoral trama regular. Gill edges sterile. Pileus cuticle hyphal, ixocutis made up of



Figs. 1-4 *M. excissa*: 1. Sporophore growing solitary on leaf litter of conifers, 2. Underview of cap bearing white and crowded lamellae and twisted rope like stipe. 3. Twisted stipe with bulbous base 4. (A-H): A. Sporophore, B. Basidiospores, C. Basidia, D. Pleurocystidia, E. Cheilocystidia, F. C.S. through pileus cuticle and context, G. C.S. through stipe cuticle and context, H. Caulocystidia.

horizontally tangled gelatinized septate hyphae giving rise to a regular turf of closely septate granular to hyaline projecting 3.3-5.6 μm broad hyphae with apical ends somewhat spatulate; context hyphal, made up of 6.4-12.8 μm broad, gelatinized, septate, irregularly placed, hyaline, inflated hyphae intermixed with 8.3-21.58 μm broad, hyaline cells. Stipe cuticle hyphal, ixocutis, made up of longitudinally tangled hyphae, giving rise to sparsely placed caulocystidia; caulocystidia 33.2-41.5 \times 4.15-5.81 μm broad, clavate to cylindrical, granular; context hyphal made up of 8.3-25.0 μm broad, longitudinally placed, hyaline, septate hyphae.

Collection Examined: Jammu and Kashmir; Kulgam, Cherenbal Kounsermag (2600 m), 33°35.627'N 074°50.771'E, growing solitary on leaf litter of conifers in coniferous forest, July 28, 2014, Nazir Ahmad Malik, PUN 9076.

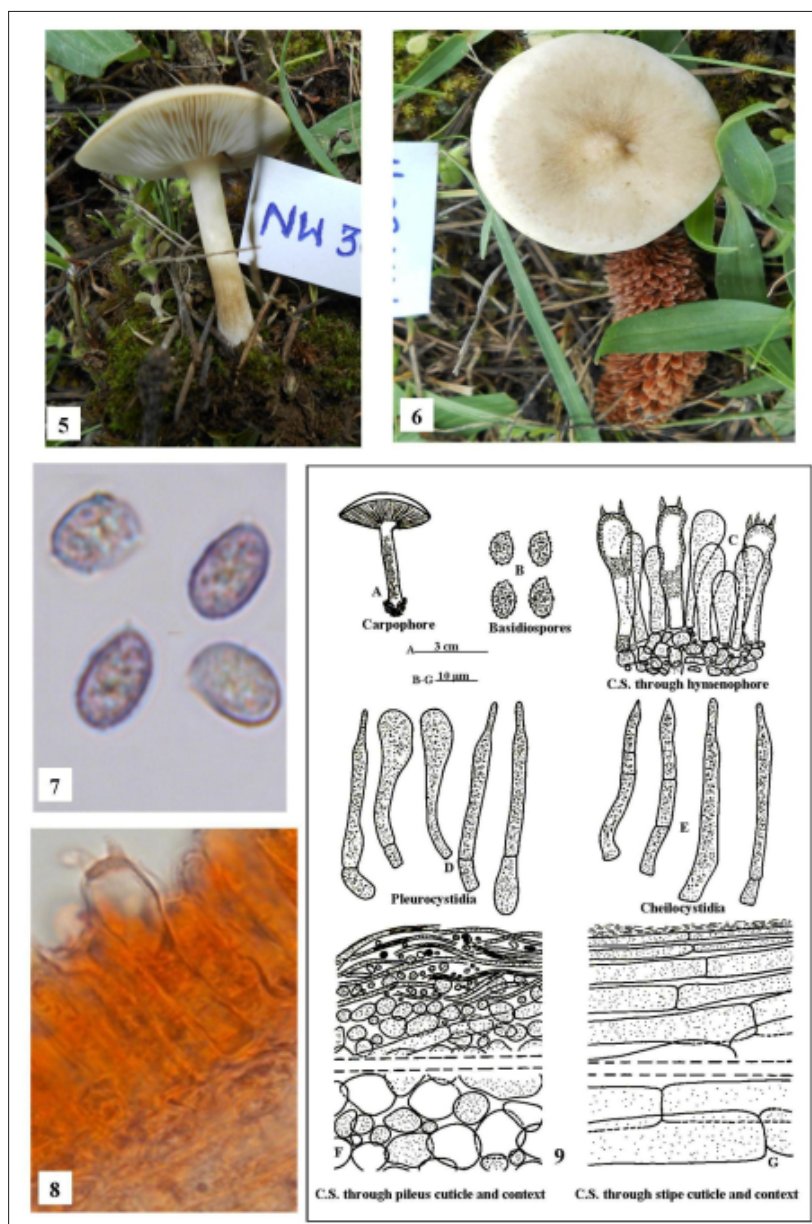
Distribution and Ecology: According to Breitenbach and Kränzlin (1991) *M. excissa* is a rare species, distributed in Europe, commonly occurring during spring in pastures or along forest edges. Antonin *et al.* (2017) reported this species as widely distributed in Europe growing under *Pinus* and *Quercus* on sandy soil and on montane meadow or pastures in grass up to subalpine vegetation zone. During the present study this species was found growing solitary on leaf litter of conifers in coniferous forest of Kashmir Himalayas at 2600 m in the rainy season.

Remarks: All the morphological characters of the presently examined collection match well with the description of *M. excissa* as given by Breitenbach and Kränzlin (1991) and Antonin *et al.* (2017). This species is characterized in possessing grey (20B₁) to reddish grey (7B₂) cap with an acute umbo and hollow, twisted rope like stipe. The basidiospores are verrucose, amyloid and the pleurocystidia and cheilocystidia are fusoid ventricose, lageniform with apical encrustation and secondary septa. All the key features of this collection fits into the details provided by Breitenbach and Kränzlin (1991) for *M. excissa*. This species is not earlier known from India thus is a new record.

Melanoleuca paedida (Fr.) Kühner & Maire, *Bulletin de la Société Mycologique de France* 50: 18 (1934). **Figs. 5-9**

Sporophore up to 4.5 cm in height. Pileus up to 3.8 cm broad, applanate, umbonate, umbo acute; margin irregular, non striate, splitting at maturity; surface greyish orange (5B₂) with brownish orange (5C₂) centre, moist; cuticle fully peeling; flesh up to 0.1 cm thick, creamy white, unchanging; odor mild. Pileal veil absent. Lamellae adnexed to notched, subdistant, forked towards the margins, unequal, not in series, broad (up to 0.2 cm), white (10A₁) to pale yellow (4A₃), unchanging; gill edges smooth, white; lamellulae present. Stipe central, up to 3.5 cm long, up to 0.5 cm broad above and 0.6 cm broad at the base, almost equal in diameter throughout; surface white to pale orange (5A₃), unchanging, hollow, scaly, scales fibrillose to floccose, exannulate.

Basidiospores 7.47 - 9.96 \times 5.81 - 6.64 μm Q = 1.3; ellipsoid, verrucose, warty, amyloid; apiculate, apiculus up to 0.83 μm long. Basidia 23.24 - 34.86 \times 7.47 - 9.13 μm , clavate, granular, bisterigmate to tetrasterigmate; sterigmata 3.32-5.0 μm long, granular. Pleurocystidia 28.22-53.12 \times 5.81-10.0 μm , claviform to stinging hair like with tubular apex, septate, thickly granular. Cheilocystidia 33.2-51.46 \times 5.0-8.3 μm , stinging hair like with tubular apex, secondary septa present, thickly granular, not abundant, gill edges heteromorphous.



Figs.5-9 *M. paedida*: 5. Sporophore growing solitary in natural habitat, 6. Carpophore with prominent umbo on the pileus surface, 7. Microphotograph showing amyloid ornamented basidiospores, 8 Basidium, 9 (A-G) A. Sporophore, B. Basidiospores, C. Basidia, D. Pleurocystidia, E. Cheilocystidia, F. C.S. through pileus cuticle and context, G. C.S. through stipe cuticle and context.

Hymenophoral trama regular. Pileus cuticle gelatinized, made up of sub-radially tangled, granular, 1.66 - 2.49 μm broad hyphae; pilocystidia absent; context made up of 4.98 - 14.94 μm broad, hyaline to granular, cellular elements. Stipe cuticle hyphal, made up of longitudinally arranged, 2.5 - 5.8 μm broad, septate hyphae; context hyphal, made up of, 6.64 - 15.0 μm broad, septate, hyphae. Clamp connections absent throughout.

Collection Examined: Jammu and Kashmir, Baramulla, Tangmarg (1850 m) 34° 10.911' N 074° 21.955' E growing in

groups on *Picea* cones in the open coniferous forest, Naseema Aqbar Wani, PUN 9295, May 4, 2013.

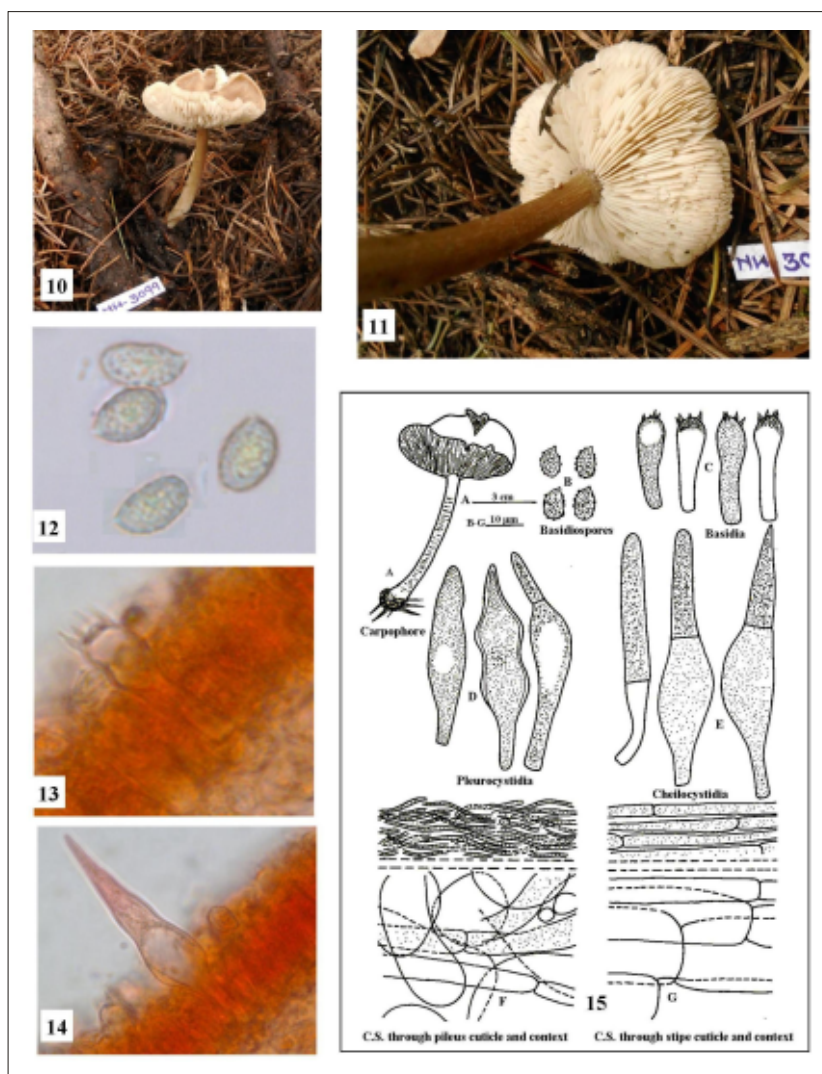
Distribution and Ecology: Breitenbach and Kränzlin (1991) collected *M. paedida* from Switzerland at an altitude of 550 m growing in forest meadows and cow pastures and from under *Picea* near the forest edge in the month of April during spring. The present collection has been found growing in groups on *Picea* cones scattered in open grasses near the forest edge in the month of May from Jammu and Kashmir.

Remarks: The details of the present collection match well with the description provided for *Melanoleuca paedida* by Breitenbach and Kränzlin (1991) and Kalmer *et al.* (2018). Spore size, carpophore morphology, secondary septa in cheilocystidia and pleurocystidia are in conformity but the encrustations as described for *M. paedida* by Breitenbach and Kränzlin (1991) are not very clear in the presently examined collection although these are densely granular. The present collection was documented growing scattered on cones of *Picea* in the open area. The only difference being in the gill edge color which in *M. paedida* is yellowish brown while this character is absent in our collection. Presently, this species has been recorded for the first time from India.

Melanoleuca subalpina (Britzelm.) Bresinsky & Stangl., *Beihefte zur Zeitschrift für Pilzkunde* 1: 46 (1976). **Figs. 10-15**

Sporophore up to 8.5 cm in height. Pileus up to 5.5 cm broad, infundibuliform, undulating, umbonate, umbo obtuse, splitting near the umbo; margin irregular, non striate; splitting at maturity; surface pale orange (5A₃) to brownish orange (5C₄) with a darker greyish orange (5B₄) centre, shiny; cuticle half peeling; flesh up to 0.4 cm thick, white, unchanging; odor mild. Pileal veil absent. Lamellae adnexed to subdecurrent to somewhat notched, close, rarely forked towards the margins, unequal, not in series, broad (up to 0.5 cm), white (10A₁) to brownish orange (5C₄), unchanging, gill edges smooth, lamellulae present. Stipe central, up to 7.2 cm long, up to 0.5 cm broad above, up to 0.5 cm broad in the middle and up to 0.7 cm broad at the base, with a slightly bulbous base, surface light brown (7D₃), unchanging, hollow; scaly, scales fibrillose to floccose, white mycelial mat present at the base of the stipe, exannulate.

Basidiospores 7.47 - 9.13 \times 4.15 - 5.81 μm Q = 1.8, ellipsoid, verrucose, rough, with blunt tipped isolated warts, amyloid; apiculate, apiculus up to 0.83 μm long. Basidia 25.0-33.2 \times 7.5-8.3 μm , clavate, granular, without basal clamps, tetrasterigmate; sterigmata 2.5-5.0 μm long, granular.



Figs. 10-15 *M. subalpina* 10. Sporophore growing solitary to scattered on needles of *Pinus*, 11. Underview of cap showing adnexed to somewhat notched lamellae, 12. Microphotograph showing amyloid ornamented basidiospores, 13. Basidium, 14. Pleurocystidium fusoid ventricose with long tubular apex. 15(A-G) A. Carpophore, B. Basidiospores, C. Basidia, D. Pleurocystidia, E. Cheilocystidia, F. C.S. through pileus cuticle and context, G. C.S. through stipe cuticle and context.

Pleurocystidia 50.0 - 96.3 x 8.3-15.0 μm , lageniform to fusoid ventricose with long tubular apex, double walled, secondary septa observed in few, thickly granular in the upper portion, tips non encrusted, abundant. Cheilocystidia 56.44 - 89.64 x 6.64-9.13 μm , similar to pleurocystidia; gill edges heteromorphous. Hymenophoral trama regular. Pileus cuticle gelatinized, made up of sub-radially tangled, granular, 1.66 - 2.49 μm broad hyphae; pilocystidia absent; context made up of 6.64-15.0 μm broad, septate, granular, hyphae intermingled with 4.15-35.0 μm broad hyaline to granular, cellular elements. Stipe cuticle hyphal, made up of longitudinally arranged, 3.32-5.81 μm broad, septate hyphae; context hyphal, made up of 6.64-3.24 μm broad, septate, hyphae. Clamp connections absent throughout.

Collection Examined: Jammu and Kashmir, Kupwara, Bangus Valley (2500 m) 34° 16.550 N 074° 12.892 E, growing solitary to scattered on needles of *Pinus*, in coniferous forest, Naseema Aqbar Wani, PUN 9296, August 1, 2014.

Distribution and Ecology: *M. subalpina* was reported growing in an alpine pasture among grasses in the month of June from Pontresina by Breitenbach and Kränzlin (1991). The present Indian collection has been found growing solitary to scattered on needles of *Pinus* in coniferous forest in the month of August.

Remarks: The present collection matches well with the description provided for *M. subalpina* by Breitenbach and Kränzlin (1991). It is characterized by the presence of silky shining cap, with a broad dark umbo in the centre and undulate margin of the cap, visibly broader stipe base, notched forking gills especially near the margin; densely granular apex of cheilocystidia and pleurocystidia. But apical cap of crystals as described by Breitenbach and Kränzlin (1991) could not be seen. Further, the caulocystidia could not be located in the presently worked out collection may be due to the fact that the caulocystidia are reported to be present only in the apex of the stipe by Breitenbach and Kränzlin (1991). *M. subalpina* is recorded for the first time from India.

CONCLUSION

With the addition of three species of *Melanoleuca* documented in this manuscript, the total number of species reported from India has gone to seven.

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