



A new species of *Metallolophia* Warren, 1895 (Lepidoptera: Geometridae: Geometrinae), and notes on *M. opalina* (Warren, 1893), from eastern Himalaya, India

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Abstract

A new species, *Metallolophia taleensis*, **sp. nov.**, is described and illustrated from Tale Wildlife Sanctuary, Lower Subansiri District, Arunachal Pradesh, India, based on male specimens. A second species, *Metallolophia opalina* (Warren, 1893), is recorded from India after more than a century, extending its range eastwards into Arunachal Pradesh, India.

Key words: biodiversity, moth taxonomy, eastern Himalaya, Tale WLS, Archaeobalbini

Introduction

Warren (1895) described the genus *Metallolophia* Warren, 1895 (Lepidoptera: Geometridae: Geometrinae, Archaeobalbini) with *Hypochroma vitticosta* Walker as the type species. The tribal placement of *Metallolophia* has undergone numerous revisions. Warren (1893), in a study of Indian Geometrinae, placed it in the subfamily Pseudoterpinae, which Prout (1912) demoted to the tribe Pseudoterpini, and this tribal assignment was subsequently used for *Metallolophia* by numerous authors (Holloway 1996; Pitkin *et al.* 2013). Recently, Murillo-Ramos *et al.* (2019) listed this genus in the tribe Archaeobalbini. Prout (1920–1941) listed five *Metallolophia* species globally while Parsons *et al.* (1999) listed eleven species. Han *et al.* (2005) described five new species from China, taking the total known *Metallolophia* to sixteen species. Kirti *et al.* (2019) listed three species of *Metallolophia* from India *M. assamensis* Orhant, 2000, *M. ocellata* (Warren, 1897) and *M. opalina* (Warren, 1893). In this paper, two species of *Metallolophia* Warren, 1895, which were recorded during biodiversity assessments in Tale WLS, Arunachal Pradesh, India, are discussed.

Material and methods

We conducted numerous moth surveys in the study area, Tale Wildlife Sanctuary, Lower Subansiri District, Arunachal Pradesh. Moths were surveyed from 17 to 24 September 2011, 17 to 23 April 2019, 21 to 23 May 2019 and 26 August to 6 September 2019 at multiple locations, namely Pange Range Office, Tale Valley, Pamruk, Suchusi village and the Inspection Bungalow at Hapoli-Ziro. The GPS coordinates and altitudes as well as survey month and survey effort for these survey sites are mentioned in Table 1.

Surveys were conducted using a 160 W mercury vapour bulb on a 4 ft. by 5 ft. white cloth screen powered with a Honda™ EP1000 portable generator in September 2011, April 2019 and May 2019. In August and September

2019, surveys were conducted with LepiLED Maxi supported by three 20,000-mAH Li-Polymer power banks. No collection was done in September 2011 and individuals were only photographed on the moth screen. All field photographs were taken using a Nikon™ D750 camera with an AF-S VR Micro-Nikkor™ 105mm f/2.8G IF-ED lens.

A collection permit for Lepidoptera was obtained from the Office of the Principal Chief Conservator of Forests (WL & BD), Arunachal Pradesh Forest Department (Letter No. CWL/Gen/173/2018-19/Pt. VII/3993-94 dated 8/3/2019). Hence, moth collection was conducted during the April, May, August and September, 2019 field surveys. Pinned *Metallolophia* specimens are deposited in the Research Collections (<http://collections.ncbs.res.in/>) of National Centre for Biological Sciences, Bengaluru, India (NCBS). Tissue (three legs each) was collected from all the *Metallolophia* specimens in molecular grade 100% ethanol and these tissue samples are also deposited in the NCBS Research Collections.

The genitalia of the specimens were dissected after dissolving extraneous abdominal tissue with 10% KOH (w/v) at 95°C. The dissected genitalia were preserved in vials containing anhydrous glycerol at room temperature in an air-conditioned room (22–26°C) and were photographed using a Leica digital camera (MC 120 HD) mounted onto a Leica S8APO stereomicroscope (Leica Microsystems, Germany). Multiple images were taken and stacked, improving depth of field, with CombineZM (Hadley 2010).

TABLE 1. A List of study sites at Tale Wildlife Sanctuary, Arunachal Pradesh, India.

| S No | Name of site | GPS reading | Altitude | Months surveyed | No of nights of survey |
|------|------------------------------------|---------------------------|----------|--------------------|------------------------|
| 1 | Pange Range Office | N27° 32.867' E93° 53.898' | 1,858 m | Apr, May, Aug, Sep | 20 |
| 2 | Tale Valley | N27° 32.050' E93° 57.083' | 2,353 m | Aug, Sep | 2 |
| 3 | Inspection Bungalow Ziro-Hapoli | N27° 40.279' E93° 55.027' | 1,584 m | Apr, Sep | 2 |
| 4 | Pamluk | N27° 40.279' E93° 55.027' | 1,110 m | Aug, Sep | 3 |
| 5 | Suchusi, Ziro-Hapoli | N27° 30.938' E93° 50.246' | 1,523 m | Sep | 1 |

Results

A review of the known species of *Metallolophia* globally and in India (Hampson 1895; Prout 1920–1941; Parsons *et al.* 1999; Han *et al.* 2005; Kirti *et al.* 2019) revealed that one of the two species we collected at Tale was new to science, which we describe below. The second species, *M. opalina*, was recorded for the first time in Arunachal Pradesh, and represents the first published records from India in more than a century.

Metallolophia taleensis Sondhi, Nath, Sondhi and Kunte, sp. nov.

Type Material. Holotype (Figure 1a, b): Male, India, Arunachal Pradesh, Lower Subansiri District, Tale Wildlife Sanctuary, Pange Range Office, N27° 32.867' E93° 53.898', 1858 m, 27.viii.2019, leg. Sanjay Sondhi. Pinned specimen, voucher code NCBS-BM344, along with tissue (legs) deposited in the Research Collections of NCBS.

Paratype (Figure 1c, d; Figure 4a): Male, India, Arunachal Pradesh, Lower Subansiri District, Tale Wildlife Sanctuary, Pange Range Office, N27° 32.867' E93° 53.898', 1858 m, 27.viii.2019, leg. Sanjay Sondhi. Pinned specimen, voucher code NCBS-BM346, along with tissue (legs) deposited in the Research Collections of NCBS. The live image of the paratype is shown in Figure 4a.

Description. Holotype. Male. Forewing length: 28.5 mm. **Upperside:** Head, thorax and abdomen pale rufous-brown. Collar black. Antennae brown, unipectinate. Ground colour of wings creamy-white suffused with olive-green and speckled with black; termen slightly crenulate, cilia creamy-white with olive-green scales where veins end. **Forewing:** Costa ochreous from wing base up to three-quarters towards apex. An olive-green subapical mark. An antemedial black curved line with prominent olive suffusion basally. A prominent reniform discocellular olive-green oval spot, prominently edged with black, touching the ochreous costal band. Prominent black postmedial line, which is straight and at right angles to inner margin initially, before it curves outwardly to form a tooth-shaped curve, slightly pinched in the centre, ending in V-shape at the costa. A subapical olive-green patch beyond the tooth-shaped mark. **Hindwing:** With black antemedial line (which is somewhat obscure) and prominent postmedial curved

line. Black postmedial line curves evenly from mid-costa to CuA_1 , from where it straightens towards the inner margin. An olive-green spot in cell, smaller than that on forewing, and not so prominently black-edged. Prominent olive-green triangular patches between vein-ends, beginning from the outer margin of varying lengths. **Underside:** Head, thorax, palpi and proboscis orange-brown. Abdomen pale brown. **Wing:** Costa and veins orange-yellow. With prominent, broad, dark-purple submarginal band, with a paler spot at the apex. Prominent postmedial series of conjoined dark purple spots forming a more or less continuous band on both forewing and hindwing; the band angled at M3 on the forewing; more or less forming an even curve on the hindwing. Large black oval cell-end spot and smaller black oval spot in cell on forewing and hindwing, with postdiscal bands closer to the submarginal band than the cell-end spot.

Variation: The paratype (Figure 1c, d) shows very little variation from the holotype. The reniform discocellular olive-green oval spot is more prominently edged black on the upperside of the forewing of the paratype. On the underside, the orange-yellow venation is more prominent in the paratype.

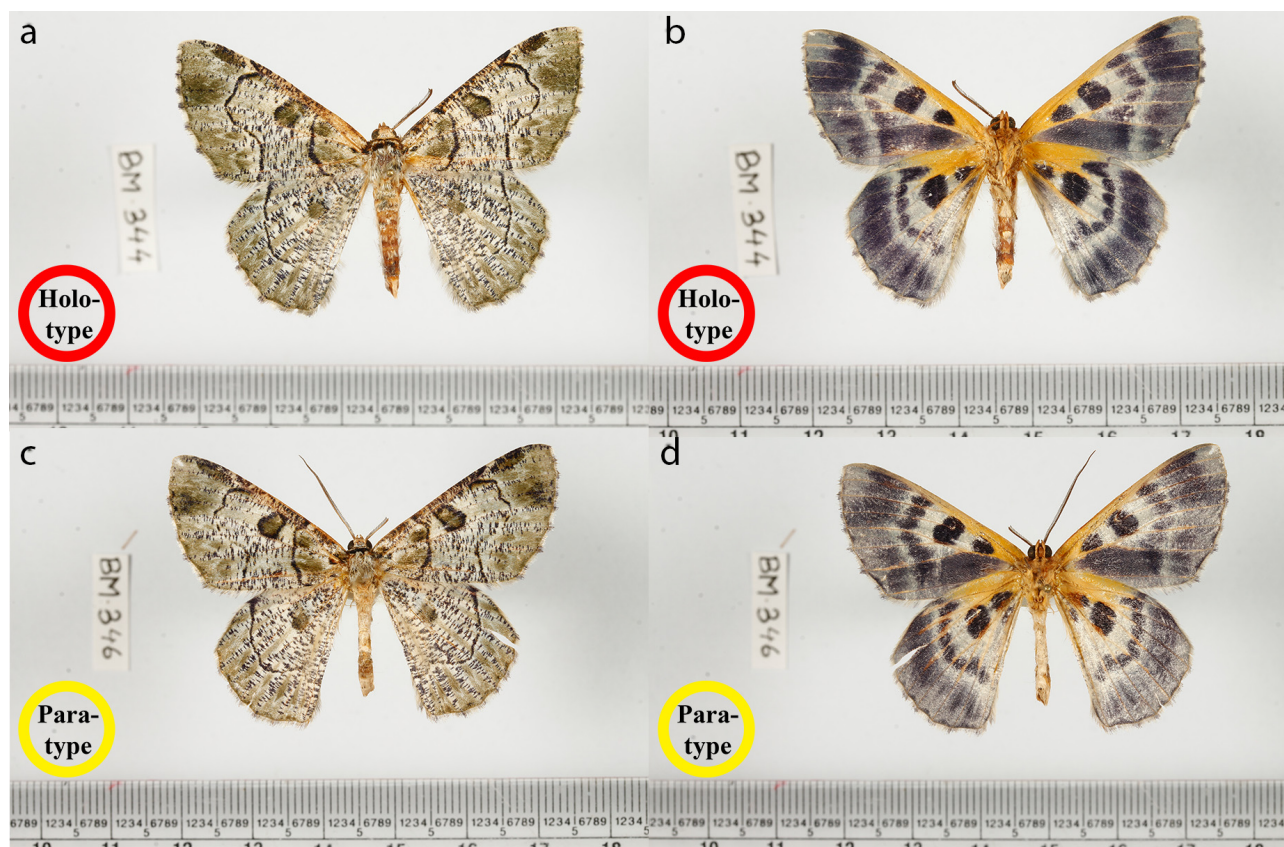


FIGURE 1. a–d: *Metallolophia taleensis* sp. nov. a–b. holotype male (NCBS-BM344) upperside and underside. c–d. paratype male (NCBS-BM346) upperside and underside. Both types were collected from Pange, Tale WLS, Lower Subansiri District, Arunachal Pradesh, India.

Genitalia of the holotype (Figure 3a). Uncus broad, falcate, bent downward at the distal tip in lateral profile, consisting of two elliptical lobes tapered and converged at the distal end in dorsal view. Tegumen formed by two conjoined lobes marked with a median suture. Vinculum slender, almost straight and long, with short saccus. Valve composed of pronounced costal process, basal process, extended saccular process, and laminar valve produced at the middle of ventral margin. Costal process of valve fan-shaped with a narrow proximal portion and a broad ellipsoidal spinous distal end. Basal process elongated with an expanded proximal part and a discoidal distal end with rounded dorsal margin and angular ventral tip. Saccular extension ends in a spinous convex knob-shaped structure. Aedeagus bilaterally asymmetrical with sub-zonal sheath almost 1.5X longer than supra-zonal sheath; supra-zonal area distally consists of ridged, spined extended ventral projection rounded at distal end.

Variation: Male genitalia of paratype (Figure 3b) exhibits no significant variation from holotype. Distal part of the basal process is comparatively flatter along distal margin with more angular ventral tip, which could be considered minor individual variation.

Diagnosis: Based on the *Metallolophia* key developed by Han *et al.* (2005), the absence of a prominent postmedial band on the underside of the forewing and hindwing distinguishes *M. taleensis* **sp. nov.** from *M. albescens*, *M. vitticosta*, *M. opalina*, *M. purpurivenata*, *M. medullosa*, *M. subradiata*, *M. variegata*, and *M. cineracea*.

Of the *Metallolophia* species with a prominent postmedial band on the underside of both wings, *M. assamensis* Orhant (Han *et al.* 2005; Figs. 22, 23, 61), has angled postmedial lines on the upper side of both wings, unlike *M. taleensis* **sp. nov.**, which has a smoothly curved line on the upper side of the hindwing and a slightly sinuous, curved line on the upperside of the forewing. *M. ocellata* (Han *et al.* 2005; Figs. 32–35, 51, 64) and *M. devecsisi* (Han *et al.* 2005; Figs. 36–39, 52, 65, 78), which resembles this species on the underside, lacks curved lines on the upperside of the forewing and hindwing. In addition, *M. devecsisi* has the anterior end of the postmedial band towards the costa on the underside of its forewing curved, rather than angled in the holotype and paratype of *M. taleensis* **sp. nov.**

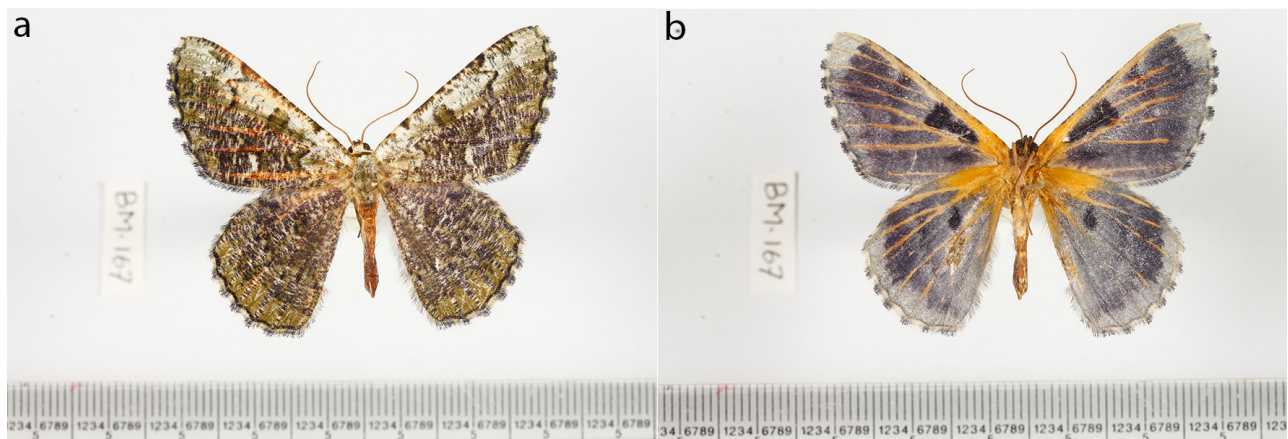


FIGURE 2. *Metallolophia opalina* a–b. male (NCBS-BM167), upperside and underside. Collected from Pange, Tale WLS, Lower Subansiri District, Arunachal Pradesh, India.

M. taleensis **sp. nov.** most closely resembles *M. stueningi*, *M. arenaria*, *M. cuneataria* and *M. inanularia*.

Metallolophia taleensis **sp. nov.** differs from *M. stueningi* (Han *et al.* 2005; Figs. 42, 43, 67), known only from Vietnam, in *M. stueningi* having the antemedial line outlined with white on its inner edge, while the postmedial line is outlined with white on its outer edge on the upperside of the forewing. The postmedial line in *M. stueningi* is smoothly curved beyond the cell, while it is slightly sinuous beyond the cell in *M. taleensis* **sp. nov.** The large reniform discal spot in *M. stueningi* is smaller and its black edging is weak. On the underside, the submarginal purple band in *M. stueningi* is significantly reduced. On the underside of both wings, *M. stueningi* has the trace of a postmedial black line, which is absent in *M. taleensis* **sp. nov.** *M. stueningi* male genitalia differ from that of *M. taleensis* **sp. nov.** in following aspects: tip of basal process discoidal with an angular ventral tip; costal process fan-shaped with a narrow proximal stalk-like structure, whereas in *M. stueningi* costal process gradually becomes broader from proximal to distal end (Han *et al.* 2005).

Metallolophia arenaria (Han *et al.* 2005; Figs. 24–27, 50, 62, 75), another similar species recorded only in China, has termen of both wings without crenulations, unlike *M. taleensis* **sp. nov.** in which both wing margins are strongly crenulate. The antemedial and postmedial lines on the upperside of the forewing in *M. arenaria* is similar to *M. taleensis* **sp. nov.**, these lines are absent or invisible on the upperside of the hindwing in *M. arenaria*, but are prominent in *M. taleensis* **sp. nov.** On the underside, *M. arenaria* resembles *M. taleensis* **sp. nov.** but cell spot and the cell end spot on the forewing and the hindwing are more widely separated in *M. taleensis* **sp. nov.** On the underside of the hindwing, in *M. arenaria*, the postdiscal band is midway between the cell-end spot and the submarginal band, while in *M. taleensis* **sp. nov.**; the postdiscal band is much closer to the submarginal band. In *M. taleensis* **sp. nov.**, the submarginal band is broader and more prominent. Male genitalia of *M. arenaria* differ from that of *M. taleensis* **sp. nov.** in the following aspects: valve much narrower than *M. arenaria*, uncal lobes closer at distal tip unlike *M. arenaria* where uncal lobes are conjoined at base. Distal part of basal process flat rather than a concave notch in *M. arenaria*. Apical part of saccular process knob-shaped and spinous region much broader compared to *M. arenaria* in lateral profile (Han *et al.* 2005).

Metallolophia cuneataria (Han *et al.* 2005; Figs. 28, 29, 63, 76), a species known from Guangxi, China, has the reniform discal spot on upperside and underside of forewing narrower towards costa. In *M. taleensis* **sp. nov.**, the

reniform discal spots on both upperside and underside of forewings are oval-shaped and not prominently narrowing towards costa. In *M. cuneataria*, postdiscal band on the underside of the hindwing narrower and angled at Cu_2 , and midway between the cell-end spot and the obscure purple submarginal band. In *M. taleensis* **sp. nov.**, the postdiscal band is broader, consists of separate spots, banded together, and is smoothly outwardly concave and closer to the submarginal band and the sub-marginal band is broader and more prominent. Male genitalia of *M. taleensis* **sp. nov.** differs from *M. cuneataria* in following aspects: apex of valva less rounded than *cuneataria*, uncal lobes closer at tip than basal area unlike *M. cuneataria*, distal part of basal have angular ventral tip compared rounded end in *M. cuneataria*. Aedeagus is almost of equal width in sub-zonal area, whereas in *M. cuneataria* aedeagus is broader in the middle near the annulus region and distally tapers (Han *et al.* 2005).

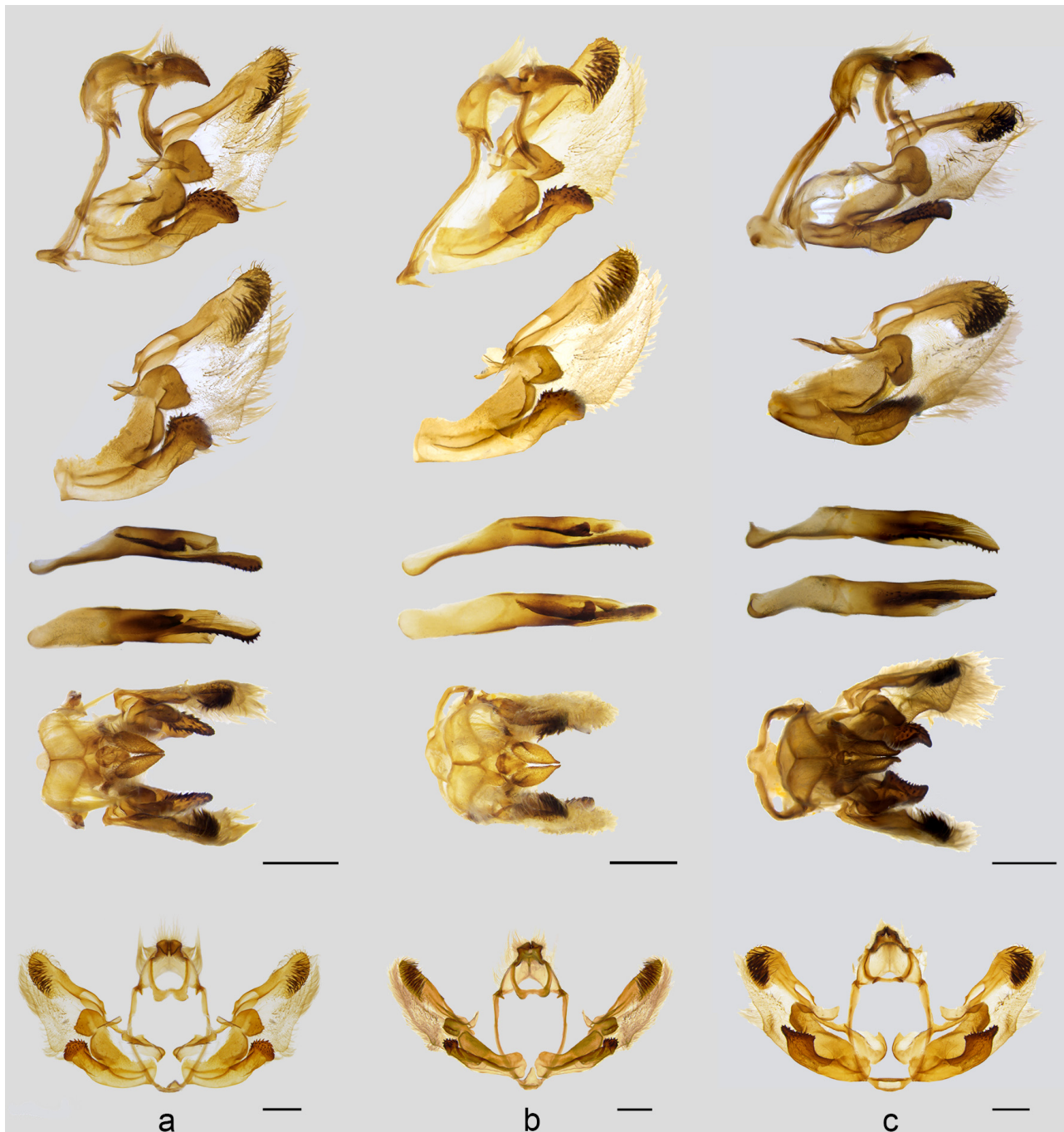


FIGURE 3. a–c: Genitalia of *Metallolophia* spp., a. *M. taleensis* **sp. nov.**, (NCBS-BM344), holotype, male. b. *M. taleensis* **sp. nov.**, (NCBS-BM346), paratype, male. c. *M. opalina* (NCBS-BM167), male. For each panel, top to bottom: genital capsule (with left valve removed), lateral view; left valve, external view; phallus; genital capsule, dorsal view; distal view. Scale for Figure 3a–c: 1 mm.

Metallolophia inanularia (Han *et al.* 2005; Figs. 30, 31, 77), a species known from Guangxi, China, has the reniform discal spot on upperside of forewing almost without the black ring, which is present and prominent in *M. taleensis* **sp. nov.** The reniform discal spot on upperside of hindwing is weak in *M. inanularia*, while it is prominent in *M. taleensis* **sp. nov.** On the underside, *M. inanularia* has the traces of a black postmedial line on both wings, which *M. taleensis* **sp. nov.** On the underside of the hindwing, the dark purple cell-end spot in *M. inanularia* is large, touching the postmedial band outwardly and the cell spot on its inner edge. Finally, the submarginal dark purple bands on the underside of both wings are much reduced in *M. inanularia*. Han *et al.* (2005) show only the female genitalia; hence no comparison has been done. The external morphology of the male is sufficient to separate *M. taleensis* **sp. nov.** and *M. inanularia*.

Metallolophia flavomaculata (Han *et al.* 2005; Fig. 40, 41, 66), a species known from Fujian and Fukien, China has yellow-brown markings, completely lacking olive-green on the upperside and purple on the underside. Male genitalia morphology of *M. flavomaculata* differs from *M. taleensis* **sp. nov.** in following aspects: distal part of basal process more extended and rounded ventrally in *flavomaculata* compared to angled ventral tip in *M. taleensis* **sp. nov.**. Saccus narrower and longer in *flavomaculata* compared to *M. taleensis* **sp. nov.** (Han *et al.* 2005).

In summary, *M. taleensis* **sp. nov.** can be separated from all its congeners by the following external morphological features: *Upperside*: Presence of prominent oval reniform black-edged olive-green spot on forewing, smaller spot on hindwing. Black antemedial and postmedial lines on forewing and hindwing. *Underside*: Forewing and hindwing with broad, dark-purple, continuous submarginal band and with a series of dark-purple conjoined spots, forming a band which is closer to the broad submarginal band than the cell-end spot.

Distribution and flight period of *M. taleensis* **sp. nov.**

Metallolophia taleensis **sp. nov.** has only been recorded at the type locality so far in the month of August. Moth surveys were conducted at multiple locations at Tale Wildlife Sanctuary in the months of April, May, August and September. This species was not recorded at any other location or in any other month.

Habits and habitat. The moth came to both mercury vapour and LepiLED light sources, with the individuals sitting on the moth screen with both wings spread (Fig. 4a), as is typical of most Geometridae. Both the specimens came to light between 1900 and 2000 hrs.

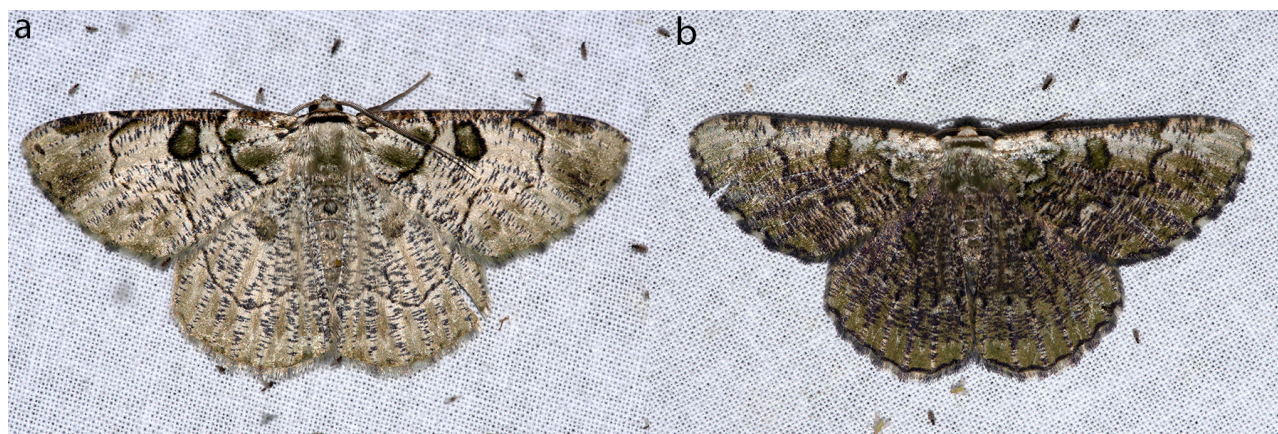


FIGURE 4. a–b: a. *Metallolophia taleensis* **sp. nov.** habitus, 27.viii.2019. b. *Metallolophia opalina* habitus, 27.viii.2019. Both individuals were photographed at Pange, Tale WLS, Lower Subansiri District, Arunachal Pradesh, India.

Life history of the new species. Nothing is known about its life history.

Etymology of the new species. The species is named after its type locality, the Tale Wildlife Sanctuary, Arunachal Pradesh, India.

Range extension of *Metallolophia opalina* (Warren, 1893) in Arunachal Pradesh

Material examined: Three specimens from Arunachal Pradesh, NCBS-BM167, NCBS-BM541 and NCBS-BM598,

matched the description of *M. opalina* (Warren 1893; Hampson 1895; Prout 1920–41; Han *et al.* 2005), as described below.

Male, India, Arunachal Pradesh, Lower Subansiri District, Tale Wildlife Sanctuary, Pange Range Office, N27° 32.867' E93° 53.898', 1858 m, 26.viii.2019, leg. Sanjay Sondhi. Pinned specimen, voucher code NCBS-BM541, along with tissue (legs) deposited in the Research Collections of NCBS.

Male, India, Arunachal Pradesh, Lower Subansiri District, Tale Wildlife Sanctuary, Pange Range Office, N27° 32.867' E93° 53.898', 1858 m, 27.viii.2019, leg. Sanjay Sondhi. Pinned specimen, voucher code NCBS-BM598, along with tissue (legs) deposited in the Research Collections of NCBS.

Male, India, Arunachal Pradesh, Lower Subansiri District, Tale Wildlife Sanctuary, Pange Range Office, N27° 32.867' E93° 53.898', 1858 m, 27.viii.2019, leg. Sanjay Sondhi. Pinned specimen, voucher code NCBS-BM167, along with tissue (legs) deposited in the Research Collections of NCBS (Figure 2 a,b). A live individual on the moth screen, which was not collected, is shown in Figure 4b.

Diagnosis for *M. opalina* Warren: Based on the *Metallolophia* key developed by Han *et al.* (2005), the absence of a prominent postmedial band on the underside of the forewing and hindwing means the specimens listed above belong to the following species group of *Metallolophia*: *M. albescens*, *M. vitticosta*, *M. opalina*, *M. purpurivenata*, *M. medullosa*, *M. subradiata*, *M. variegata* and *M. cineracea*. The subcostal area in these specimens is pale, postmedial line bending towards base at costa, forewing length more than 27 mm in all the three specimens, the underside of forewing not greyish-brown, but purple, with a pale submarginal band. The underside forewing does not have black round spot proximal to the discal spot, but has an elongate purple streak, located proximally to the discal spot. The underside of the hindwing also purple with a paler submarginal band and has a smaller discal spot. The three specimens, of which only NCBS-BM167 illustrated in Figure 2, closely match *M. opalina* (Han *et al.* 2005; Figs. 6, 7, 45, 54, 69). The male genitalia morphology of these specimens is compared with other species under *Metallolophia* known from India described in (Han *et al.* 2005), and findings are summarised below.



FIGURE 5. Map with spot locations and historical records of *Metallolophia* species in India.

Socius gradually tapered from the base to the apex and the apical end forms a thinner hook-like structure. Valves have extended saccular processes, basal processes and spined costal processes; aedeagus is bilaterally asymmetrical, and uncus is bifurcated, which are characteristics of *Metallolophia*. Uncus clearly consists of two lobes, inner margins of these uncal lobes almost straight, and bent outward at the distal tip from dorsal view resembling *M. opalina*. In the lateral profile, uncal lobes are wider at the bases and gradually tapers at the distal tips bent downward. Tegumen also consists of two conjoined lobes with median suture from dorsal view. Vinculum slender like other species of *Metallolophia*. Valve laminar produced at the middle of ventral margin. The costal process of valve is

fan shaped and broad at the end. Distal part of the basal process of valve is bean shaped, and the saccular process is short, broad, and linear in the lateral profile, whereas in dorsal view the tip is curved lunar shaped with serrated surface. The whole genital capsule including valve components closely resemble to the male genital morphology of *M. opalina* (Figure 3c).

The original description of *M. opalina* was based on specimens “taken by native collectors on the Nepal frontier at 7,000–8,000 feet” (Warren 1893). These specimens were collected by H. J. Elwes, and based on the notes by Warren (1893) it would appear that these were collected in Nepal, and not Sikkim. Han *et al.* (2005) designated this type specimen, a female, as the lectotype. Han *et al.* (2005) list a female specimen collected at 2,440 m by H. J. Elwes in 1889, a male specimen collected in July, 1886 at 2,134 m by Pilcher, apparently, both from Sikkim. Huang Fusheng collected another specimen in August 1974 at 930 m at Medog, Tibet, which is located due north of the state of Arunachal Pradesh. The three specimens of *M. opalina* collected from Tale WLS, Lower Subansiri District, Arunachal Pradesh, represent the first published records of this species from India since its original description and extend its known range eastwards by over 900 km to Arunachal Pradesh. Moth surveys were conducted at multiple locations at Tale Wildlife Sanctuary in the months of April, May, August and September. This species was not recorded at any other location or in any other month.

Conclusion

Table 2 provides an overview of the known Indian *Metallolophia* and their Indian and global distribution. Figure 5 shows the distribution of Indian species. The *Metallolophia* genus is uncommon throughout its range. No *Metallolophia* species have been recorded during 250 days of moth surveys in the last decade in Arunachal Pradesh, Assam, Meghalaya and Nagaland (Sanjay Sondhi pers. obs.) indicating that this genus is not common anywhere in India. The iNaturalist (accessed July 2020) website lists only seven observations of this genus from Asia. The Moths of India website (Sondhi *et al.* 2020) does not list any sightings of this genus from India. In addition, the sighting of *M. opalina* Warren in India after 120 years and the discovery of the new species *M. taleensis* underscore the need for additional biodiversity assessments in this region.

TABLE 2. Distribution of Indian *Metallolophia*.

| S No | Species | Indian Distribution | Global Distribution | References |
|------|--|---------------------------------------|---|-------------------------------------|
| 1 | <i>Metallolophia assamensis</i> Orhant, 2000 | Kaziranga and Nameri, Assam | Endemic to the Assam Valley so far as known | Han <i>et al.</i> 2005 |
| 2 | <i>Metallolophia ocellata</i> (Warren, 1897) | Khasi Hills and Garo Hills, Meghalaya | NE India to southern Vietnam | Warren 1897; Han <i>et al.</i> 2005 |
| 3 | <i>Metallolophia opalina</i> (Warren, 1893) | Sikkim, Arunachal Pradesh | E. Himalaya, Nepal, Tibet | Warren 1893; Han <i>et al.</i> 2005 |
| 4 | <i>Metallolophia taleensis</i> sp. nov. | Tale WLS, Arunachal Pradesh | Endemic to Tale Valley so far as known | |

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References

- Hampson, G.F. (1895) *The Fauna of British India including Ceylon and Burma. Moths. Vol. 3. Noctuidae (cont.) to Geometridae*. Taylor & Francis, London, 546 pp., 226 figs.
- Han, H.X., Galsworthy, A. & Xue, D.Y. (2005) A revision of the genus *Metallolophia* Warren (Lepidoptera, Geometridae, Geometrinae). *Journal of Natural History*, 39 (2), 165–195.
<https://doi.org/10.1080/00222930310001657865>
- Holloway, J.D. (1996) The Moths of Borneo: Family Geometridae, Subfamilies Oenochrominae, Desmobjathrinae and Geometrinae. *The Malayan Nature Journal*, 49 (3/4), 147–326, 427 figs., 12 pls.
- Hadley, A. (2010) *CombineZM*. Available from: <https://combinezm.en.lo4d.com/windows> (accessed 28 July 2020)
- iNaturalist (2020) Available from: <https://www.inaturalist.org> (accessed 28 July 2020)
- Kirti, J.S., Chandra, K., Saxena, A. & Singh, N. (2019) *Geometrid Moths of India*. Nature Books of India, New Delhi, 296 pp.
- Orhant, G. (2000) Nouveaux Geometridae Est-Asiatiques (Lepidoptera Geometridae. Geometrinae & Ennominae). *Bulletin de la Société à Entomologique de Mulhouse*, 2000, 1–9, pls. 1–28 figs.
- Parsons, M., Scoble, M., Honey, M., Pitkin, L. & Pitkin, B. (1999) *Geometrid Moths of the World: A Catalogue (Lepidoptera, Geometridae)*, 1016 pp. + 129 pp. (index).
<https://doi.org/10.1071/9780643101050>
- Pitkin, L.M., Hongxiang, H. & James, S. (2007) Moths of the tribe Pseudoterpnini (Geometridae: Geometrinae): a review of the genera. *Zoological Journal of the Linnean Society*, 150, 343–412.
<https://doi.org/10.1111/j.1096-3642.2007.00287.x>
- Prout, L.B. (1912) Lepidoptera Heterocera, Family Geometridae, subfamily Hemitheinae. In: Wytzman P. *Genera Insectorum. Vol. 129*. Verteneuil & Desmet, Bruxelles, pp. 1–274, pls. 1–5.
- Prout, L.B. (1920–1941) The Indo-Australian Geometridae. In: Seitz, A. (Ed.), *The Macrolepidoptera of the World. Vol. 12*. Verlag A. Kernen, Stuttgart, pp. 1–356, pls. 1–41.
- Sondhi, S., Sondhi, Y., Roy, P. & Kunte, K. (Eds.) (2020) *Moths of India. Version 2.00*. Indian Foundation for Butterflies. Available from <https://www.mothsofindia.org> (accessed 15 April 2020)
- Warren, W. (1893) On new genera and species of moths of the family Geometridae from India, in the collection of H.J. Elwes. *Proceedings of the Zoological Society of London*, 2, 341–434, pls. 30–32.
- Warren, W. (1895) New species and genera of Geometridae in the Tring Museum. *Novitates Zoologicae*, 2, 82–159.
- Warren, W. (1897) New genera and species of Drepanulidae, Thyrididae, Epiplemidae, Uraniidae and Geometridae in the Tring Museum. *Novitates Zoologicae*, 4, 195–262.
<https://doi.org/10.5962/bhl.part.21182>