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TWO NEW RECORDS OF THE GENUS *SOROLOPHA* (LEPIDOPTERA: TORTRICIDAE: OLETHREUTINAE) FROM INDIA

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ABSTRACT

Present study report distributional records of two species of the genus *Sorolopha* (Lepidoptera: Tortricidae: Olethreutinae) namely *Sorolopha dorsichlora* Razowski, 2009 and *Sorolopha leptochlora* Turner, 1916 for the first time from India. The species are redescribed based on adult morphological characters, wing venation, and male genitalia. Photographic illustrations of adult habitus, wing venation, their distribution, checklist for the genus and taxonomic notes are provided for both the species.

Keywords: Meghalaya, Microlepidoptera, morphology, National Pusa Collection, Uttarakhand

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The genus *Sorolopha*, first described by Lower in 1901, is among the largest genera within the tribe Olethreutini (Tortricidae: Olethreutinae), comprising 75 recognized species (Gilligan et al., 2018). This genus exhibits its greatest diversity in the Oriental Region, where nearly 60 species have been documented; six species are known from the Australian Region and two from the Palaearctic (Brown, 2005; Horak, 2006).

Diakonoff (1973) provided a comprehensive treatment of *Sorolopha* and related genera, illustrating the genitalia of most species and subdividing the genus into five species groups, primarily based on valva shape. He also noted that the morphological characteristics of *Sorolopha* are similar to those of the closely related genus *Eudemis*. The monophyly of *Sorolopha* is well supported by the slender socii, hairy throughout but with stronger apical bristles, by a valva with an elbow or projection on its ventral margin and by a sterigma usually fused with S7. The diversity of secondary sexual structures found in the genus is reflected in the three generic synonyms described by the Australian fauna (Horak, 2006). *Eudemopsis* appears to be the most likely sister group; together with *Sorolopha,* it lacks the large tuft of bristles at the outer base of the valva and the distally free gnathos, which are present in *Eudemis* and *Penthostola* (Diakonoff, 1978). On the other hand, in *Sorolopha*, the shape of the tegumen apex, the long drooping socii, and the modified caulis-anellus structure could represent possible synapomorphies shared with the genus *Rhectogonia*, along with the modified scales on the sides of the male abdomen and the female signum.

Larvae of some *Sorolopha* species feed by making leaf rolls on economically important trees such as *Cinnamomum zeylanicum* (Blume, 1826)*, Litsea glutinosa* (Robinson, 1911)*, Michelia champaca* Linnaeus 1753, *Persea americana* Miller 1768, and *Syzygium cumini* Linnaeus 1753 (Fletcher, 1932; Meyrick, 1936; Diakonoff, 1973; Robinson et al., 2001).

Clark (1958) studied all ten recorded species of Indian *Sorolopha*, providing illustrations of both adults and genitalia. This work was later continued by Diakonoff (1968, 1973), Rose et al. (2005), and Nedoshivina (2013). However, new records of several Olethreutinae species are still anticipated, given the group's species diversity in neighbouring countries (Liu and Bai 1982, 1985; Kuznetzov, 1988; Tuck and Robinson, 1994). In the present study, as part of the revision of the Tortricidae of India (Naik et al., 2021; Naik et al., 2022; Naik and Shashank, 2022; Reddy and Shashank, 2022; Reddy and Shashank, 2023; Poon et al., 2024; Naik et al., 2024; Naik and Shashank, 2024a, 2024b), *Sorolopha dorsichlora* Razowski, 2009, and *S. leptochlora* Turner, 1916, of the subfamily Olethreutinae, are newly recorded from India. These additions bring the total number of *Sorolopha* species described from India to twelve.

MATERIALS AND METHODS

The specimens for this study were collected from the states of Meghalaya and Uttarakhand, India, using

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light traps with mercury vapour lamps. Standard methods for collecting, processing, and preserving Lepidoptera, as outlined by Holloway et al. (2001), were employed. Specimens were examined under a Leica EZ4 compound microscope, and voucher specimens are deposited in the Indian Agricultural Research Institute – National Pusa Collection, Division of Entomology, New Delhi (INPC: http://grbio.org/cool/nwky-2b63).

Genitalia slides were prepared using the methods of Robinson (1976) and Common (1970), with slight modifications. The abdomens of male and female specimens were carefully detached and subjected to a 10-minute boiling treatment in a 10% KOH solution. Following this, the genitalia were thoroughly washed with 30% ethanol and dissected in the same solution. Dissected genitalia were stained using Eosin Y (1%) solution for enhanced visibility and contrast. Stained genitalia were delicately mounted on glass slides using Euparal as the mounting medium. Wing venation was done by using Eosin Y stain after careful removal of scales. The illustrations of wings, abdomen, and genitalia structures were done using Leica DFC425C digital camera mounted on a Leica M205FA stereo zoom automontage microscope, and images were revised using Adobe Photoshop®CS5. The forewing length was measured from the outer edge of the tegula to the tip of the wing apex. The terminology of Razowski (2003) was adopted to describe the wing pattern and Horak (2006) was adopted for the description of the male and female genitalia and the nomenclature of wing venation proposed by Comstock and Needham (1898-99), followed by Richards et al. (1957) and modified by Miller (1970).

ABBREVIATIONS

INPC – National Pusa Collection, New Delhi, India

ANIC – Australian National Insect Collection, CSIRO, Canberra, Australia

MNHU – Museum für Naturkunde Berlin

TL – Type locality

RESULTS AND DISCUSSION

Morphological descriptions of two new records

Genus *Sorolopha* Lower, 1901

Type species: *Sorolopha cyclotoma* Lower, 1901, by monotypy. Trans. R. Soc. S. Austral., 25: 73

=*Acanthothyspoda* Lower, 1908, Trans. R. Soc. S. Austral., 32: 319. Type species: *Acanthothyspoda elaeodes* Lower, 1908.

=*Alypeta* Turner, 1916, Trans. R. Soc. S. Austral., 40: 528. Type species: *Alypeta delochlora* Turner, 1916.

=*Choganhia* Razowski, 1960, Polskie Pismo Ent., 30: 387. Type species: *Argyroploce sphaerocopa* Meyrick, 1930.

Diagnosis: Adults are medium-sized. Labial palpi are moderately long and porrect, with the second segment slightly curved and weakly to moderately dilated distally, featuring a dorsal scale tuft. Forewings are highly variable in shape: sub rectangular, elongate-subtruncate, or moderately broad with distally curved costa; most species exhibit bright colouration, often in shades of green or brownish-grey, with an ocellar area containing a rounded brown spot. Male genital characteristics exhibit: uncus short, generally obtuse, occasionally replaced in some species; tegumen long, narrow, somewhat triangular; socius extends from the base of the uncus, long, slender, and pendulous, with setae on the inner surface, apically clavate; gnathos forms a weakly sclerotized or simple membranous median band; valva variable in shape and complicated; short costal process present; most species possess a distinct neck; posterior edge of the basal opening is weakly sclerotized; sacculus bears one or two clusters of spines protruding ventrally in some species; cucullus ventral side more or less prominent, constricted near the middle, often adorned with strong spines or a band of long bristles; may possess a scale tuft from the outer surface of the ventral margin, phallus medium in length, slender, and curved, weakly tapering towards the apex; vesica lacks cornuti. Whereas female genital characteristics exhibits: sterigma a funnel-shaped with a variably developed ventral margin; spinulose and weakly sclerotized, featuring a deep mesial split; colliculum long and sclerotized in some species; ductus bursae anterior portion sclerotized ventrally, with the ductus seminalis originating from mid-length or farther posterior of the ductus bursae; corpus bursae round to pear-shaped; signum comprises a single thorn-shaped sclerite or two small rounded patches on the corpus wall, often unequal in size.

1. *Sorolopha dorsichlora* Razowski, 2009 (Figures 1-9)

Type locality: Vietnam, Sa Pa, Fan Si Pang Mountains.

Holotype: MNHU. (♂).

Diagnosis: Adults are medium-sized moths characterized by a greenish head and an ochreous-green face. Forewing with the brownish ground colour, brown costal strigulae, and weak greenish suffusions postmedially, with a green dorsal half and green colouration along the termen. Hindwings are brownish with an anal tuft of black and ochreous brown cilia. The ninth abdominal sternite has a spinose plate. Male

genitalia exhibit a reduced, rounded lobe-like uncus; tegumen wide, flat subtriangular; socius slender, weakly sclerotized pendant from the base of the uncus, with long spiniform setae apically; gnathos arises from the apical third of the tegumen; anellus closely surrounds the base of the phallus; valva broad basally with an elongated slender neck, a ventral bean-shaped spinose cucullus, and an angulate sacculus with a cluster of setae followed by spines; phallus slender, strongly curved, and tapers towards the apex. Female genitalia are distinguished by lamella antevaginalis is represented by two oblique, dark spindle-shaped folds with a V-shaped median split, surrounded by a rounded area of dense short scales; ductus bursae long and membranous; corpus bursae membranous, with a small sclerotized hook-like signum and a small sclerotized patch.

Description: Head (Figure 5). Ocellus large. Head greenish, face ochreous green; vertex and dorsal part of frons clothed with long pale green rough, upwardly projected scales. The ventral part of the frons region is covered with small, flat, upwardly raised green pale ochreous scales. Labial palpi clothed with forwardly projected green scales, first segment short, ocherous; second segment long, broader towards the apex, clothed with long green, interspersed with dark blackish grey scales; small third segment, stout, with small green with light yellow scale, almost concealed in the second segment. Antenna filiform, brownish orange suffused with pale ochreous scales; cilia short. Chaetosema present.

Thorax: greenish ochreous-fulvous, a median transverse band of black irroration, sides of thorax and posterior crest green. Wings (Figures 1, 2): Forewing (wingspan 18-20 mm; n=4) costa slightly straight; termen weakly oblique. Brownish ground colour, brown costal strigulae and weak greenish suffusions postmedially, green dorsal half and part along termen; cilia greenish with ochreous interruptions. Hindwing brownish, anal tuft black; cilia ochreous brown. Wing venation (Figures 3, 4): Forewing with all the veins separated beyond the discal cell. CuA2 is wavy-like, and CuP is well-defined and remains at the margin. Hindwing with M3 and CuA1connate basally, CuP indistinct.

Abdomen (Figure 6)*:* Pale ochreous, dorsum suffused and mixed with fuscous, 9th sternite with spinose plate. Male genitalia (Figures 7, 8): Uncus reduced as a rounded lobe; tegumen subtriangular, wide and flat with a diagonal sclerotized line at 2/3 basally; socii slender, weakly sclerotized, pendant from the base of the uncus, curved and long 1/3 of tegumen length, moderately long spiniform setae apically; gnathos arising from apical 1/3 of tegumen; anellus closely surrounding at base of the phallus; valva broad basally, elongated slender neck with ventral bean shaped spinose cucculus; sacculus angulate with an angular bunch of setae followed by a group of spines; dorsal part of cucullus slender, constricted basally; phallus slender, strongly curved with tapering towards apex.

Female genitalia (Figure 9)*:* Papillae anales narrow with dense setae; posterior apophyses longer than anterior apophyses; sterigma rectangular, lamella antevaginalis represented by two oblique dark spindle-shaped folds, median split V-shaped; this sterigma below surrounded by a rounded field of very dense short scales; ductus bursae long, membranous; corpus bursae membranous with small sclerotized hook like signum and small sclerotized patch.

Material studied: India: Meghalaya: Ri Bhoi: CPGSAS campus, Umiam, 25°40’42’’N, 91°54’42’’E, 1520m, 1♂ and 3♀, 15.iii.2021, Mercury vapour lamp coll. Santhosh Naik G & Sunil; genitalia slide no. L00051312 (♂), L00051311 (♀).

Distribution: India (Meghalaya Present study); Vietnam.

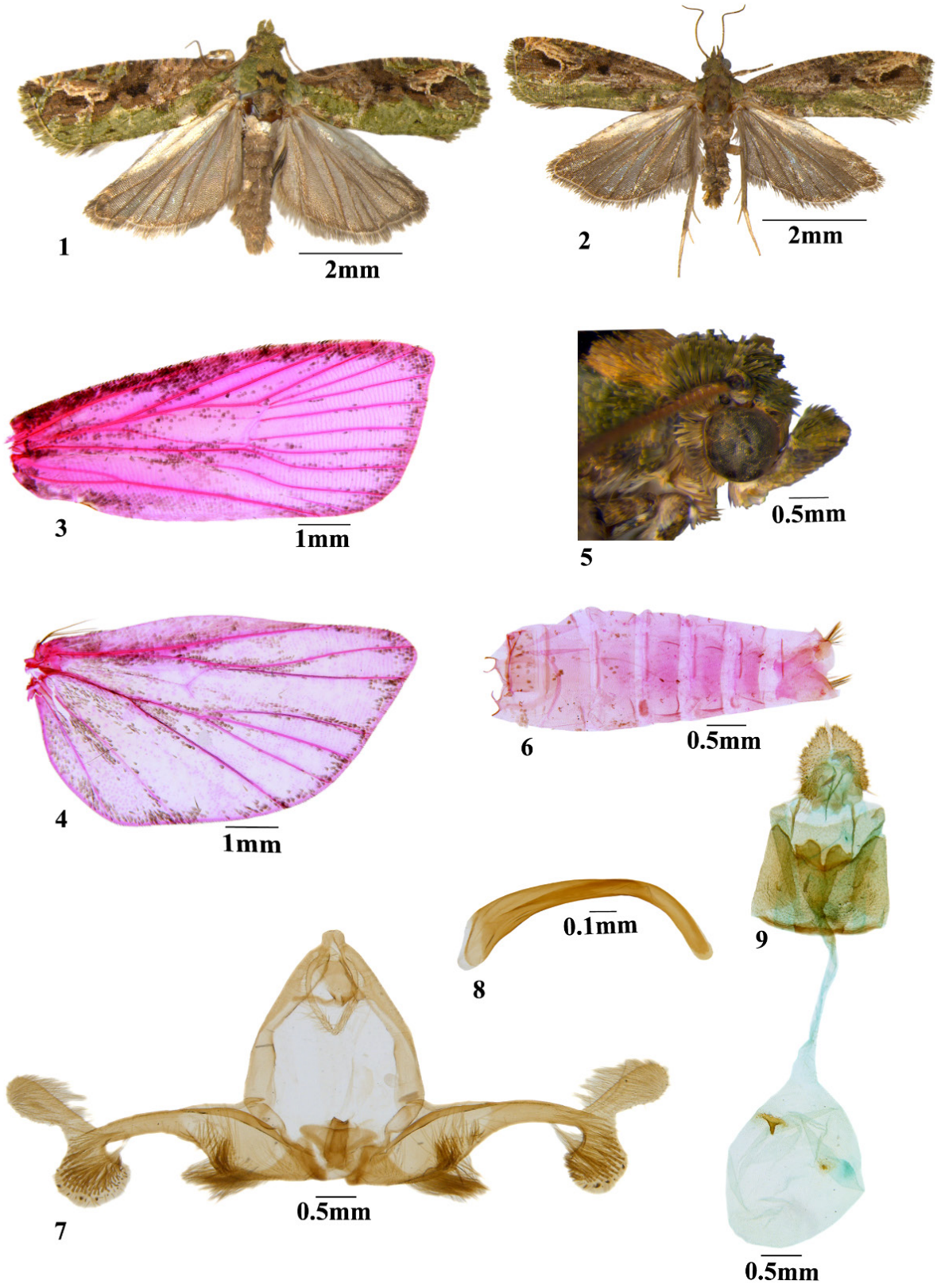
Remarks: S. dorsichlora is closest to its sister species *S. chiangmaiensis* Kawabe, 1989, but differences in male genitalia characteristics. Recognised or distinguished by parallel edges of the neck of the valva, not constricted at the cucullus and strongly curved phallus, tegumen broad, valva relatively bigger rounded and broad base and apical cucullus is broader whereas in *S. chiangmaiensis* tegumen relatively smaller, pointed valvar base and relatively smaller cucullus. The species is a new country record, with earlier records known only from Vietnam.

2. *Sorolopha leptochlora* Turner, 1916 (Figures 10-16)

Type locality: Australia (Queensland, Cairns)

Holotype: ANIC. (♂).

Diagnosis: Head is predominantly green, with ochreous face. Forewings are subtruncate and subrectangular, often uniform width with a continuously curved costa and a rounded termen, fuscous with a crest of scales on the dorsum and a green costal edge, exhibiting fuscous strigulation, anterior half features a bright green area, while a dark brown band runs medially, and the remainder of the apical half is dark brownish with a pale brown irregular patch and 3-4 small dark brown costal strigulae; hind wings pale brown. Presence



Figures 1-9. *Sorolopha dorsichlora* Razowski, 2009: 1. Adult male; 2. Adult female; 3. Labial palpi; 4. Abdomen; 5. Forewing; 6. Hindwing; 7. Male genitalia; 8. Phallus; 9. Female genitalia.

of long hairs on the first three abdominal sternites. Male genitalia is characterised as reduced to a rounded lobe and moderately setose uncus; tegumen subtriangular, wider base and narrows towards the apex; socius slender, pendant from the base of the uncus, curving and extending to one-third of the tegumen's length, with long spiniform setae at apex; gnathos arises from apical third of tegumen, lacking gnathal hooks; transtilla membranous, with the well-developed process; valva with a group of moderately setose structures at the base of sacculus, with a sclerotized costal process; sacculus with long sclerotized spines interspersed with long setae, with moderate basal excavation; cucullus deeply notched medially; juxta medium-sized, subtriangular, and rounded at apex; vinculum medium, membranous; phallus medium, subtriangular, enlarging at the base and tapering towards the apex.

Description: Head**.** Ocellus small. Head green, face ochreous; vertex and dorsal part of frons clothed with long pale green rough, upwardly projected scales. The ventral part of the frons region is covered with small, flat, upwardly raised green pale ochreous scales. Labial palpi slender, clothed with forwardly projected brownish-green scales, first segment short, ocherous brown, second segment long, broader towards the apex, clothed with small green, interspersed with dark ochreous green scales, small third segment, stout, with small green with light yellow scale, almost concealed in the second segment. Antenna filiform, brownish orange suffused with pale ochreous scales; cilia short. Chaetosema present.

Thorax: ochreous-fulvous, a median transverse band of black irroration, sides of thorax and posterior crest green, turning bluish-lilac in certain lights. Wings (Figure 10): Forewing (wingspan 12 mm) subtruncate, sub-rectangular, uniform width, costa curved throughout, termen rounded, fuscous with a small crest of scales on the dorsum with a green costal edge, strigulated with fuscous. The anterior half of the wing forms a bright green area, with a posterior acute angle projecting to the upper angle of the cell; a dark brown band runs medially; the remainder apical half with dark brownish with pale brown irregular patches, 3-4 small dark brown costal strigulae; cilia green, slightly suffused with ochreous, a sub-basal and a postmedian brown shade, and faint brown bars. Hind wing fuscous, thinly scaled towards the base, pale brown with greyish cilia along the apical and anal margin.

Abdomen (Figure 11)*:* Pale ochreous, dorsum suffused and mixed with fuscous dark brown, long hairs on first 3 abdominal sternite. Male genitalia (Figures 12-16): Uncus reduced as rounded lobe, moderately setose; tegumen subtriangular, wide basally, narrow towards apex; socii slender, pendant from the base of the uncus, curved and long 1/3 of tegumen length, long spiniform setae apically; gnathos arising from apical 1/3 of tegumen; gnathal hooks absent; transtilla membranous with well-developed transtilla process; valva with a group of moderately setose basally of sacculus with the sclerotized costal process; sacculus with long sclerotized spines mixed with long setae medially and basal excavation moderate; cucullus deeply notched medially with dorsal portion projection as rounded lobe, dense setae, ventral portion projection as rounded lobe wider than a dorsal portion, bearing dense spines and spiniform setae; juxta medium, subtriangular, wider and rounded apically; vinculum medium, membranous; phallus medium, subtriangular, enlarged basally, taper to apically, cornuti absent.

Female: Unknown.

Material studied: India: Uttarakhand: Dehradun: Wildlife Institute of India, 30°18'59"N, 78°10'05"E, 447m, 1♂, 03.viii.2017, Mercury vapour lamp coll. Twinkle S; genitalia slide no. L00051350 (♂).

Distribution: India (Uttarakhand): Australia (Turner, 1916).

Remarks: Sorolopha leptochlora is closely related to its sister species *S. rubescens* Diakonoff, 1973 but, in *S. leptochlora* broader tegumen, valva broader and spinose, socii longer, phallus is smaller whereas in *S. rubescens* narrow tegumen and valva, phallus long and strongly curved.

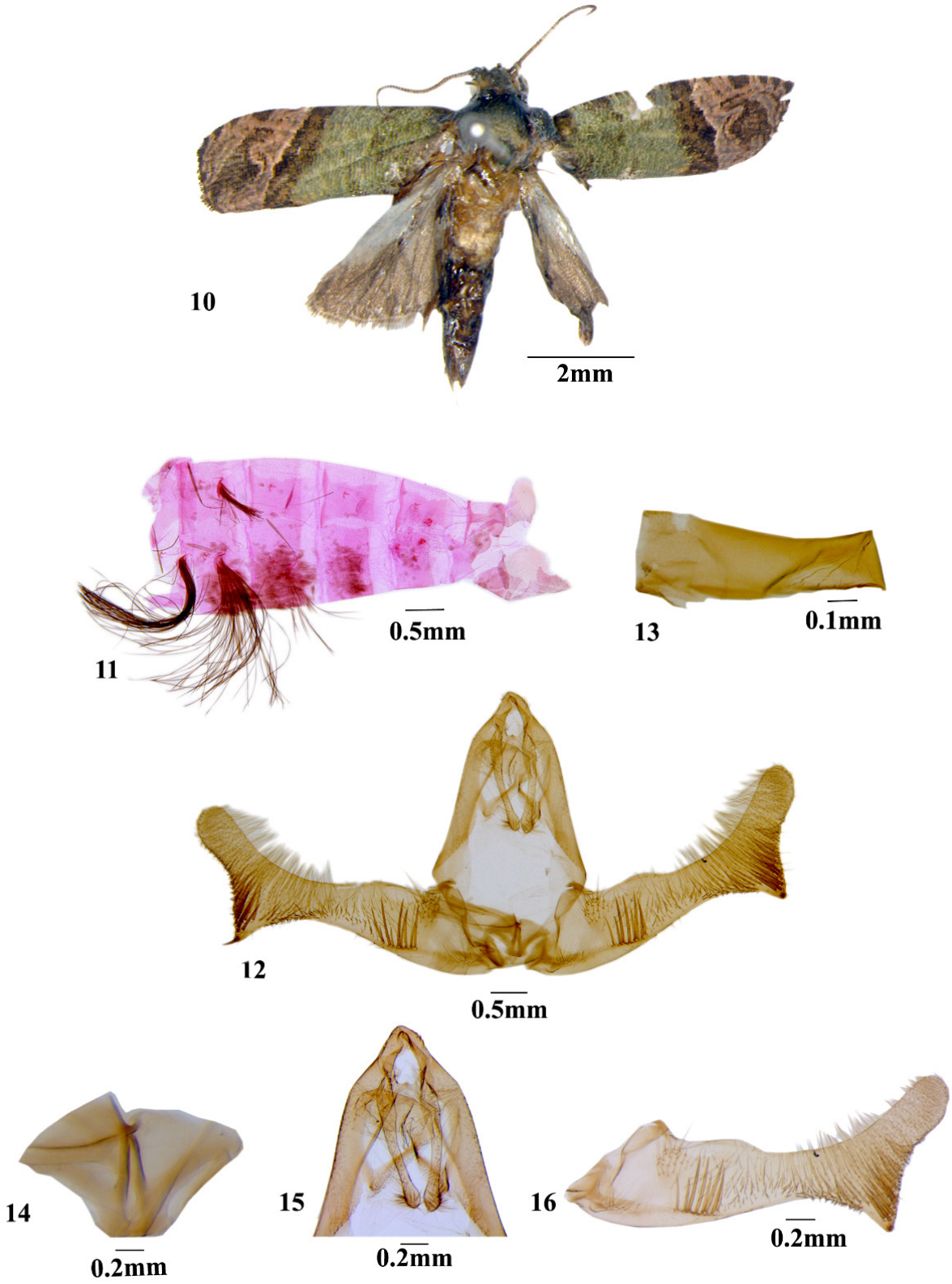
Checklist of *Sorolopha* Lower, 1901 from India

1. *Sophronia aeolochlora* (Meyrick, 1916)

Argyroploce aeolochlora Meyrick, 1916; Exotic Microlepid. 1: 562.
TL: India, Assam, Khasi Hills (now in Meghalaya).
Holotype: BMNH. (♂).
Distribution: India (Meghalaya); Thailand (Kawabe, 1989).
Illustrations: Adult and genitalia (Clarke, 1958: 480).

2. *Sorolopha archimedias* (Meyrick, 1912)

Argyroploce archimedias Meyrick, 1912; Exotic Microlepid. 1: 63.
=*Eudemis oxygona* Diakonoff, 1968; Bull. U.S. natn. Mus. 257 (1967): 50.
TL: China, Hong Kong (*archimedias*); Philippine Islands, Luzon, Los Banos (*oxygona*).
Lectotype: BMNH. (♂).



Figures 10-16. *Sorolopha leptochlora* Turner, 1916: 10. Adult male; 11. Abdomen; 12. Male genitalia; 13. Phallus; 14. Juxta; 15. Socii; 16. Valva.

Distribution: India; China (Hong Kong); Indonesia (Java); Philippine Islands; Sri Lanka; Thailand (Diakonoff, 1973; Pinkaew, 2007).
Host: The larval food plant is *Litsea glutinosa* (Lauraceae) (Diakonoff, 1973)
Illustrations: Adult (Diakonoff, 1968: 419) and genitalia (Clarke, 1958: 540).

3. *Sorolopha callichlora* (Meyrick, 1909)

Argyroploce callichlora Meyrick, 1909; J. Bombay nat. Hist. Soc. 19: 603.
TL: India, Assam, Khasi Hills (now in Meghalaya).
Holotype: BMNH. (♂).
Distribution: India (Meghalaya); Vietnam (Nedoshivina, 2013).
Illustrations: Adult and genitalia (Clarke, 1958: 491).

4. *Sorolopha camarotis* (Meyrick, 1936)

Argyroploce camarotis Meyrick, 1936; Exotic Microlepid. 4: 612.
=*Sorolopha longurus* Liu & Bai, 1982, Entomotaxonomia 4: 168.
=*Sorolopha micheliacola* Liu, 2001, Fauna of Insects in Fujian Province of China 5: 45.
TL: India, Bengal, Kalimpong (*camarotis*); China, Jiangxi, Jiulian Mt (*longurus*); China (*micheliacola*).
Lectotype: BMNH. (♂).
Distribution: India (Meghalaya, West Bengal); Indonesia (Java); Malaysia; Thailand (Robinson et al., 1994).
Hosts: Larvae are reported to feed on *Michelia champaca* (Magnoliaceae) and *Syzygium cumini* (Myrtaceae) (Meyrick, 1936; Robinson et al., 2001).
Illustrations: Adult and genitalia (Clarke, 1958: 491).

5. *Sorolopha dorsichlora* Razowski, 2009

TL: Vietnam, Sa Pa, Fan Si Pang Mountains.
Holotype: MNHU. (♂).
Distribution: Vietnam; India (Meghalaya) (Present study)

6. *Sorolopha herbifera* (Meyrick, 1909)

Argyroploce herbifera Meyrick, 1909; J. Bombay nat. Hist. Soc. 19: 603.
TL: India, Assam, Khasi Hills (now in Meghalaya).
Lectotype: BMNH. (♂).
Distribution: India (Meghalaya, Uttarakhand); Indonesia (Java); Malaysia (Malaya); Nepal; Sabah; Sri Lanka; Sumatra; Thailand; Vietnam (Robinson et al., 1994; Pinkaew, 2007; Koçak and Kemal, 2012; Nedoshivina, 2013).
Host: Cinnamomum zeylanicum (Lauraceae) is reported to be the host plant (Fletcher, 1932; Diakonoff, 1973).
Illustrations: Adult (Nedoshivina, 2013: 228) and genitalia (Clarke, 1958: 516; Rose et al., 2005: 274).

7. *Sorolopha leptochlora* Turner, 1916

Alypeta leptochlora Turner, 1916; Trans. R. Soc. S. Austral. 40: 529.
TL: Australia (Queensland, Cairns).
Holotype: ANIC. (♂).
Distribution: Australia; India (Uttarakhand) (Present study)

8. *Sorolopha liochlora* (Meyrick, 1914)

Argyroploce liochlora Meyrick, 1914; J. Bombay nat. Hist. Soc. 22: 771.
TL: India, Karnataka, Kanara, Ganesh Gudi.
Holotype: BMNH. (♂).
Distribution: India (Karnataka); Indonesia (Celebes, Sumatra) (Diakonoff, 1973).
Illustrations: Adult and genitalia (Clarke, 1958: 559).

9. *Sorolopha mniochlora* (Meyrick, 1907)

Eucosma mniochlora Meyrick, 1907; J. Bombay nat. Hist. Soc. 18: 138.
TL: India, Tamil Nadu, Palni Hills.
Lectotype: BMNH. (♂).
Distribution: India (Tamil Nadu).
Illustrations: Adult and genitalia (Clarke, 1958: 528).

10. *Sorolopha phyllochlora* (Meyrick, 1905)

Argyroploce phyllochlora Meyrick, 1905; J. Bombay nat. Hist. Soc. 16: 585.
=*Argyroploce ptilosema* Meyrick, 1916; Exotic Microlepid. 1: 563.
TL: Ceylon (= Sri Lanka), Haragam (*phyllochlora*); India, South India, Shevaroys (*ptilosema*).
Lectotype: BMNH. (♂).
Distribution: India (Meghalaya, Tamil Nadu, Uttarakhand); Sri Lanka (Diakonoff, 1973; Koçak and Kemal, 2012).
Host: Larvae have been reported to be leaf rollers on *Persea americana* (Lauraceae) (Meyrick, 1936).
Illustrations: Adult and genitalia (Clarke, 1958: 535).

11. *Sorolopha prasinias* (Meyrick, 1916)

Argyroploce prasinias Meyrick, 1916; Exotic Microlepid. 1: 562.
TL: India, Karnataka, Kur, Kanara.
Lectotype: BMNH. (♂).

Distribution: India (Karnataka); Sri Lanka; Vietnam (Diakonoff, 1973; Koçak and Kemal, 2012; Nedoshivina, 2013).
Illustrations: Adult (Nedoshivina, 2013: 228) and genitalia (Clarke, 1958: 540; Diakonoff, 1973: 552).

12.*Sorolopha semifulva* (Meyrick, 1908)

Schoenotenes semifulva Meyrick, 1908; J. Bombay nat. Hist. Soc. 18: 620.
TL: India, Assam, Khasi Hills (now in Meghalaya).
Lectotype: BMNH. (♀).
Distribution: India (Meghalaya).
Illustrations: Adult and genitalia (Clarke, 1958: 255).

The study includes significant findings of *Sorolopha dorsichlora* Razowski, 2009 and *S. leptochlora* Turner, 1916 moths within the Tortricidae family from India with redescription illustrations and include two new distributions or country records for the first time from India. Collected from various localities (Meghalaya and Dehradun) thereby expanding the understanding of the distribution of this genus. The taxonomic descriptions or redescriptions, including morphological characteristics, wing venation and genitalia structures, offer valuable insights into the identification of the species. Overall, this study contributes to the advancement of knowledge on the biodiversity of *Sorolopha* moths in India and underscores the importance of continued taxonomic research for the conservation and management of insect diversity. We hope that future exploration and documentation of Olethreutinae from fauna in diverse ecosystems of India will further enhance our understanding of the diversity of Indian Tortricidae moths.

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AUTHOR CONTRIBUTION STATEMENT

Santhosh Naik: collected and studied specimens, analysis, and the preparation of illustrations, written draft manuscript. Shashank PR: funding acquisition, planning the work, drafting and editing the manuscript.

CONFLICTS OF INTEREST

There is no conflict of interest.

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