

Two Geometrid Species, *Mixochlora argentifusa* and *Scopula tsushimana* (Lepidoptera: Geometridae), New to Korea

Sei-Woong Choi^{1,*}, Sung-Soo Kim², Un-Hong Heo³

¹Department of Environmental Education, Mokpo National University, Muan 58554, Korea

²Research Institute for East Asian Environment and Biology, Seoul 05236, Korea

³Independent Researcher, Seoul 05300, Korea

ABSTRACT

Two geometrid species, *Mixochlora argentifusa* (Walker, 1861) and *Scopula tsushimana* Kaneko, 2018, were newly recorded from Korea. *Mixochlora argentifusa*, a species of Geometrinae, is characterized by dark greenish, inverse triangular central fascia with a large lunular discal dot and a thick subterminal line of the falcate forewing and band-shaped medial and subterminal lines of the hindwing. *Scopula tsushimana*, a species of Sterrhinae, is characterized by dark blackish, slanted, dentate ante- and postmedial, and subterminal lines with a black, minute discal dot of the forewing and a relatively thick, blackish antemedial line and strongly undulating postmedial and subterminal lines of the hindwing. We provide diagnosis, description of adults and immatures, if available, and illustrations of the adults, and male and female genitalia.

Keywords: Geometridae, Geometrinae, Sterrhinae, new record, Korea

INTRODUCTION

This paper reports two new geometrid species from Korea: *Mixochlora argentifusa* (Walker) and *Scopula tsushimana* Kaneko. The genus *Mixochlora* Warren, 1897 consists of medium and large-sized, falcate-winged geometrid moths in the subfamily Geometrinae. The genus was erected by Warren (1897) based on the type species *M. alternata* Warren and comprise six species and one subspecies in the Asian region such as Himalayas, New Guinea, Borneo, Sumatra, Java, China, Taiwan, and Japan (Holloway, 1996).

The genus *Scopula* Schrank, 1802, consists of small and medium-sized geometrid moths with whitish or grayish wings and undulating transverse lines (Hausmann, 2004; Sihvonen, 2005; Choi and Kim, 2016). The genus *Scopula* is characterized by the absence of posterolateral appendices on the male eighth abdominal sternite, a separated sacculus and valvula of the valva, and an urceolate juxta in the male genitalia, and a spinous signum in the female genitalia (Sihvonen, 2005). Approximately 800 species of *Scopula* are known worldwide (Hausmann, 2004; Sihvonen, 2005), and 39 species are found in Korea (Choi and Kim, 2016).

MATERIALS AND METHODS

Moths were collected at night using either UV-light bucket trap with a 12 V battery (BioQuip, USA) or a white screen sheet. For genitalia slide preparation, each specimen was prepared by boiling the abdomen in 10% KOH for approximately 15–20 min. The scales and tissues were removed, stained with Chlorazol black, and mounted on slides in Euparal mountant. The wingspan was the measured distance from the tip of the left forewing to the tip of the right forewing. Larvae were collected through the direct observation of plants and were reared at one of the authors' house (UHH) until eclosion.

The terminology of the adult characteristics, including the male and female genitalia, refers to Hausmann (2004). All materials have been deposited in the Insect Collection, Department of Environmental Education, Mokpo National University, South Korea and at the National Institute of Biological Research, Incheon, South Korea. Abbreviations are as follows: TL, type locality; GN, Gyeongsangnam-do; JN, Jeollanam-do; and JJ, Jeju-do.

© This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

***To whom correspondence should be addressed**

Tel: 82-61-450-2783, Fax: 82-61-450-2789
E-mail: choisw@mokpo.ac.kr

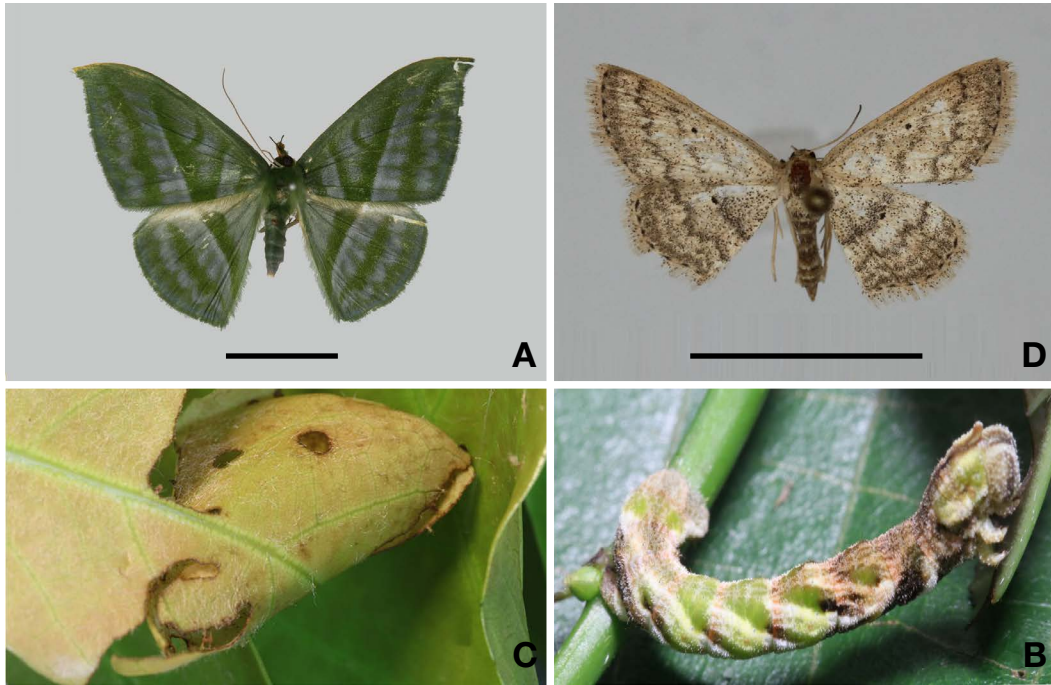


Fig. 1. *Mixochlora argentifusa* and *Scopula tsushimana* in Korea. A, *Mixochlora argentifusa* (adult); B, *M. argentifusa* (last instar); C, *M. argentifusa* (pupa); D, *Scopula tsushimana* (adult). Scale bars: A, D=10 mm.

SYSTEMATIC ACCOUNTS

Order Lepidoptera Linnaeus, 1758
 Family Geometridae Leach, 1815
 Subfamily Geometrinae Leach, 1815
 Genus *Mixochlora* Warren, 1897

Mixochlora Warren, 1897: 42. Type species: *Geometra vittata* Moore, 1867

¹**Mixochlora argentifusa* (Walker, 1861) (Fig. 1A–C)

Geometra argentifusa Walker, 1861: 526. TL: Sarawak, Borneo.

Mixochlora argentifusa: Holloway, 1996: 217.

Material examined. 1 female, Korea: JN: Wando, Wando Arboretum, 18 Sep 2018 (larvae), 26 Oct 2018 (eclosion), Heo UH; 1 female, Wando, Wando Arboretum, 8 Sep 2019 (larvae), 18 Sep 2019 (eclosion), Heo UH; 1 female, Wando, Wando Arboretum, 18 Sep 2018 (larvae), 23 Sep 2019 (eclosion), Heo UH; 2 males, Wando, Wando Arboretum, 8 Sep 2019 (larvae), 28 Sep 2019 (eclosion), Heo UH; 1 female, Jangheung, Mt. Cheongwansan, 25 Sep 2019 (larvae), 15 Oct 2019 (eclosion), Heo UH; 1 female, GN: Sacheon, Jangjeon-ri, 22 Sep 2016, Jeon JA.

Diagnosis. *Mixochlora argentifusa* is externally similar to *M. vittata* (Moore, 1867), but can be distinguished by the male genitalia, which show a large hooked sclerotized process on the costa whereas *M. vittata* has a series of spinular processes on the costa.

Description. Wingspan 28–31 mm (male) 30–31 mm (female). This greenish, falcate winged species can be distinguished by the bipectinate male and filiform female antennae, broad and greenish frons; long, greenish, and projected labial palpi; dark green basal line; dark green ante- and postmedial lines that form an inversed triangle central fascia with a long dark green lunular discal dot; dark green subterminal line on the forewing; and dark green, transverse antemedial and subterminal lines on the hindwing. The larvae can be distinguished by a light blackish head, light blackish thorax and abdomen with V-shaped thick, green stripes (Fig. 1B). The pupa is within a cocoon in a curled oak leaf (Fig. 1C). The male genitalia can be distinguished by the bifurcated digitate uncus; long, medially united socii; V-shaped juxta with a long medial united base; slender, membranous valva with a large hooked, sclerotized process on the costa; a series of spinular processes on the harpe and sacculus; and the slender, distally triangularly sclerotized aedeagus without a cornutus (Fig. 2A, B). The female genitalia can

Korean name: ¹*멧쟁이푸른자나방 (신칭)

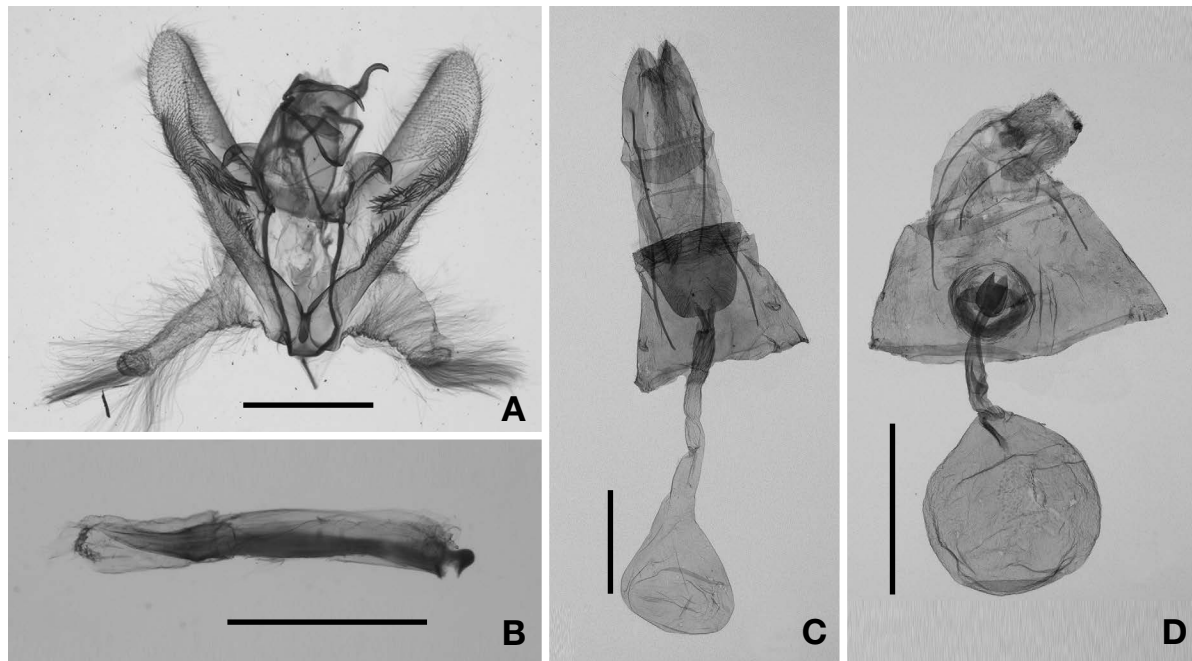


Fig. 2. Male and female genitalia of *Mixochlora argentifusa* and *Scopula tsushimana* in Korea. A–C, *Mixochlora argentifusa*; D, *Scopula tsushimana*. Scale bars: A–D=1 mm.

be distinguished by the simple papillae anales; large, broad, and cup-shaped antrum; narrow colliculum; long, tubular, medially bent ductus bursae; and ovate, membranous corpus bursae without a signum (Fig. 2C).

Distribution. Korea, Borneo, Peninsular Malaysia, Sumatra, Sulawesi.

Remarks. The biology of *Mixochlora argentifusa* is similar to that of *M. vittata*, feeding on *Quercus* species (Nakajima and Sato, 1979). *Mixochlora argentifusa* feeds on *Q. acuta* Thunb. and *Castanea crenata* Siebold & Zucc. (Fagaceae) in Korea.

Subfamily Sterrhinae Meyrick, 1892

Genus *Scopula* Schrank, 1802

Scopula Schrank, 1802: 162. Type species: *Phalaena paludata* Linneaus, 1767 (= *Phalaena ornata* Scopoli, 1763).

¹**Scopula tsushimana* Kaneko, 2018 (Fig. 1D)

Scopula tsushimana Kaneko, 2018: 285. TL: Japan, Tsushima Island.

Scopula hypochra: Choi and Kim, 2016: 134 (misidentification).

Material examined. 1 female, Korea: JJ: Jeju, Hallarim-

eup, Geum-orum, 9 Oct 2017, Jun JA; 1 female, JN: Haenam, Sani-myon, 34°42'34"N, 126°23'03"E, 2 m a.s.l., 13 May 2017, Choi SW; 1 female, Muan, Chungkye, 6 Nov 2000, Choi SW.

Diagnosis. This species can be distinguished by dark blackish, slanted, dentate ante- and postmedial, and subterminal lines with a black, minute discal dot of the forewing and a relatively thick, blackish antemedial line and strongly undulating postmedial and subterminal lines of the hindwing.

Description. Wingspan 16–17 mm. This grayish winged sterrhine species can be distinguished by the filiform antennae; short labial palpi, being barely extended beyond the frons; dark grayish, slanted, dentate ante- and postmedial lines; a blackish discal dot on the forewing; dark grayish, thick, slanted antemedial line; and undulating postmedial line with a blackish discal dot on the hindwing. The female genitalia can be distinguished by the short papillae anales; rounded and sclerotized postvaginalis; strongly tulip-shaped sclerotized antrum; short ductus bursae; and ovate corpus bursae with a patch of minute spicules (Fig. 2D).

Distribution. Korea, Japan.

Remarks. Choi and Kim (2016) reported *Scopula hypochra* in Korea, but an examination of the female genitalia revealed this report of *S. hypochra* to be in error.

ORCID

Sei-Woong Choi: <https://orcid.org/0000-0001-6326-399X>
Sung-Soo Kim: <https://orcid.org/0000-0001-5693-4142>
Un-Hong Heo: <https://orcid.org/0000-0002-2534-0605>

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

We are grateful to Dr. Ju-A Jeon for providing materials. The study was supported by a grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR201902205).

REFERENCES

Choi SW, Kim SS, 2016. A checklist of the genus *Scopula* (Lepidoptera: Geometridae) including description of a new species and three newly recorded species from Korea. *Zootaxa*, 4178:131-137. <https://doi.org/10.11646/zootaxa.4178.1.6>
Hausmann A, 2004. The Geometrid moths of Europe. Vol. 2.

Apollo Books, Stenstrup, pp. 1-600.
Holloway JD, 1996. The moths of Borneo, part 9: Geometridae (incl. Orthostixini), Oenochrominae, Desmobathrinae, Geometrinae, Ennominae addenda. *Malayan Nature Journal*, 49:147-326.
Kaneko T, 2018. A new species of the Sterrhinae (Geometridae) from Tsushima Is., Nagasaki Prefecture, Japan. *The Japan Heterocerists' Journal*, 287:285-286.
Moore F, 1867-1868. On the Lepidopterous insects of Bengal. Part III. *Proceedings of the Zoological Society of London*, 1867:612-686.
Nakajima H, Sato R, 1979. A list of the food-plants of the Japanese Geometridae. II Archiearinae, Oenochrominae and Geometrinae. *Japan Heterocerists' Journal*, 100:663-680.
Schrank FP, 1802. *Fauna Boica: durchgeachte Geschichte der in Baiern einheimischen und zahmen Thiere*. Bd. 2, Abt. 2. Nürnberg, pp. 1-412.
Sihvonen P, 2005. Phylogeny and classification of the Scopuli-moths (Lepidoptera: Geometridae, Sterrhinae). *Zoological Journal of Linnean Society*, 143:473-530. <https://doi.org/10.1111/j.1096-3642.2005.00153.x>
Walker F, 1861. List of the specimens of lepidopterous insects in the collection of the British Museum. Vol. 22. British Museum, London, pp. 1-526.
Warren W, 1897. New genera and species of moths from the Old-World Regions in the Tring museum. *Novitates Zoologicae*, 4:12-130.

Received January 13, 2020
Revised July 7, 2020
Accepted July 7, 2020