

Six Species of Moths (Lepidoptera) New to Korea

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ABSTRACT

As a result of investigating biodiversity of lepidopteran fauna in Korea, six species of moths within five families are reported for the first time: *Bucculatrix splendida* Seksjaeva (Bucculatricidae), *Caloptilia isochrysa* (Meyrick) (Gracillariidae), *Depressaria spectrocentra* Meyrick (Depressariidae), *Sergeya temulenta* (Omelko) (Gelechiidae), *Thiotricha attenuata* Omelko (Gelechiidae) and *Philenora latifasciata* Inoue & Kobayashi (Erebidae). Among them, *Philenora* Rosenstock, 1885 and *Sergeya* Ponomarenko, 2007 are newly recorded genera for the country. The diagnoses, redescrptions, photographs of adult and genitalia, and DNA barcode information are provided in this study.

Keywords: Lepidoptera, new records, taxonomy, DNA barcode

INTRODUCTION

Moths are a diverse group constituting at least 90% of the order Lepidoptera with 129 families worldwide (Lees and Zilli, 2019). The higher classification of moths has been made based mainly on the morphological structures of adults. The mouthparts are a key for identifying the most primitive groups of moths and the pattern of female genital openings is generally used to separate the other main subgroups (Young, 1997; Lees and Zilli, 2019). The great majority of moths (over 98%) are included in a clade Ditrysia of which females bear two genital openings, one for mating and the other for laying eggs (Regier et al., 2009; Mitter et al., 2017; Lees and Zilli, 2019). The Ditrysia can be further divided into three clades, Apoditrysia, Obtectomera, and Macroheterocera, based on the morphology and molecular evidence (Minet, 1991; Regier et al., 2009; Bazinet et al., 2013; Heikkilä et al., 2015). The latter group Macroheterocera comprises five superfamilies commonly known as ‘macro-moths’, separated from all remaining groups of moths collectively called as ‘micro-moths’ (Davis et al., 2022; Zahiri and Rajaei, 2023).

In Korea, currently 4,101 species have been recorded within 67 moth families (National Institute of Biological Resources, 2022). The number of newly recorded species has increased rapidly in recent years, especially as a result of investigating indigenous species on the Korean Peninsula by the National Institute of Biological Resources (NIBR) (Bae et al., 2021).

This study was conducted as part of the project to explore the biodiversity of lepidopteran fauna in the country. In this paper, we report six unrecorded species of moths within five families (Erebidae, Bucculatricidae, Depressariidae, Gracillariidae, and Gelechiidae) and provide the diagnostic characteristics, redescrptions, images of adults and genitalia, and the information of DNA barcoding.

MATERIALS AND METHODS

All materials were collected from Jeju-do and Jeollanam-do of Korea using 300–400 W mercury vapor or metal-halide light traps from 2013 to 2022, except *Thiotricha attenuata* Omelko. A single specimen of *T. attenuata* collected from Gangwon-do was examined during a visit to the collection of NIBR in 2022.

For preparations of genitalia, abdomens were boiled in 10% KOH for 10–15 min, and brushed in distilled water according to Li (2002). Eosin Y and Chlorazol Black E were used together for staining and the slides were mounted using Euparal resin. Images of adults and genitalia were photographed with Dhyana 400DC camera (Tucsen Photonics, China) coupled with a Leica Z16 APO microscope (Wetzlar, Germany).

Genomic DNA was extracted following Lee and Jeun (2022) for the species examined. The sequences were aligned using ClustalW in MEGA 5.2 (Kumar et al., 2016), and the final

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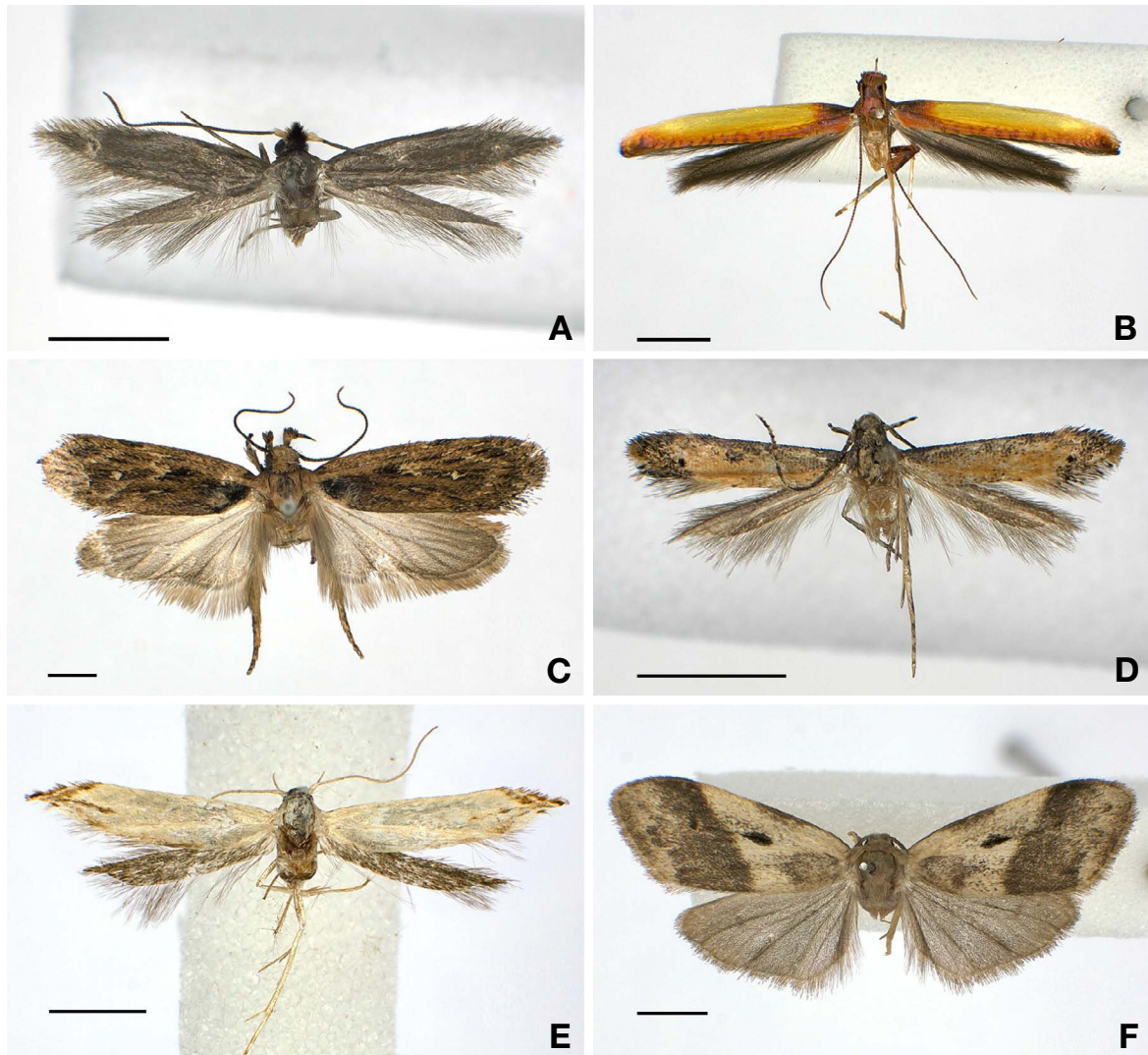


Fig. 1. Adults of six unrecorded species. A, *Bucculatrix splendida* Seksjaeva, male; B, *Caloptilia isochrysa* (Meyrick), female; C, *Depressaria spectrocentra* Meyrick, male; D, *Sergeya temulenta* (Omelko), male; E, *Thiotricha attenuata* Omelko, female; F, *Philenora latifasciata* Inoue & Kobayashi, female. Scale bars: A–F=0.2 mm.

cytochrome c oxidase subunit I (*COI*) barcode region (658 bp) were registered in GenBank (accession numbers OQ605711–OQ605715), except *T. attenuata* of which the DNA was not obtained due to the poor sample quality. Specimens and dissections of examined materials are currently deposited in two institutes, NIBR and Jeju National University (JNU), and the genomic DNA is stored in JNU.

SYSTEMATIC ACCOUNTS

Order Lepidoptera
Superfamily Gracillarioidea

Korean name: ¹*갯빛선굴나방 (신칭)

Family Bucculatricidae
Genus *Bucculatrix* Zeller, 1839

¹**Bucculatrix splendida* Seksjaeva, 1992 (Figs. 1A, 2A)
Bucculatrix splendida Seksjaeva, 1992: 426; 1996: 887;
Kobayashi et al., 2010: 14. Type locality: Primorsky Krai,
Russia.

Material examined. Korea: 1♂, Jeollanam-do, Sinan-gun, Aphae-eup, Daechon-ri, 16 May 2022, leg. Ga-Eun Lee, genitalia slide no. LGE22088 (NIBRIN0000980216), DNA voucher no. LGE-G634.

Diagnosis. Externally, the species can easily be recognized

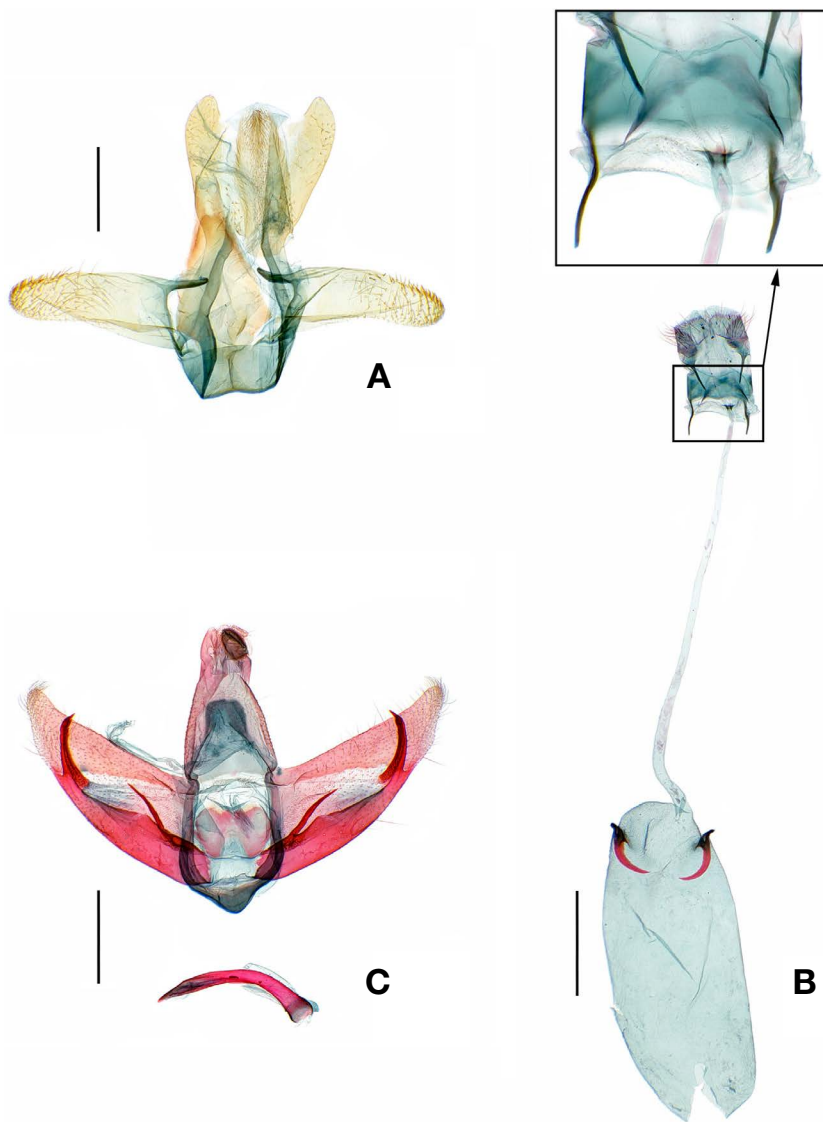


Fig. 2. Genitalia of three unrecorded species. A, Male genitalia of *Bucculatrix splendida* Seksjaeva; B, Female genitalia of *Caloptilia isochrysa* (Meyrick); C, Male genitalia of *Depressaria spectrocentra* Meyrick. Scale bars: A=0.2 mm, B, C=0.5 mm.

by the black vertex tuft and the fuscous forewing without any markings. The male genitalia are diagnosed by the small socius, the broad uncus + tegumen complex, the valvae gradually narrowing toward apex and the aedeagus almost 3 times length of the valvae (Kobayashi et al., 2010).

Redescription. Adult (Fig. 1A). Wingspan 5.5–8.0 mm (Seksjaeva, 1992; Kobayashi et al., 2010), 9.0 mm in a Korean specimen. Head with frons mixed fuscous and cream, vertex tuft black except anterior margin cream. Eye-cap cream. Antenna grey. Thorax and tegula fuscous. Forewing, hindwing, and fringe scales uniformly fuscous. Legs grey to fuscous, mid-femur strongly mixed with cream. *Male genitalia* (Fig. 2A). Socius small and lobbed. Uncus + tegumen broad.

Valva gradually narrowed, distal 1/2 setose, apex rounded. Juxta oblong. Vinculum ribbon-shaped. Aedeagus (missing in fig. 2A) approximately 3 times as long as valva, basal 1/4 dilated, then uniformly elongate, slightly curved apically.

Distribution. Korea (Jeollanam-do), Japan, Russia.

Host plant. *Artemisia princeps* Pamp. (Asteraceae) (Kobayashi et al., 2010).

GenBank accession number. OQ605711.

DNA sequence matching results. The DNA barcode of *B. splendida* obtained in this study showed 99.49% genetic similarity to *Bucculatrix* sp. registered in BOLD (BIN ID: BOLD:ACQ2770).

Remarks. The larvae are known to share the same host plant

with *B. notella* Seksjaeva which is a leaf miner on *Artemisia princeps* Pamp. (Kobayashi et al., 2010). See Seksjaeva (1992; fig. 4) for the illustrations of male genitalia, Seksjaeva (1996; fig. 4) for female genitalia and Kobayashi et al. (2010; pl. 1; figs. 3, 9, 10) for adults and genitalia.

Family Gracillariidae

Subfamily Gracillariinae

Genus *Caloptilia* Hübner, 1825

¹**Caloptilia isochrysa* (Meyrick, 1908) (Figs. 1B, 2B)

Gracilaria isochrysa Meyrick, 1908: 829. Type locality: Khasi Hills, India.

Caloptilia solaris Kumata, 1966: 15.

Caloptilia isochrysa Kumata, 1982: 39; Hirowatari, 2013: 95.

Material examined. Korea: Jeju-do: 1♀, Jeju-si, Haeandong, Sanrok Road, 18 Jun 2021, leg. Ga-Eun Lee, genitalia slide no. LGE21043 (NIBRIN0000980213), DNA voucher no. LGE-G560; 2♀, Seogwipo-si, Sanghyo-dong, 9 Jun 2022, leg. Ga-Eun Lee.

Diagnosis. The species can be differentiated from other related species by the brassy-yellow forewing with the base and dorsum reddish brown. The forewing color pattern of *C. isochrysa* resembles that of *C. zachrysa* Meyrick, but Kumata (1982) mentioned that the wing span of *C. isochrysa* is larger and the brassy-yellow costal area is much broader than the latter species (see Kumata, 1982; figs. 13, 49 for the illustrations of adults and genitalia of *C. zachrysa*). The female genitalia (Fig. 2B) are somewhat similar to those of *C. cecidophora* Kumata (see Kumata, 1982; figs. 44, 58, 61, 66, 69, 79, 87 for the illustrations of adults and genitalia) in having very long and slender ductus bursae, a short antrum and a pair of hook-shaped signa. In *C. isochrysa*, however, the shape of lamella postvaginalis is trapezoidal with deeply emarginated anterior margin and the corpus bursae are elliptical whereas the lamella postvaginalis is sub-elliptical and the corpus bursae are elongate oval in the latter species.

Redescription. *Adult* (Fig. 1B). Wingspan 14.0–15.0 mm (Meyrick, 1908; Kumata, 1966; Sakamaki, 2013), 14.0 mm in Korean specimens. Head with frons shining white, vertex coppery-reddish. Labial palpus white, segment II strongly mixed or slightly tinged with yellow and blackish-brown scales, segment III tipped with blackish-brown. Antenna coppery-reddish, annulated with brown. Thorax and tegula coppery-reddish. Forewing coppery-reddish in basal 1/7 and along dorsum, with a very broad brassy-yellow area from near base to apex, fuscous strigulae present on dorsum, sometimes indistinct; fringe scales orange yellow around apex, mixed

coppery-reddish and fuscous on dorsum. Hindwing and fringe scales fuscous. Legs with fore coxa dark fuscous, fore femur and tibia coppery-reddish; fore tarsus white apically ringed with coppery-reddish, broadly orange at middle of tarsomere I and base of tarsomeres II–V; mid leg as in fore leg; hind leg brassy-yellow, tibia with dorsal margin grey, tarsus strongly mixed with white. *Female genitalia* (Fig. 2B). Papillae anales covered with various lengths of setae. Apophyses anteriores almost as long as apophyses posteriores. Lamella postvaginalis weakly sclerotized, subtrapezoidal, with anterior margin deeply concave. Antrum very short. Ductus bursae very long and slender, slightly broadening toward corpus bursae. Corpus bursae elongate oval, 5/6 length of ductus bursae, with a pair of hooked signa near posterior margin.

Distribution. Korea (Jeju-do), Japan, India, Nepal.

Host plant. *Cleyera japonica* Thunb. (Theaceae) (Kumata, 1982).

GenBank accession number. OQ605712.

DNA sequence matching results. The DNA barcode obtained in this study showed 99.54% genetic similarity to Japanese *C. isochrysa* registered in GenBank (accession no. LC127830).

Remarks. See Kumata (1966; figs. 18, 39, 59 as *C. solaris*) and Kumata (1982; figs. 49, 59, 81) for the illustrations of adults and genitalia.

Superfamily Gelechioidea

Family Depressariidae

Subfamily Depressariinae

Genus *Depressaria* Haworth, 1811

²**Depressaria spectrocentra* Meyrick, 1935 (Figs. 1C, 2C)

Depressaria spectrocentra Meyrick, 1935: 593; Clarke, 1963: 182; Sakamaki, 2013: 197. Type locality: Okinosima, Japan.

Material examined. Korea: Jeju-do: 1♂, Jeju-si, Aewol-eup, Gwakji-ri, 18 May 2021, leg. Ga-Eun Lee, genitalia slide no. LGE22041 (NIBRIN0000980215), DNA voucher no. LGE-G641.

Diagnosis. It is difficult to distinguish the species from its allies based solely on external characteristics since many species of the genus have dark brown forewings marked with black streaks. The male genitalia of *D. spectrocentra* (Fig. 2C) are characterized by the well-developed cuiller (distal process of sacculus) and clavus (basal process of sacculus) and the short, curved aedeagus. Such genital morphology is somewhat similar to those of *D. emeritella* Stainton and *D. sibirilla* Lvovsky, but in *D. spectrocentra* the cuiller is more

Korean name: ¹*비쭈기가는나방(신칭), ²*검정무늬큰원뿔나방(신칭)

strongly curved with pointed apex and the clavus is narrower compared to the latter species.

Redescription. *Adult* (Fig. 1C). Wingspan 20.0–21.0 mm (Meyrick, 1935; Sakamaki, 2013), 20.5 mm in a Korean specimen. Head brownish-ochre, frons with lateral margins fuscous. Labial palpus brownish-ochre, segment I with a black line on outer surface; segment II heavily scattered with black scales, protruding on ventral surface; segment III slender, slightly longer than 1/2 length of II, black at base and at middle. Antenna light ochre on ventral surface, dark fuscous to black on dorsal surface. Thorax and tegula brownish-ochre, broadly scattered with brown scales, strongly mixed with fuscous on posterior margin of thorax. Forewing mixed brown and brownish-ochre, black at base below costa, the black scales broadly spreading toward apex, forming short and irregular longitudinal streaks in distal half of wing; fringe scales mixed black and brownish-ochre. Hindwing grey, fringe scales light brown except base dark grey. Legs mixed black and brownish-ochre, darker on outer surface. *Male genitalia* (Fig. 2C). Gnathos oval. Tegumen subtriangular, with anterior margin deeply concave. Valva elongate-triangle, slightly curved; apex blunt, densely setose; clavus slender, slightly curved outward, gradually narrowed toward pointed apex; cuiller situated after middle of valva, curved inward, sharply pointed at apex. Aedeagus short, strongly curved, gradually narrowed from base to apex.

Distribution. Korea (Jeju-do), Japan.

Host plant. Unknown.

GenBank accession number. OQ605713.

DNA sequence matching results. The DNA barcode obtained in this study showed 99.54% genetic similarity to Japanese *D. spectrocentra* (accession no. MN968432) registered in GenBank.

Remarks. See Lepiforum (2023) for the illustrations of adults and male genitalia and see Clarke (1963; plate 88, figs. 2–2c) for female genitalia (holotype).

Family Gelechiidae

Subfamily Gelechiinae

Genus *Sergeya* Ponomarenko, 2007

¹**Sergeya temulenta* (Omelko, 1998) (Figs. 1D, 3A, 3B)
Sinevia temulenta Omelko, 1998, in Omelko & Omelko: 245; Sakamaki, 2013: 279. Type locality: Primorsky Krai, Russia.
Sergeya temulenta Ponomarenko, 2008: 328; Leley, 2016: 129.

Material examined. Korea: 1♂, Jeollanam-do, Sinan-gun,

Aphae-eup, Daecheon-ri, 9 Sep 2021, leg. Ga-Eun Lee, genitalia slide no. LGE22063, DNA voucher no. LGE-G631.

Diagnosis. The species can be diagnosed by the brown forewing with the dark fuscous costa and the termen, and the presence of a black spot at the end of the discal cell. The male genitalia (Fig. 3A) are characterized by the tufted uncus, the reduced tegumen, the broad valvae and the anellus lobes bearing a robust spine. Also, it is distinctive as the abdominal segment II (Fig. 3B) bears a bundle of hair pencils. The female genitalia are unknown for the species.

Redescription. *Adult* (Fig. 1D). Wingspan 7.0–8.6 mm (Omelko, 1998; Sakamaki, 2013), 7.0 mm in a Korean specimen. Head with frons shining light grey, vertex strongly mixed with fuscous. Labial palpus mixed light grey and cream, segment II with outer surface fuscous; segment III 2/3 length of II, ringed with fuscous at base and at middle. Antenna with ventral surface light brown, dorsal surface fuscous except distal 1/2 alternating with light brown. Thorax light brown, medially suffused with fuscous. Tegula fuscous, slightly tinged with light brown posteriorly. Forewing ground color brown, fuscous at base; costa broadly fuscous, this dark shade extended and sometimes forming an indistinct spot at middle of wing; distal 1/4 of wing broadly fuscous beyond cell, a small black spot just before the fuscous area near tornus, apex same as ground color; fringe scales mixed light brown and fuscous. Hindwing and fringe scales dark grey. Legs cream to light brown, strongly mixed with fuscous on outer surface. *Male genitalia* (Fig. 3A). Uncus tufted with long hairs. Gnathos absent. Tegumen small, subtriangular. Valva large and broad, gradually widening toward apex; apex rounded, with long dense hairs. Anellus lobe oval, bearing a robust, hooked apical spine. Vinculum simple, band-like. Saccus large, gradually narrowed from base, slightly constricted before apex; apex sparsely setose, blunt. Aedeagus with basal 1/3 dilated, then narrowed toward apex, distal 2/3 sinuous.

Distribution. Korea (Jeollanam-do), Japan, Russia.

Host plant. Unknown.

GenBank accession number. OQ605714.

DNA sequence matching results. The DNA barcode obtained in this study did not match any sequences available on BOLD or GenBank database.

Remarks. *Sergeya temulenta* was originally described in a monotypic genus *Sinevia* by Omelko in Omelko and Omelko (1998). However, it is a homonym of *Sinevia* Kerzhner in Hemiptera, and Ponomarenko (2008) later proposed a new replacement name *Sergeya* to accommodate the species. The genus has been assigned to the subfamily Gelechiinae, but the systematic position needs to be re-evaluated (Sakamaki, 2013). The male genital structure with a robust spine is tenta-

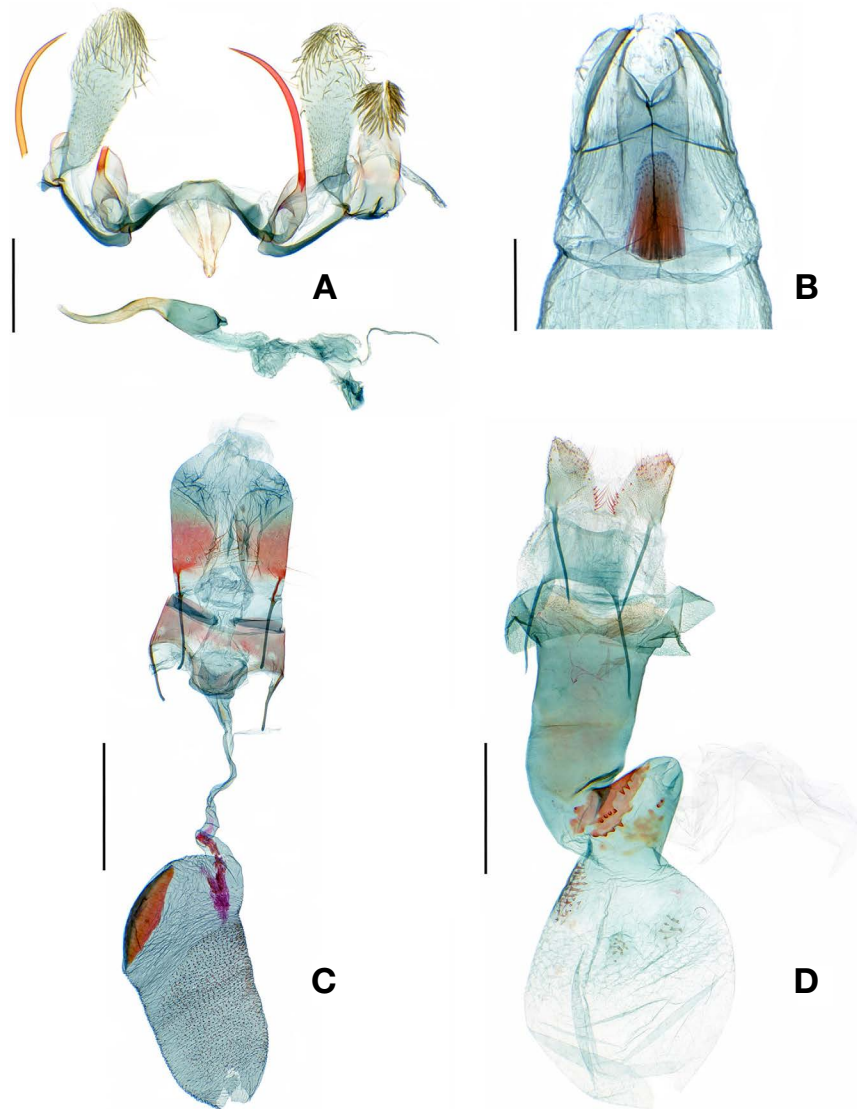


Fig. 3. Genitalia and abdomen of three unrecorded species. A, Male genitalia of *Sergeya temulenta* (Omelko); B, Male abdominal segment I-III of *S. temulenta* (Omelko); C, Female genitalia of *Thiotricha attenuata* Omelko; D, Female genitalia of *Philenora latifasciata* Inoue & Kobayashi. Scale bars: A, B=0.2 mm, C, D=0.5 mm.

tively interpreted as anellus lobes in this study. The terminology should be further refined based on comparative studies with other related species. See Omelko (1998; figs. 10–13) for the illustrations of the forewing and the male abdomen and genitalia. *Sergeya* is reported from Korea for the first time in this study.

Subfamily Thiotrichinae
Genus *Thiotricha* Meyrick, 1886

¹**Thiotricha attenuata* Omelko, 1993 (Figs. 1E, 3C)

Korean name: ¹*가는무늬빗줄빨나방 (신칭)

Thiotricha attenuata Omelko, 1993: 212; Omelko, 1999: 182; Ueda & Fujiwara, 2005: 75. Type locality: Primorsky Krai, Russia.

Polyhymno attenuata (Omelko): Park & Ponomarenko, 2007: 43; Ponomarenko, 2008: 91; Sakamaki, 2013: 48, 297.

Material examined. Korea: Gangwon-do: 1♀, Inje-gun, Girin-myeon, Bangdong-ri, 21 Jul 2012, leg. Sung-Soo Kim, genitalia slide no. LGE22108 (NIBRIN0000714209).

Diagnosis. The species can be recognized by the cream to dark grey forewing having a narrow longitudinal streak in

distal 1/4. The forewing patten of *T. attenuata* is simpler compared to its allies because many species in the genus have broad bands or streaks lying from the base to the apex. The female genitalia (Fig. 3C) are distinctive as the corpus bursae contain numerous spines and the signum is large semi-elliptical.

Redescription. *Adult* (Fig. 1E). Wingspan 10.0–12.7 mm (Omelko, 1993; Sakamaki, 2013), 11.5 mm in a Korean specimen. Head creamy white. Labial palpus cream, with segment I very short, segment II slightly longer than III. Antenna cream, female with flagellum shortly ciliated. Thorax and tegula creamy white. Forewing cream, anterior edge of costa black at base; a brown costal streak from distal 1/5 of wing, obliquely running toward apical spot; beyond this, another brown streak running along costa, reaching apical spot distally; a brown median streak from distal 1/4 of wing, running longitudinally and confluent with former costal streak before apical spot; apical spot black, elongate oval; termen strongly mixed with white, a small brown spot on termen near apex; dorsum scattered with fuscous, this dark shade slightly expanded near tornus; fringe scales white to grey. Hindwing and fringe scales fuscous. Legs creamy white in part, scales mostly denuded. *Female genitalia* (Fig. 3C). Papillae anales sparsely setose. Apophyses anteriores slightly shorter than apophyses posteriores. Sternum VIII short, with anterior margin strongly elongate. Ostium bursae large and round. Ductus bursae broad at base, then slightly narrowed, anterior 3/4 almost uniformly elongate toward corpus bursae; a small sclerite near base of ductus bursae. Corpus bursae elongate oval, slightly longer than ductus bursae, set with numerous minute spines in anterior 2/3; signum large, elliptical, situated in posterior 1/3.

Distribution. Korea (Gangwon-do), Japan, Russia.

Host plant. Unknown.

GenBank accession number. The DNA barcode of *T. attenuata* was not obtained in this study.

Remarks. The Korean specimen has the forewing color lighter than the type materials from Russia, which have dark brown wings (Omelko, 1993). See Omelko (1993; fig. 24) and Park and Ponomarenko (2007; pls. 16, 71) for the illustrations of adults and genitalia.

Superfamily Noctuoidea

Family Erebidae

Genus *Philenora* Rosenstock, 1885

¹**Philenora latifasciata* Inoue & Kobayashi, 1963

(Figs. 1F, 3D)

Philenora latifasciata Inoue & Kobayashi, 1963: 3; Kishida, 2011: 156. Type locality: Kumanotaira, Gumma Pref., Japan.

Material examined. Korea: Jeju-do: 1♀, Jeju-si, Jocheon-eup, Seonheul-ri, 4 Jun 2013, leg. Ga-Eun Lee; 2♀, Seogwi-po-si, Topyeong-dong, Donnaeko, 18 Sep 2021, leg. Ga-Eun Lee, genitalia slide no. LGE22015 (NIBRIN0000980214), DNA voucher no. LGE-G624.

Diagnosis. The species can be distinguished from other congeneric species by the forewing with a broad dark grey postmedian band and a black elliptical spot in the cell. The female genitalia (Fig. 3D) are diagnosed by the broad ductus bursae and the large toothed signum situated at the entrance of the corpus bursae.

Redescription. *Adult* (Fig. 1F). Wingspan 14.0–17.0 mm (Kishida, 2011), 15.5–19.5 mm in Korean specimens. Head, labial palpus, thorax and tegula pale grey-brown, sometimes strongly mixed with fuscous. Antenna mixed grey-brown and fuscous, female with flagellum shortly ciliated. Forewing ground color pale grey-brown, costa sometimes with a fuscous, semi-elliptical marking from basal 1/4 to 1/2 of wing; a round, fuscous marking on dorsum, situated from base to basal 1/4 of wing; an elliptical black spot in discal cell; beyond this, a very broad dark fuscous postmedian band, its inner margin obliquely extended from distal 1/3 of costa to 1/2 of dorsum, outer margin somewhat indistinct and nearly reaching termen; fuscous scales scattered between former markings; fringe scales mixed grey-brown and fuscous. Hindwing fuscous, fringe scales as in forewing. Legs pale grey-brown, fore and mid legs strongly mixed with fuscous. *Female genitalia* (Fig. 3D). Papillae anales with posterior margin sparsely setose, a row of stiff setae along basal 1/3 of inner margins. Apophyses anteriores as long as apophyses posteriores. Segment VIII weakly sclerotized, slightly concave posteriorly. Ductus bursae very broad, moderately sclerotized, strongly curved near corpus bursae; a large signum placed at the shoulder, with a row of teeth along its lateral margins. Corpus bursae oval, membranous, as long as ductus bursae, with a group of spines near entrance of ductus bursae, two smaller groups of spines at posterior 1/3.

Distribution. Korea (Jeju-do), Japan, Taiwan.

Host plant. Unknown.

GenBank accession number. OQ605715.

DNA sequence matching results. The DNA barcode obtained in this study did not match any sequences available on BOLD or GenBank database.

Remarks. See Kishida (2011; pl. 2-021) and Inoue and Kobayashi (1963; fig. 1c) for the illustrations of adults, and see Inoue and Kobayashi (1963; fig. 1a, 1b) for male and female genitalia. *Philenora* is a small genus mainly distributed in the Australian region (Common, 1990; Savela, 2023). It is considered as a heterogenous group (Inoue and Kobayashi, 1963;

Cerny and Pinratana, 2009), but further review is required for this little-known genus. The genus is reported from Korea for the first time in this study.

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CONFLICTS OF INTEREST

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

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