

## Seven New Records of Geometrid Moths (Lepidoptera: Geometridae) from Korea

Sei-Woong Choi<sup>1,\*</sup>, Sung-Soo Kim<sup>2</sup>, Un-Hong Heo<sup>3</sup>

<sup>1</sup>Department of Environmental Education, Mokpo National University, Muan 58554, Korea

<sup>2</sup>Research Institute for East Asian Environment and Biology, Seoul 05236, Korea

<sup>3</sup>107-604 Sinwon Arsis, Suncheon 38613, Korea

### ABSTRACT

The family Geometridae, which is one of the most species-rich taxa of Lepidoptera, includes more than 23,000 species worldwide and over 800 species in South Korea. Herein, we record six species of Geometridae for the first time in Korea. *Jodis urosticta* and *Jodis amamiensis* can be characterized by their greenish wings and strongly dentate ante- and postmedial lines on the fore- and hindwings. These species can also be separated by the shape of the valva of the male genitalia. *Pelagodes antiguadraria* can be characterized by their greenish wings, whitish medial bands on the forewing and whitish postmedial line on the hindwing. *Brabira kasaii* can be characterized by the thick grayish band-shaped central fascia of their fore- and hindwings. *Sauris marginepunctata* can be characterized by the greenish ground color of the forewing, the dark ochreous medial bands and subterminal line and the grayish hindwing. *Philereme vetulata* can be characterized by their dark brownish wing color and the band-shaped central fascia of the forewing, as well as the medially projected postmedial line of the hindwing. *Echthrocollix minuta* can be characterized by their pale grayish wing color, brownish postmedial and subterminal lines and large discal dot.

**Keywords:** taxonomy, Lepidoptera, Geometridae, new record, Korea

### INTRODUCTION

Geometridae are slender-bodied, broad-winged moths with a small to large wingspan. These organisms comprise one of the largest moth groups of Lepidoptera, with over 23,000 species worldwide. The monophyly of the group is well defined (Sihvonen et al., 2011), and they can be identified by the absence of ventral prolegs of abdominal segments A3–A5 as well as the unique structure of the tympanal organs at the base of the abdomen (Minet and Scoble, 1999; Sihvonen et al., 2011). In South Korea, the family includes about 800 species (Choi, 2006). Herein, we describe seven species of Geometridae for the first time: *Jodis urosticta*, *Jodis amamiensis*, *Pelagodes antiguadraria*, *Brabira kasaii*, *Sauris marginepunctata*, *Philereme vetulata*, and *Echthrocollix minuta*.

Examination of adults, including the male and female genitalia, is in reference to Hausmann (2001). Abbreviations

are as follows: TL, type locality; GW, Gangwon-do; GB, Gyungnsanbuk-do; GN, Gyungnsangnam-do; and JN, Jeollanam-do.

### SYSTEMATIC ACCOUNTS

Order Lepidoptera Linnaeus, 1758  
Family Geometridae Stephens, 1829  
Subfamily Geometrinae Leach, 1815  
Genus *Jodis* Hübner, [1823] 1816

<sup>1\*</sup>*Jodis urosticta* Prout, 1930 (Figs. 1A, 2A–C)  
*Jodis urosticta* Prout, 1930: 295. TL: [Japan] Tokyo.

**Material examined.** Korea, 1♂, JN: Wando, Gunwoemyeon, Wando Arboretum, 16 Jul 2015, Kim SS; 1♂, Wando, Gunwoemyeon, Wando Arboretum, 16 Sep 2015, Kim

Korean name: <sup>1\*</sup>톱니줄무늬푸른자나방(신칭)

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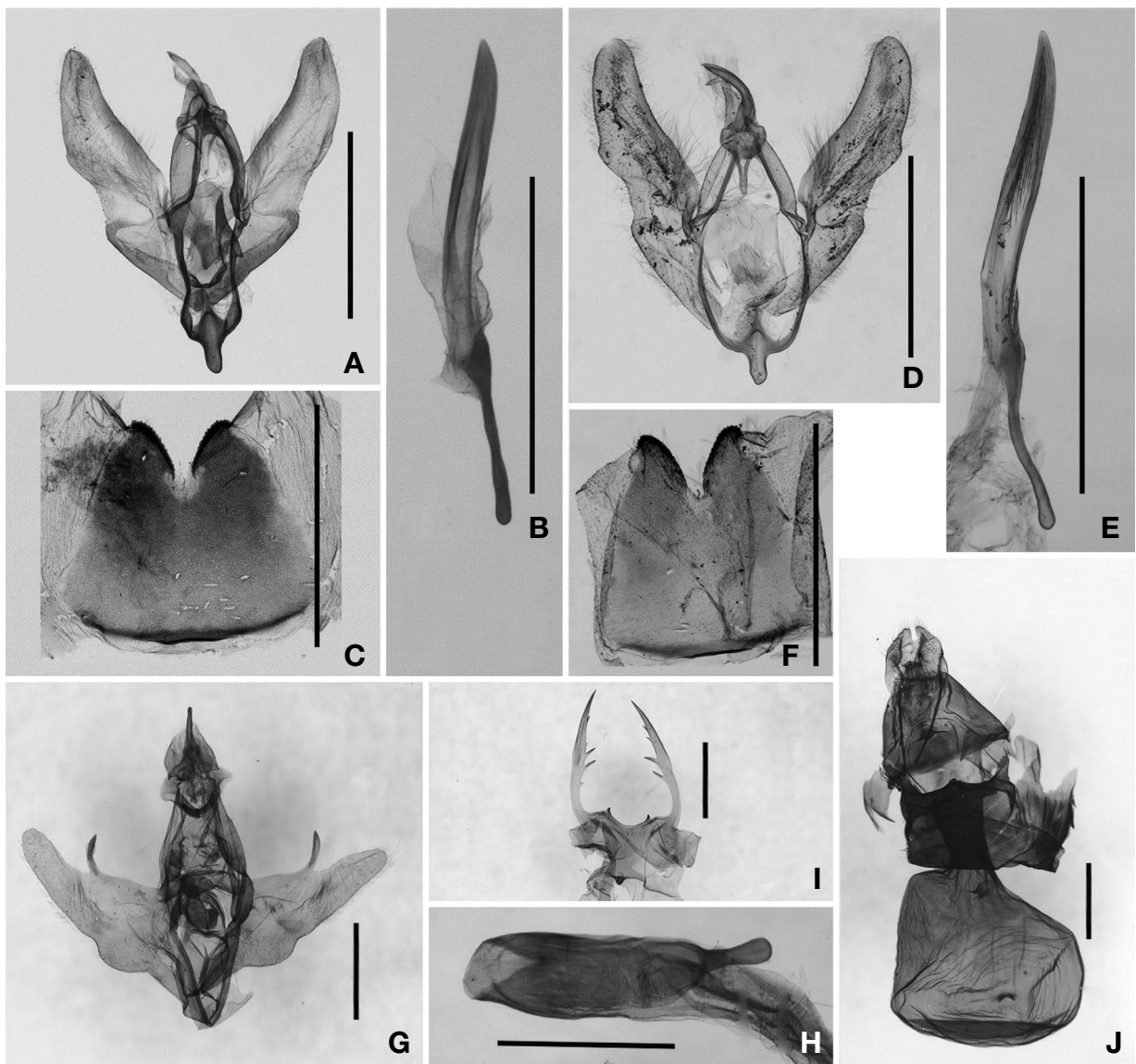
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**\*To whom correspondence should be addressed**  
Tel: 82-61-450-2783, Fax: 82-61-450-2789  
E-mail: choisw@mokpo.ac.kr

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**Fig. 1.** Adults of three species of Geometrinae in Korea. A, *Jodis urosticta* Prout; B, *Jodis amamiensis* Inoue; C, *Pelagodes antiguadraria* (Inoue). Scale bars: A-C=10 mm.



**Fig. 2.** Male and female genitalia of three Geometrinae species in Korea. A, D, G, Genital capsule; B, E, H, Aedeagus; C, F, I, Male 8th abdomen; J, Female genitalia; A-C, *Jodis urosticta*; D-F, *Jodis amamiensis*; G-J, *Pelagodes antiguadraria*. Scale bars: A-J=1 mm.

SS.

**Diagnosis.** This species is characterized by the light greenish ground color of its fore- and hindwings, whitish strongly dentate antemedial and postmedial lines of both wings and the pale yellowish costa of the forewing. This species is very similar to *Jodis amamiensis*, but distinguished by its relatively smaller wingspan and the pale yellowish costa of its forewing. The male genitalia can be identified by the long slender uncus and socii, as well as the medially projected gnathos, the membranous juxta, the medially strongly projected saccus and the long slender valva. Although the male genitalia of *Jodis urosticta* are similar to those of *J. amamiensis*, they can be distinguished by the broad sacculus without a projected process of the valva.

**Description.** Wingspan 18–19 mm. Antennae bipectinate in male; frons slender, grayish; labial palpi long, twice the eye diameter, upturned, well projected beyond the frons. Body and legs covered with whitish scales. Forewing: light blue greenish; costa pale grayish; antemedial line whitish, dentate; postmedial line whitish, strongly dentate, medially strongly projected; central fascia tapering to dorsum. Hindwing: light blue greenish; antemedial line whitish undulating; postmedial line whitish strongly dentate, medially projected. Male genitalia: uncus long, slender; socii long, digitate, slightly shorter than the uncus; gnathos long, medially fused; juxta simple, membranous; saccus long sclerotized process. Valva long and slender; costa weakly sclerotized, distally upturned; sacculus triangular, medially weakly projected. Aedeagus long spinular, basal stalk long, strongly sclerotized; vesical with two tubular bands of minute spicules. Posterior margin of the eighth sternum strongly sclerotized with dense minute teeth and medial notch.

**Distribution.** Korea, Japan.

**Remarks.** In Japan, this species is known as polyphagous feeding *Alnus pendula* (Betulaceae), evergreen oak spp. (Fagaceae), *Acer palmatum* (Asteraceae), *Rhododendron kaempferi* (Ericaceae), and *Hydrangea serrata* (Hydrangeaceae) (Nakajima, 2011). This species is bivoltine, flying April to May and September in Japan (Nakajima, 2011). In Korea two specimens were caught in July and September and the identification based on the genitalia confirmed that the specimens were *Jodis urosticta*.

<sup>1</sup>\**Jodis amamiensis* Inoue, 1982 (Figs. 1B, 2D–F)

*Jodis amamiensis* Inoue, 1982: 434, Pl. 58, fig. 31. TL: [Japan] Amami-Oshima Island, Higashinakama.

**Material examined.** Korea, 2♂, JN: Wando, Isl. Bogil-do, 34°08'47"N, 126°34'08"E, 47 m, 30 Jun 2008, Choi SW;

1♂, Wando, Gunwoe-myeon, Wando Arboretum, 16 Jul 2015, Kim SS.

**Diagnosis.** This species is characterized by the green grayish ground color of its fore- and hindwings, the whitish strongly dentate antemedial and postmedial lines of both wings and the pale yellowish costa of the forewing. Although this species is very similar to *Jodis urosticta*, it can be distinguished by its relatively larger wingspan and the indistinct costa of its forewing. The male genitalia can be identified by the long slender uncus and socii, the medially projected gnathos, the membranous juxta, the medially strongly projected saccus and the long slender valva. The male genitalia of *Jodis amamiensis* are similar to those of *J. urosticta*, but are distinguished by the medially projected process of the sacculus.

**Description.** Wingspan 20–22 mm. Antennae bipectinate in male; frons slender, brownish; labial palpi long, twice the eye diameter, upturned, well projected beyond the frons. Body and legs covered with whitish scales. Forewing: dark greenish; antemedial line whitish, dentate; postmedial line whitish, strongly dentate, medially strongly projected; central fascia tapering to dorsum. Hindwing: dark greenish; antemedial line whitish undulating; postmedial line whitish strongly dentate, medially projected. Male genitalia: uncus long, slender; socii long, digitate, slightly shorter than the uncus; gnathos long, medially fused; juxta simple, membranous; saccus long sclerotized process. Valva long and slender; costa weakly sclerotized, distally upturned; sacculus triangular, medially weakly projected. Aedeagus long spinular, basal stalk long, strongly sclerotized; vesical with two tubular bands of minute spicules. Posterior margin of the eighth sternum strongly sclerotized with dense minute teeth and medial notch.

**Distribution.** Korea, Japan.

**Remarks.** Host plant is unknown. This species is bivoltine in Japan (Nakajima, 2011).

Genus *Pelagodes* Holloway, 1996

<sup>2</sup>\**Pelagodes antiquadraria* Inoue, 1976 (Figs. 1C, 2G–J)

*Thalassodes antiquadraria* Inoue, 1976: 9, figs. 4–6. TL: [Japan] Okinawa Island, Yona.

**Material examined.** Korea, 1♂, GB: Gyeongju, Sannaemyeon, Eomeo-ri, 16 Jul 2012, Kim SS; 1♀, JN: Jindo, Mt. Chumchalsan, 34.472194, 126.323528, 431 m, 6 Jul 2016, Choi SW.

**Diagnosis.** This species is characterized by the light green ground color of its fore- and hindwings, the whitish ante-

Korean name: <sup>1</sup>\*뽕족줄무늬푸른자나방 (신칭), <sup>2</sup>\*민줄무늬푸른자나방 (신칭)

and postmedial lines of the forewing and the whitish postmedial line of the hindwing. The male genitalia can be identified by the tapered uncus and the triangular valva with a long projected costa, as well as the stout aedeagus with a long basal stalk. The female genitalia can be identified by the broad antrum with a small medial projection of the lamella postvaginalis, the short ductus bursae and the large corpus bursae posteriorly with a nipple-shaped process and anteriorly with a small lunular process.

**Description.** Wingspan 29 mm. Antennae bipectinate in male and filiform in female; frons slender, brownish; labial palpi moderate, about 1.5 times the eye diameter, upturned, projected beyond the frons. Body covered with white scales. Forewing: green; antemedial line white slanted; postmedial line white, weakly slanted. Hindwing: green, postmedial line white, medially strongly curved; termen weakly projected. Male genitalia: uncus tapered; socii triangular; gnathos semi-circular; juxta membranous; saccus rounded. Valva long, triangular, distally tapered; costa medially with a long spinular

process; sacculus basally expanded, medially weakly invaginated. Aedeagus stout, basally a long nipple-shaped stalk; vesical without a cornutus. Posterior margin of the eighth sternum sclerotized with symmetrical spinular processes. Female genitalia: papillae anales simple, broad; apophyses posteriores almost twice the length of apophyses anteriores; lamella postvaginalis medially projected; antrum broad; ductus bursae short, about half of the length of corpus bursae; corpus bursae large, ovate with a small nipple-shaped posterior process and a small lunular anterior process.

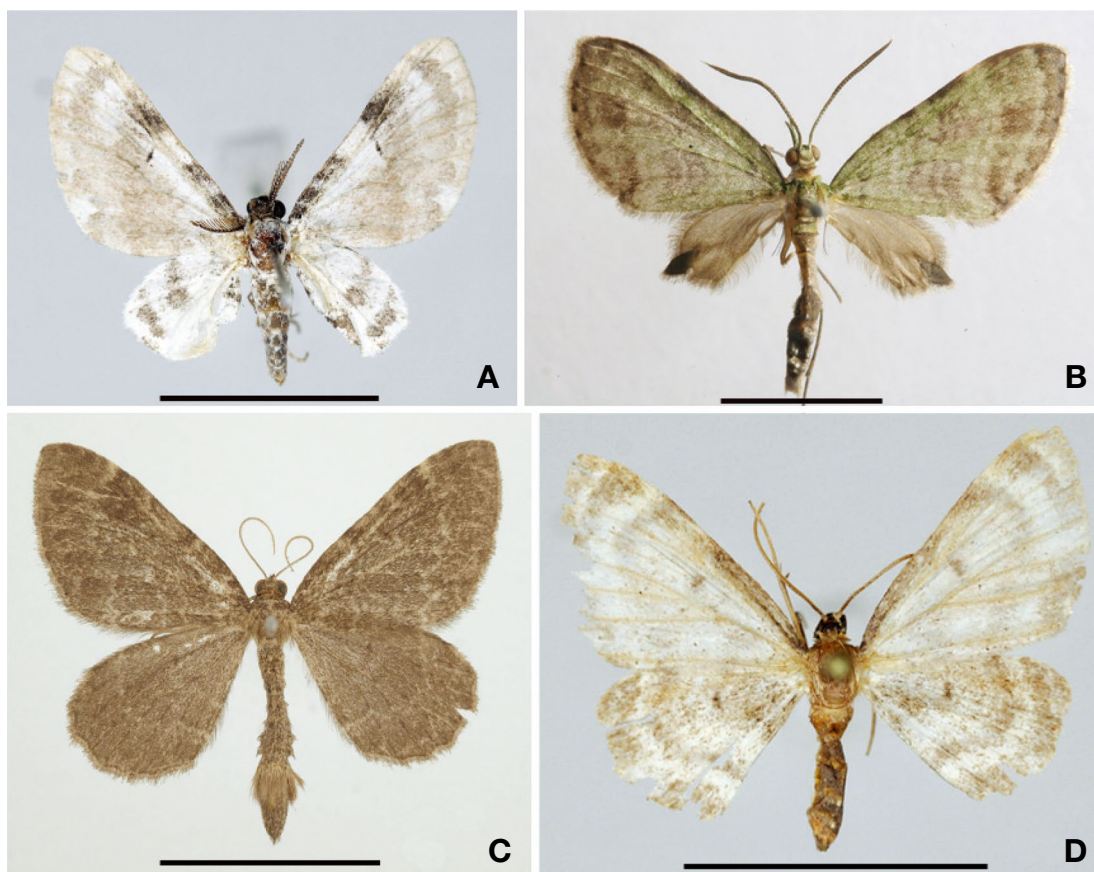
**Distribution.** Korea, Japan, China (Hong Kong), Taiwan, Thailand, northern India.

**Remarks.** This species feeds on *Schima liukiensis* Nakai (Theaceae) in Japan (Nakajima, 2011).

Subfamily Larentiinae Duponchel, 1845

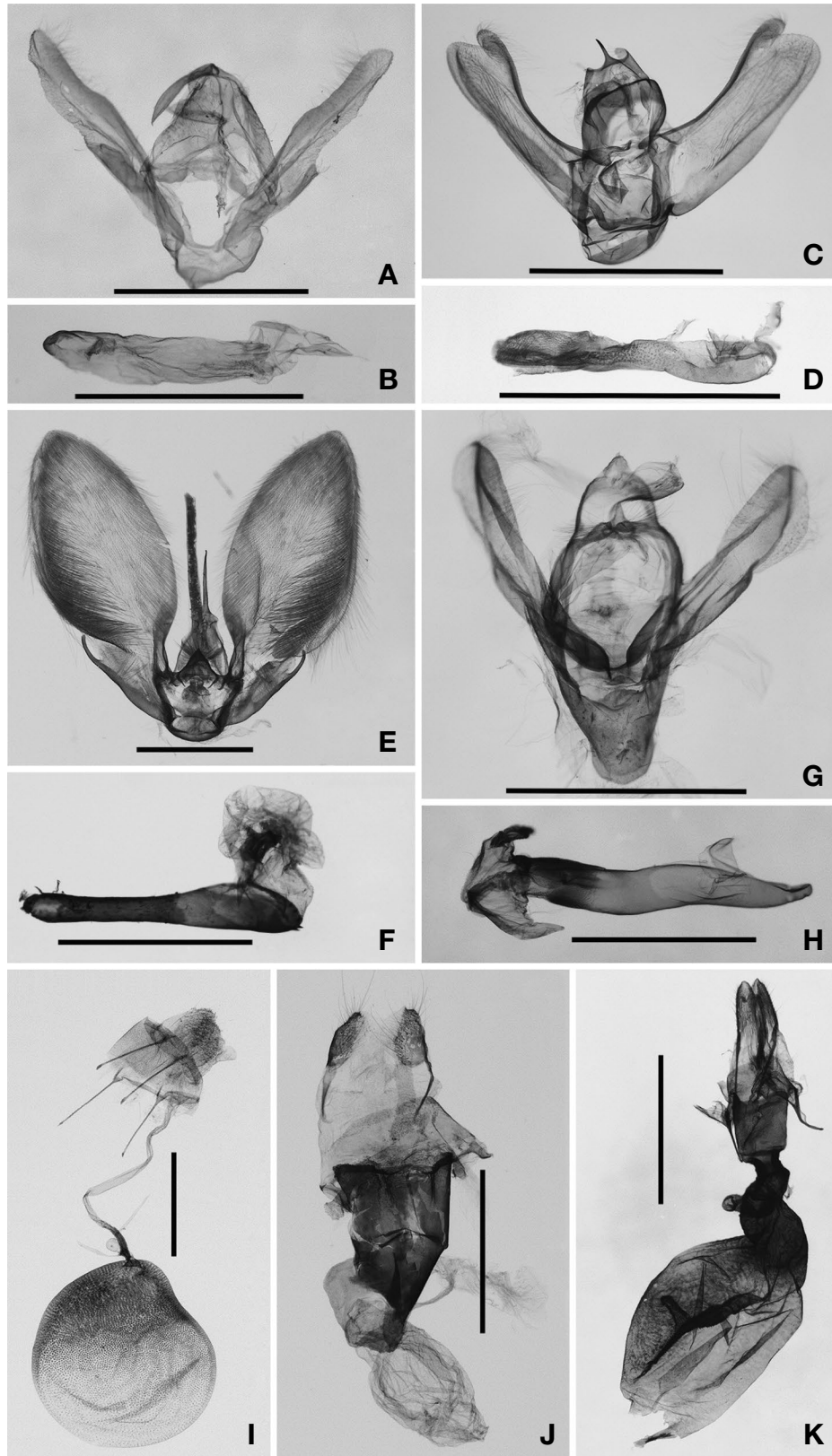
Genus *Brabira* Moore, 1888

<sup>1</sup>\**Brabira kasaii* Sato, 1986 (Figs. 3A, 4A, B)



**Fig. 3.** Adults of four species of Larentiinae in Korea. A, *Brabira kasaii* Sato; B, *Sauris marginepunctata* (Warren); C, *Philereme vetulata* (Denis and Schiffermüller); D, *Echthrocollix minuta* (Butler). Scale bars: A–D = 10 mm.

Korean name: <sup>1</sup>\*꼬마잔날개물결자나방 (신칭)



**Fig. 4.** Male and female genitalia of four Larentiinae species in Korea. A, B, *Brabira kasaii*; C, D, I, *Sauris marginepunctata*; E, F, J, *Philereme vetulata*; G, H, K, *Echthrocollix minuta*. Scale bars: A-K=1 mm.

*Brabira kasaii* Sato, 1986: 129, figs. 1, 2, 5–8. TL: [Japan] North Honshu, Aomori Prefecture, Higashidori, Ori.

**Material examined.** Korea, 1♂, GB: Gyeongju, Gujeong-dong, Sojeong hill (Bulguk), 12 Jul 2012, Kim SS.

**Diagnosis.** This species is characterized by its bipectinate male antennae, the white ground color of the fore- and hindwings, the thick grayish band-shaped central fascia and a dark grayish undulating subterminal line on the forewing, as well as a blackish band-shaped central fascia and subterminal line on the hindwing. This species is similar to *Brabira artemidora*, it can be distinguished by the broad band-shaped central fascia and subterminal line of the forewing and the band-shaped central fascia and subterminal line of the hindwing. The male genitalia can be identified by the long slender valva with medially expanded costa and sacculus. Although the male genitalia of the species are similar to those of *B. artemidora*, they can be distinguished by the medially expanded costa and the projected sacculus process of the valva.

**Description.** Wingspan 17 mm. Antennae bipectinate with long pectination in male; frons broad, dark ochreous, bottom whitish; labial palpi moderate, about 1.5 times the eye diameter, upturned, weakly projected beyond the frons. Body covered with yellowish scales. Forewing: white, basal part costally blackish; central fascia light grayish band, costally blackish, dorsally expanded, with thin blackish discal dot; subtermen dark grayish with whitish undulating line. Hindwing: whitish, central fascia black band; subtermen with black band. Male genitalia: uncus long, slender; tegumen broad, triangular, almost same length of the vinculum; saccus broad, rounded. Valva long, slender; costa medially expanded; sacculus expanded. Aedeagus long, tubular, distally with a small sclerotized process.

**Distribution.** Korea, Japan.

**Remarks.** Two species of *Brabira* are distributed throughout South Korea: *B. artemidora* (Oberthür) and *B. kasaii*.

Genus *Sauris* Guenée, 1858

<sup>1</sup>\**Sauris marginepunctata* (Warren, 1899)

(Figs. 3B, 4C, D, I)

*Holorista marginepunctata* Warren, 1899: 339. TL: [Philippines] Negros.

*Sauris plagulata* Bastelberger, 1911: 241. TL: [Taiwan] Arizan.

**Material examined.** Korea, 1♂, JN: Gwangyang, Mt. Baekunsan, Donggok valley, larva 14 Jul 2016, ex pupae 19 Jul

2016, feeds on *Acer pictum* var. *mono*, Heo UH; 1♀, Wando, Gunwoe-myeon, Wando Arboretum, 16 Jul 2015, Kim SS.

**Diagnosis.** This species is characterized by the long porrect labial palpi, the greenish ground color of its forewing with dark ochreous medial bands and a dark ochreous subterminal line and termen, and the grayish hindwing with a large blackish sexual scale in males. The male genitalia can be identified by the short uncus, the well-developed digitate socii and the long, slender, distally bifurcated valva with the sclerotized costa. The female genitalia can be distinguished by the narrow, membranous antrum, the long thin ductus bursae and the large, ovate corpus bursae that are densely filled with minute spicules.

**Description.** Wingspan 20–27 mm. Antennae in both sexes relatively thick, filiform, frons slender and greenish, labial palpi long, porrect, more than three times the eye diameter. Body covered with yellowish white scales; legs simple. Forewing: greenish, basal part dark greenish thick line; central fascia with brown undulating medial lines; subtermen brownish band, tapered to dorsum; termen brownish. Hindwing: grayish in both sexes, male with reduced wing, long sexual tufts on dorsum base, and large black scale on mid-termen. Male genitalia: uncus slender, socii digitate, well developed; tegumen broad, hood-shaped; juxta membranous; saccus broad, semi-rounded. Valva long, slender, distally bifurcated; costa thin, sclerotized, distally expanded. Aedeagus long; vesica covered with spicules. Female genitalia: Papillae anales simple, not projected; apophyses posteriores almost same length of apophyses anteriores; antrum narrow, membranous; ductus bursae thin, long, coiled anteriorly, membranous; corpus bursae ovate densely filled with minute spicules.

**Distribution.** Korea, Japan, Taiwan, Philippines, Borneo.

**Remarks.** This species feeds on *Prunus zippeliana*, *Rosa* sp. (Rosaceae) and *Machilus thunbergii* (Lauraceae) in Japan (Nakajima and Yazaki, 2011). In southern Korea, the larva was reared with *Acer pictum* var. *mono* (Sapindaceae).

Genus *Philereme* Hübner, 1825

<sup>2</sup>\**Philereme vetulata* ([Denis and Schiffermüller, 1775])

(Figs. 3C, 4E, F, J)

*Geometra vetulata* Denis and Schiffermüller, 1775: 109. TL: [Austria] Vienna district.

*Acidallia affectata* Eversmann, 1842: 557. TL: [Russia] Volga, Sarepta.

*Campogramma subuctata* Walker, 1862: 1331.

*Phalaena undulataria* Hufnagel, 1767: 512. TL: [Germany]

Korean name: <sup>1</sup>\*미무늬초록물결자나방 (신칭), <sup>2</sup>\*미검정물결자나방 (신칭)

Berlin region.

*Scotosia vetulata vetustata* Staudinger, 1897: 81. TL: [Russia] Amur, Askold, Ussuri, Bikim, Suifun, Sutschan.

**Material examined.** Korea, 1♂1♀, GW: Dunnae-myeon, Hyuncheon-ri, Heongseong, 10 Jun 2016, Kim SS.

**Diagnosis.** This species is characterized by the dark brownish ground color of its fore- and hindwings, a band-shaped central fascia with costally and medially projected postmedial line, a minute blackish discal dot on the forewing and the medially projected postmedial line on the hindwing. Although this species is similar to *Philereme corrugata*, it can be distinguished by the medially projected postmedial line of the forewing and the medially projected postmedial line of the hindwing. The male genitalia can be identified by the long, spinular uncus, the triangular transtilla and the large, hairy valva. The male genitalia are similar to those of *P. corrugata*, but differ in their long sacculus process of the valva. The female genitalia can be identified by the broad antrum, the strongly sclerotized ductus bursae and the membranous corpus bursae. While the female genitalia are similar to those of *P. corrugata*, they can be distinguished by the broad, sclerotized ductus bursae.

**Description.** Wingspan 22–25 mm. Antennae filiform; frons broad, dark brownish; labial palpi long, upturned, weakly projected beyond the frons. Body covered with dark brown and yellowish white scales. Forewing: dark brown; antemedial line pale blackish, weakly undulating; discal dot minute, blackish; postmedial line pale brownish, undulating, costally and medially projected; subtermen with pale yellowish undulating line. Hindwing: dark brown; discal dot blackish; postmedial line pale brownish, undulating, medially projected. Male genitalia: uncus long, tapered; transtilla well developed, triangular, medially hairy; juxta membranous; saccus broad. Valva large and hairy, medially largely expanded; sacculus sclerotized, distally with long process. Aedeagus long, slender, distally expanded with minute processes; vesical without a cornutus. Coremata on the third sternum present. Female genitalia: papillae anales simple, weakly sclerotized; apophyses posteriores almost four times the length of apophyses anteriores; antrum broad; ductus bursae broad, short, strongly sclerotized, anteriorly tapered; corpus bursae ovate without a signum.

**Distribution.** Palearctic region including Korea.

**Remarks.** Three species of *Philereme* are distributed throughout South Korea, including the newly recorded *Philereme vetulata* (Choi, 2013). The species is oligophagous feeding on *Rhamnus* and *Frangula* (Rhamnaceae), *Crataegus* and *Prunus* (Rosaceae) and *Vaccinium* (Ericaceae) (Hausmann

and Viidalepp, 2012). The population found in the Korean peninsula can be belonged to a subspecies, *vetustata* Staudinger.

Genus *Echthrocollix* Inoue, 1953

<sup>1</sup>\**Echthrocollix minuta* (Butler, 1881)

(Figs. 3D, 4G, H, K)

*Collix minuta* Butler, 1881: 421. TL: [Japan] Yokohama.

**Material examined.** Korea, 1♂, GN: Tongyoung, Dala Park, 1 May 2014. Kim SS; 1♂4♀, JN: Sinan, Gageo-do, Mt. Doksilsan, 34°03'47"N, 125°07'22"E, 378 m, 12 Jun 2012, Choi SW.

**Diagnosis.** This species is characterized by the pale grayish ground color of the fore- and hindwings with brownish postmedial and subterminal lines and the large discal dot on both wings. The male genitalia can be identified by the short, triangular uncus, the semi-circular transtilla with medial hairs, the long saccus and the long, slender valva. The female genitalia can be identified by the broad antrum, the semi-rounded colliculum, the twisted ductus bursae and the large corpus bursae with a long longitudinal band of spicules and a short nipple-shaped band of spicules.

**Description.** Wingspan 17–19 mm. Antennae filiform, frons broad, dark ochreous; labial palpi moderate, about 1.5 times the eye diameter, upturned, projected beyond the frons. Body covered with yellowish white scales. Forewing: grayish, basal part blackish; postmedial line thick, dark brown, rounded; discal dot large, dark brown; subtermen with dark brown band; underside whitish with a discal dot and dark brown postmedial and subterminal lines. Hindwing: grayish, basally dark brownish; dark brown discal dot present; postmedial line dark brown, rounded; subtermen with dark brown band; underside with a dark brown discal dot and dark brown postmedial and subterminal lines. Male genitalia: uncus short, barely projected; transtilla medially fused with long hairs; saccus long, medially projected. Valva long slender; costa medially and distally expanded; sacculus expanded. Aedeagus, long and slender, distally sclerotized; vesica sparsely filled with minute spicules. Coremata present near genital capsule. Female genitalia: papillae anales simple, projected; apophyses posteriores almost twice the length of apophyses anteriores; antrum broad, cup-shaped; colliculum present; ductus bursae short, posteriorly twisted; corpus bursae large, ovate with a long longitudinal band of spicules and a nipple-shaped band of spicules.

**Distribution.** Korea, Japan, Taiwan.

Korean name: <sup>1</sup>\*둥근피물결자나방 (신칭)

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## REFERENCES

- Bastelberger MJ, 1911. Neubeschreibungen von Geometriden aus dem Hochgebirge von Formosa. *Internationale Entomologische Zeitschrift*, 4:241-248.
- Butler AG, 1881. Descriptions of new genera and species of Heterocerous Lepidoptera from Japan. *Transactions of the Entomological Society of London*, 29:401-426. <https://doi.org/10.1111/j.1365-2311.1881.tb03218.x>
- Choi SW, 2006. Patterns of species description and species richness of geometrid moths (Lepidoptera: Geometridae) on the Korean peninsula. *Zoological Science*, 23:155-160. <https://doi.org/10.2108/zsj.23.155>
- Choi SW, 2013. *Insect Fauna of Korea*. Vol. 16, No. 10. *Arthropoda: Insecta: Lepidoptera: Geometridae III. Geometrids*. National Institute of Biological Resources, Incheon, pp. 1-109.
- Denis M, Schiffermüller I, 1775. *Ankündigung eines systematischen Werkes von den Schmetterlingen der Wiener Gegend*. Bernardi, Vienna, pp. 1-324.
- Eversmann EE, 1842. *Quaedam Lepidopterorum. Species novae in Rossia Orientali observatae, nunc descriptae et depictae*. *Bulletin de la Société Impériale des Naturalistes de Moscou*, 15:543-565.
- Hausmann A, 2001. *The geometrid moths of Europe*. Vol. 1. Apollo Books, Stenstrup, pp. 1-282.
- Hausmann A, Viidalepp J, 2012. *The geometrid moths of Europe*. Vol. 3. Apollo Books, Stenstrup, pp. 1-743.
- Hufnagel JS, 1767. IV. Fortsetzung der Tabelle von den Nachtvögeln, welche die 3te Art derselben, nemlich die Spannenmesser (Phalaenas Geometras Linnaei) enthält. *Berlinisches Magazin*, 4:504-527.
- Inoue H, 1976. Descriptions and records of some Japanese Geometridae (V). *Tinea*, 10:7-37.
- Inoue H, 1982. *Geometridae*. In: *Moths of Japan*, Vol. 1 (Eds., Inoue H, Sugi S, Kuroko H, Moriuti S, Kawabe A, Owada M). Kodansha, Tokyo, pp. 458-460.
- Minet J, Scoble MJ, 1999. The Drepanoid/Geometroid assemblage. In: *Lepidoptera, moths and butterflies. Handbook of zoology*, Vol. IV. *Arthropoda: Insecta* (Ed., Kristensen NP). Walter de Gruyter, Berlin, pp. 301-320.
- Nakajima H, 2011. *Geometrinae*. In: *The standard of moths in Japan I* (Ed., Kishida Y). Gakken Education Publishing, Tokyo, pp. 205-224.
- Nakajima H, Yazaki K, 2011. *Larentiinae*. In: *The standard of moths in Japan I* (Ed., Kishida Y). Gakken Education Publishing, Tokyo, pp. 248-316.
- Prout LB, 1930. On the Japanese Geometridae of the Aigner collection. *Novitates Zoologicae*, 35:289-337.
- Sato R, 1986. Descriptions of a new species of *Brabira* from North Honshu and a new subspecies of *Tyloptera bella* (Butler) (Geometridae: Larentiinae) from Amami-Oshima Island, Japan. *Japan Heterocerists' Journal*, 134:129-131.
- Sihvonen P, Mutanen M, Kaila L, Brehm G, Hausmann A, Staude HS, 2011. Comprehensive molecular sampling yields a robust phylogeny for geometrid moths (Lepidoptera: Geometridae). *PLoS One*, 6:e20356. <https://doi.org/10.1371/journal.pone.0020356>
- Staudinger O, 1897. Die Geometriden des Amurgebiets. *Deutsche Entomologische Zeitschrift Iris*, 10:1-122.
- Walker F, 1862. *List of the specimens of lepidopterous insects in the collection of the British Museum*. Part. XXV. London, p. 1331.
- Warren, W. 1899. *New Drepanulidae, Thyrididae, Epiplemidae, Uraniidae, and Geometridae from the Oriental and Palaearctic regions*. *Novitates Zoologicae*, 6:313-359.

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