

One new species and one new record of lymantriine moths (Lepidoptera: Erebidae: Lymantriinae) in Korea

Nang-Hee Kim¹, Sei-Woong Choi^{1,*} and Sung-Soo Kim²

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

²Research Institute for East Asian Environment and Biology, Gangdong-gu, Seoul 05264, Republic of Korea

*Correspondent: choisw@mokpo.ac.kr

Herein, we report a new record of *Arna bipunctapex* (Hampson) and a new species, *Euproctis fulvatus* sp. nov. in Korea; both are Lymantriine moths. *Arna bipunctapex* is distinguished by a relatively large wingspan with two black dots and a small dot between these black dots in the apical region of a yellowish forewing. The male genitalia of *A. bipunctapex* can be distinguished by the lack of a process on the sacculus of valva while the female genitalia can be distinguished by an antrum that is basally flat with two lateral digitate arms. *Euproctis fulvatus* is distinguished by yellowish wings with a medially curved central fascia of the forewing. The male genitalia can be distinguished by the bifid, digitate uncus and the simple, square-shaped valva with a distal strong invaginated margin. The female genitalia can be distinguished by the long, medially twisted, ductus dorsae with simple antrum posteriorly strongly sclerotized and ovate corpus bursae without signum. Larvae of *E. fulvatus* are distinguished by a black head with a pair of long, black, lateral tufts, dorsum with 10–11 white intersegmental dots and bright red setal warts on T2–A8, and bright red glands on A6 and A7.

Keywords: Erebidae, Korea, Lepidoptera, Lymantriinae, taxonomy

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INTRODUCTION

The subfamily Lymantriinae comprises over 2,900 species in 360 genera and occurs primarily in the Old World tropics (Kitching and Rawlins, 1998). Synapomorphies of the subfamily are recognized: the prespiracular counter-tympanal hood and the strongly reduced proboscis in adults and the dorsal glands at the center of the sixth and seventh abdominal segments in larvae (Zahiri *et al.*, 2010). Recently Kim *et al.* (2016) published a checklist of the Noctuoidea from Korea, listing 50 species in 25 genera of Lymantriinae moths. In addition to that list, herein, we report two species of Lymantriinae for the first time in Korea: *Arna bipunctapex* (Hampson) and *Euproctis fulvatus* sp. nov.

MATERIALS AND METHODS

Adult moths were collected at night after entering a UV-light bucket trap (BioQuip, USA). All collected adults were preserved in a freezer and then mounted for examination. Larvae were collected through direct observation

of plants and were reared at the laboratory until eclosion. For slide preparation of male and female genitalia, each specimen was prepared by boiling the abdomen in 10% KOH for approximately 20 min. Subsequently, scales and tissues were removed, the remaining sclerotized structure was stained with chlorazol black, and mounted on slides in Euparal solution. Wingspan measurement was the distance from the tip of the left forewing to the tip of the right forewing.

Genomic DNA was extracted from moth legs using the DNeasy Blood and Tissue Extraction Kit (Qiagen, UK), according to the manufacturer's instructions. The obtained gDNA, the 658-bp 5' end region of the COI gene was amplified, using a polymerase chain reaction (PCR) method. For amplification, we used a previously described standard barcoding primer pair: LCO1490, 5'-GGT CAA CAA ATC ATA AAG ATA TTG G-3' and HCO2198, 5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3' (Folmer *et al.*, 1994). The PCR was conducted using FastMix French PCR kits (i-Taq; iNtRon Biotechnology, Korea) under the following conditions: initial denaturation for 3 min at 94°C, followed by 30 cycles of 94°C for 1 min, 50°C for 30 sec, and 72°C for 1 min, with a subse-

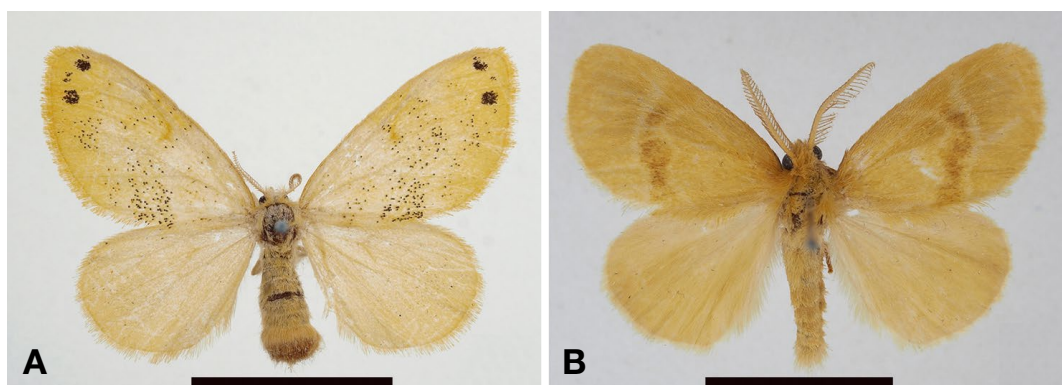


Fig. 1. Adults of two new Lymantriine species from Korea. Scale bar = 10 mm. A. *Arna bipunctapex* (Hampson), B. *Euproctis fulvatus* sp. nov.

quent final 7 min extension at 72°C. Electrophoresis was carried out using 1 × TAE buffer on 1% agarose gel with Top Green Nucleic Acid Gel Stain (LED; Genomic Base, Korea) for 15 min at 135 V to confirm successful DNA amplification. The obtained PCR products were purified with a PCR purification kit (iNtRON) and were sequenced with forward and reverse primers (Genotech Korea). Sequences were edited manually to check ambiguous bases by applying forward and reverse primer sequences using the Seqman program (DNASTAR Lasergene software, version 7.1; DNASTAR, USA). The DNA barcoding sequence was compared with publicly available sequence databases, such as Biotechnology Information (NCBI) and GenBank, and through BLAST (<http://blast.ncbi.nlm.nih.gov/Blast.cgi>) and the Barcode of Life Data (BOLD) system (<http://boldsystems.org>; Ratnasingham and Herbert, 2007).

Terminology related to adults and larvae, including male and female genitalia refers to Lafontaine and Fibiger (2006) and Wagner (2005). All materials have been deposited in the Insect Collection, Department of Environmental Education, Mokpo National University, Korea. Abbreviations: GW, Gangwon-do; GB, Gyung-sangbuk-do; GN, Gyung-sangnam-do; JB, Jeollabuk-do; and JN, Jeollanam-do.

SYSTEMATIC ACCOUNTS

Order Lepidoptera Linnaeus, 1758

Family Erebidae Leach, [1815]

Subfamily Lymantriinae Hampson, 1893

Genus *Arna* Walker, 1855

Arna bipunctapex (Hampson)

두점노랑독나방 (신칭) (Figs. 1A, 2A)

Somena bipunctapex Hampson, 1891: 57. TL: [Inida] Nilgiri.

Artaxa bipunctapex: Kirby, 1892: 453.

Aroa bipunctapex: Swinboe, 1892: 191.

Euproctis bipunctapex: Collenette, 1932: 60.

Nygmia bipunctapex: Swinhoe, 1922: 483.

Arna bipunctapex: Holloway, 1999: 46.

Material examined. 1 ♀, Chopyeong-gil, Gunoe-myeon, JN: Wando, N34°21'38.30" E126°39'51.93", 77 m, 5.XI.2015. SS Kim.

Diagnosis. Distinguished by the relatively large wingspan (27 mm) with two black dots in the apical region of the forewing. Head with pectinate female antennae with short pectinations, broad and yellowish frons and porrect and long (about twice the eye diameter) labial palpi. Forewing ground color light yellow-brown, tinged with brown scales on the central fascia and a postmedian, and apical region with two black dots. Hindwing ground color light yellow tinged with brown scales. Female genitalia (Fig. 2A). Papillae anales broad with rounded outer margin; anterior apophyses almost equal length to posterior apophyses; antrum U-shaped, basally flat, with digitate arms laterally; ductus dorsae long, twice the corpus bursae; and corpus bursae ovate without signum.

Distribution. Korea, Japan, China, Thailand, India, Nepal, Malaysia, Singapore.

Remarks. Worldwide, 12 species of *Arna* have been described. *Arna* larvae feed on *Sepium*, *Terminalis*, *Shorea*, and *Caerya* (Holloway, 1999). Up to now, two species of *Arna* are known in Korea: *A. pseudoconspersa* (Strand, 1914) and *A. bipunctapex*. These two species are similar in the shapes of their central fascia and the two black apical dots on the forewing. *A. bipunctapex* can be distinguished from *A. pseudoconspersa* by the presence of a small dot between two blackish dots in the apical region of the forewing. The male genitalia of *A. bipunctapex* can be distinguished from those of *A. pseudoconspersa* by the absence of a process on the sacculus of valva in *A. bipunctapex* (Wang *et al.*, 2010; 2011). The female geni-

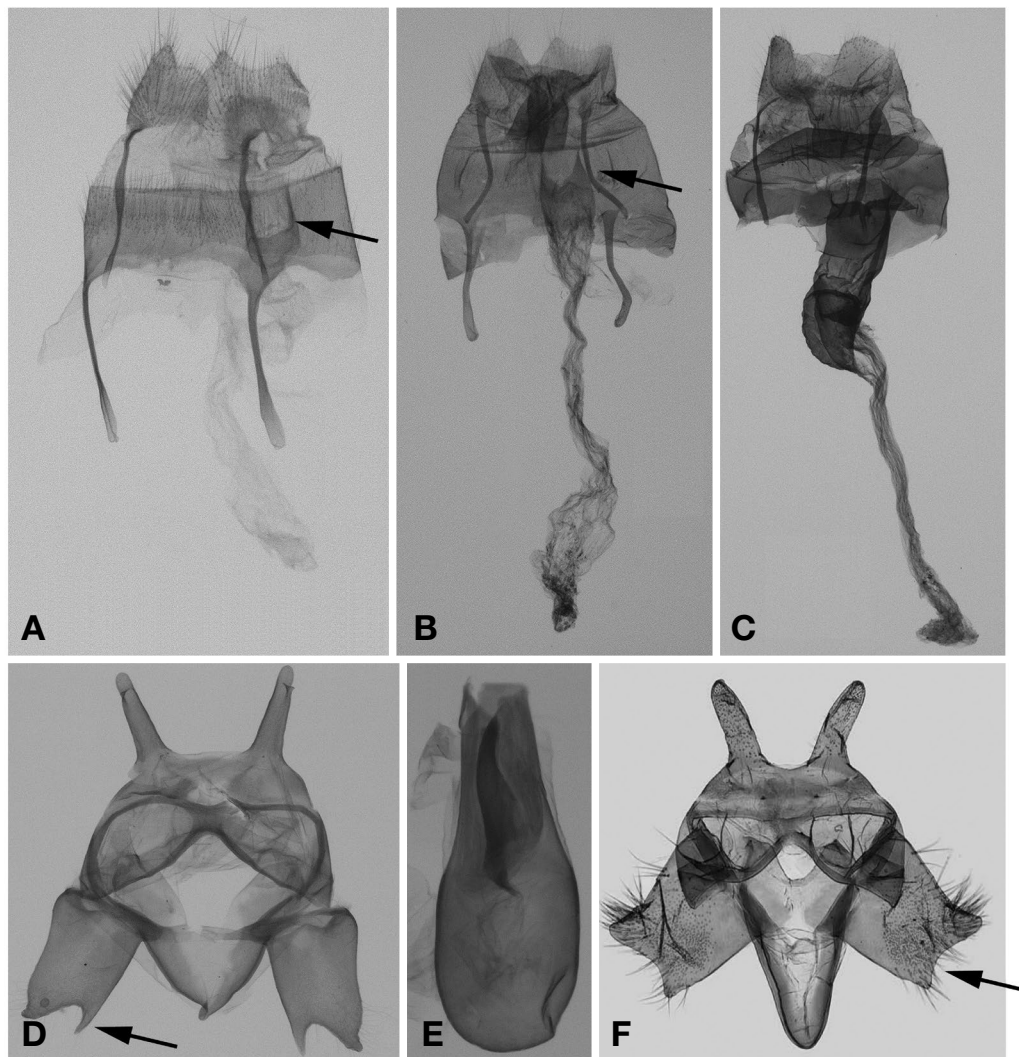


Fig. 2. Male and female genitalia of four Lymantriine species from Korea. A-C. Female genitalia, D-F. Male genitalia. A. *Arna bipunctapex* (Hampson), B. *Arna pseudoconspersa* (Strand), C-E. *Euproctis fulvatus* Choi and Kim sp. n. F. *Euproctis wilemani* Colletette (from Wang *et al.*, 2010).

talia of *A. bipunctapex* can be distinguished from those of *A. pseudoconspersa* (Fig. 2B) by the shape of the antrum, basally flat with two lateral digitate arms in *A. bipunctapex*.

Genus *Euproctis* Haworth, 1809

***Euproctis fulvatus* Kim, Choi and Kim sp. nov**
띠무늬독나방 (신칭) (Figs. 1B, 2C-E, 3)

Type. Holotype. male, Ssangyoung-ri, Hanbando-myeon, GW: Yeongwol, 3.IX.2005. SS Kim. Paratypes. 1♂, Chuncheon-si, GW: Chuncheon, 3.VIII.1998. SS Kim; 1♂ Huindol-ro, Byeonggok-myeon, GB: Yeongdeok, N36°36'24", E129°24'49" 14 m, 3.VI.2015. SS Kim;

1♂, Daedae-ri, Yueo-myon, GN: Changnyeong, N35°33'07", E128°24'53" 5 m, 29.VIII.2009. SS Kim; 1♂, Daedae-ri, Yueo-myon, GN: Changnyeong, N35°33'07", E128°24'53" 5 m, 29.VIII.2009. SS Kim; 1♂, Sinseong-ri, Seongnae-myeon, JB: Gochang, N35°32'55", E126°43'10" 12 m, 17.VI.2016. SS Kim; 1♀, Guseong-ri, Sani-myeon, JN: Haenam, N34°41'27.43" E126°24'29.96", 12 m, 25.VIII.2016. SW Choi; 2♂1♀, Guseong-ri, Sani-myeon, JN: Haenam, N34°41'27.43" E126°24'29.96", 3 m, ex. Larvae 20.IV.2017, ex pupa 8-9.VI.2017. NH Kim.

Diagnosis. Distinguished by the yellowish wing color with a medially curved central forewing fascia. Dimorphic size (wingspan male 19-25 mm, female 33 mm). Head covered with yellow scales; antenna bipectinate with long pectinations in male and short pectinations in



Fig. 3. Last instar of *Euproctis fulvatus* sp. nov.

female; frons broad and yellowish; labial palpi porrect, short and approximately equal to the eye diameter. Forewing dark yellowish; central fascia ochreous, slender, bar-shaped, medially curved. Hindwing yellowish white and termen dark yellowish. Abdomen dark yellow. **Male genitalia** (Fig. 2D, E): Uncus bifid, digitate, apically with a short triangular process; saccus V-shaped; valva simple, square, distally strongly invaginated; aedeagus stout, anterior broad; one long sclerotized cornutus present. **Female genitalia** (Fig. 2C) Papillae anales broad; ductus dorsae long, medially twisted, posteriorly strongly sclerotized with simple antrum; corpus bursae ovate without signum. **Larvae** (Fig. 3). Distinguished by a black head with a pair of long, black, lateral tufts, dorsum with 10–11 white intersegmental dots and bright red setal warts on T2–A8, and bright red glands on A6 and A7. Larva to 3 cm.

Biology. This species feeds on *Vicia angustifolia* var. *segetilis* (L.) Schreb. (1835) (Fabales). Three larvae on *Vicia* were collected on April 20 and 21, 2018, molted twice (April 28 and May 6), pupated May 19 and eclosed June 8 and 9. The species is bivoltine, flying in June and August–September in Korea.

Distribution. Korea.

Remarks. This new species is similar to *Euproctis wilemani* Collenette, but can be distinguished by the shape of male genitalia (Fig. 2F). The DNA sequence of *E. fulvatus* (Appendix 1) is similar to that of *E. pyraustis* Meyrick (GenBank accession number: KP081919), but the nucleotide sequence of *E. pyraustis* has a 9.6% sequence divergence from *E. fulvatus*.

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Appendix 1. DNA sequence of *Euproctis fulvatus* sp. nov. Sequence alignment of DNA barcoding region from *Euproctis fulvatus* sp. nov and *E. pyraustis*. The alignment was generated by the Clustal W method. Different sequences are presented.

			30			60
<i>Euproctis fulvatus</i>	AACACTTTAT	TTTATTTTGG	GAATTTGAGC	AGGAATAGTC	GGCTCATCTT	TAAGAATAAT
<i>Euproctis pyraustis</i>	.....	.....	.....	.....T	..G.....	.....
			90			120
<i>Euproctis fulvatus</i>	AATTCGAACT	GAATTAGGAA	ACCCGGGATC	TTTTATCAAT	AACGATCAAA	TCTTTAATAC
<i>Euproctis pyraustis</i>	.....T..C	.....	CT..T.....	.....T...	..T.....	.T.....
			150			180
<i>Euproctis fulvatus</i>	TATTATTACT	GCTCATGCTT	TTATTATAAT	TTTTTTTATA	GTTATACCTA	TTATAATCGG
<i>Euproctis pyraustis</i>	.....A	..A.....	.....	.....	.....A.	.....T..
			210			240
<i>Euproctis fulvatus</i>	AGGGTTTGGA	AATGATTAG	TACCATTAAT	ATTAGGAGCT	CCTGATATAG	CTTTCCCCCG
<i>Euproctis pyraustis</i>	..A.....	.....	.T.....	.....C	.....	.A..T..T..
			270			300
<i>Euproctis fulvatus</i>	AATAATAAT	ATAAGATTTT	GACTTTTACC	CCCCTCCTTA	ATTCTTCTTT	TATCAAGAAG
<i>Euproctis pyraustis</i>	T.....	.....C.	.....	A..T..T...	.....C	.C..T.....
			330			360
<i>Euproctis fulvatus</i>	AATTATTGAA	AATGGAGCTG	GAACTGGATG	AACTGTTTAT	CCTCCTCTTT	CTTCTAATAT
<i>Euproctis pyraustis</i>	.....	.....A.	.T..C.....	.....	....C....	.....
			390			420
<i>Euproctis fulvatus</i>	TGCCCATAGA	GGAAGATCAG	TCGACTTAAC	TATTTTTTCT	TTACATCTTG	CTGGAATTTC
<i>Euproctis pyraustis</i>	..G.....	.....	.T..T.....	.....C...	C.T.....	.....
			450			480
<i>Euproctis fulvatus</i>	TTCAATTTTA	GGGCAATTA	ATTTTATTAC	CACTATTATC	AATATACGTT	TAAATAATTT
<i>Euproctis pyraustis</i>	A.....	..A.....	.....	A.....T	.....	.....
			510			540
<i>Euproctis fulvatus</i>	ATCATTGAT	CAAATACCTT	TATTTGTTTG	AGCAGTTGGA	ATTACAGCCT	TCCTACTTCT
<i>Euproctis pyraustis</i>	..T.....	.....	.....C..	..T.....	.....T.	.T..T.....
			570			600
<i>Euproctis fulvatus</i>	TTTATCTCTC	CCCGTATTGG	CCGGAGCTAT	TACTATGTTA	TTAACTGATC	GAAATTTAAA
<i>Euproctis pyraustis</i>	.....	..T....A.	.T.....	..A..A...	.....	....C.T..
			630			658
<i>Euproctis fulvatus</i>	TACTTCATTT	TTGATCCTG	CAGGAGGGGG	AGATCCAATT	TTATATCAAC	ATTTATTT
<i>Euproctis pyraustis</i>	.....	....C..A.	.....A..	.....	.....	.C.....