



Sweet potato leaf worm in Japan shown to comprise two distinct species: *Aedia leucomelas* and *A. limitaris* sp. rev. (Lepidoptera: Noctuidae)

Daisuke Watabiki¹ · Shu Arai¹

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Abstract

The genus *Aedia* Hübner (Lepidoptera: Noctuidae) is distributed from Europe through Asia to Oceania, and the larva of *Aedia leucomelas* (Linnaeus) (so-called “Nakajiro-shitaba” in Japan) has long been recognized as an injurious pest of sweet potato (*Ipomoea batatas* (L.)) in Japan and Korea. In this study, we carried out a taxonomic study of the *A. leucomelas* and its relatives in Japan based on morphological and molecular analyses. The results revealed that “Nakajiro-shitaba” consists of two distinct species: *A. leucomelas* and *A. limitaris* (Walker) sp. rev. Therefore, we redescribe *A. limitaris* and provide diagnostic morphological and DNA barcode data for adults and larvae of the three Japanese *Aedia* species, i.e., *A. leucomelas*, *A. limitaris*, and *A. kumamotonis* (Matsumura). We also summarize their distribution and host plant information. Furthermore, our study clarified that *A. leucomelas* and *A. limitaris* occur sympatrically in Japan at least in some regions, and that larvae of *A. limitaris* can successfully feed and grow on the leaves of *Ipomoea batatas* same as *A. leucomelas*. These findings suggest that previous records of *A. leucomelas* in Japan may have included *A. limitaris*, consequently, re-examination of the distribution and life history of *A. leucomelas* and *A. limitaris* is required.

Keywords Morphology · DNA barcoding · Taxonomy · Agricultural pest · *Ipomoea batatas*

Introduction

The genus *Aedia* Hübner, [1823] 1816 (Lepidoptera: Noctuidae) is distributed from Europe through East and Southeast Asia to Oceania, and 21 species are known from the Indo-Australian region (Holloway 2009; Poole 1989). Among them, two species, *A. leucomelas* (Linnaeus, 1758) and *A. kumamotonis* (Matsumura, 1926) occur in Japan (Eda 2011; Sugi 1982). The larva of *A. leucomelas* is a well-known pest of sweet potato, *Ipomoea batatas* (L.) and has hitherto been recognized as an injurious pest in Japan and Korea (Lee et al. 2003; Yashiro 1940). The last instar larva consumes large amounts of leaves, and severe damage can inhibit tuber

enlargement, resulting in significant yield loss in sweet potato (Emura 2012; Mochida 2003). For these reasons, *A. leucomelas* is designated as a kind of “Plants and animals designated as harmful species” under the Plant Protection Act in Japan (MAFF 2023). The morphological differences between the larvae of *A. leucomelas* and *A. kumamotonis* have been clarified by Kuroko (1969) and Watabiki (2022).

In taxonomy, the genus *Aedia* was previously treated as a junior subjective synonym of *Catephia* Ochsenheimer, 1816 (Hampson 1894), but *Aedia* is now considered a valid genus belonging to the subfamily Aediinae (Beck 1960; Holloway 2011). *Catephia* is presently treated as one of the genera comprising the family Erebiidae (Holloway 2005; 2011). Furthermore, Holloway (2011) tentatively included *Chytonix* Grote, 1874 and *Ecpatia* Turner, 1902 in the subfamily Aediinae as genera related to *Aedia*, but recent molecular studies indicate that these two genera belong to Noctuinae (Keegan et al. 2021). Based on the above, the genus *Aedia* is presently treated as the sole genus belonging to Aediinae. A historical review of the classification of this genus was presented in detail by Holloway (2011) and Roepke (1941).

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✉ Daisuke Watabiki
dw205082@nodai.ac.jp

¹ Laboratory of Entomology, Tokyo University of Agriculture, Atsugi, Kanagawa, Japan

In Japan, *A. leucomelas* also known as “Nakajiro-shitaba” had been suspected to represent a complex of two species: *A. leucomelas* (Japanese name: Nakajiro-shitaba) and *Aedia* sp. or *A. sericea* Butler, 1882 (Japanese name: Ryukyu-nakajiro-shitaba) (Higashihirachi 1962; Takara and Azuma 1968). Sugi (1982) suggested that “Nakajiro-shitaba” indeed represents two distinct species as in the above literature, but the appropriate scientific names are uncertain as he noted. Consequently, these taxa were provisionally treated as a single species, *A. leucomelas*. This treatment still continues in Japan (Eda 2011). Therefore, we performed a taxonomic study of *A. leucomelas* complex and its relatives in Japan based on morphological and molecular analyses.

Incidentally, Ronkay et al. (2024) proposed to resurrect the genus *Anophia* Guenée, 1841 (type species: *leucomelas*) from a junior subjective synonym of *Aedia* and to place it in the subfamily Acontiinae Guenée, 1841. However, no evidence supporting this treatment was provided in the literature. Therefore, *A. leucomelas* and its relatives are treated as a member of the genus *Aedia* in this paper, following the treatment of Holloway (2011).

Materials and methods

Morphological study

We examined 302 specimens of *Aedia* spp. collected throughout Japan and the holotype specimens of *A. limitaris* (Walker, [1863] 1864) and *A. acronyctoides* (Guenée, 1852). All specimens are deposited in the following institutions: Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Tsukuba (NIAES), Laboratory of Entomology in Tokyo University of Agriculture, Kanagawa (TUA) and Oxford University Museum of Natural History, Oxford (OUMNH). Among them, a female of *A. limitaris* (Collection ID: DWOL20250806) laid eggs, and the hatched larvae were examined morphologically. The preserved larvae of *A. leucomelas* and *A. kumamotonis* used in Watabiki (2022) were also examined in this study. Images of adult specimens and larvae were taken using a digital camera EOS Kiss X8i with a lens EF-S 35 mm F2.8 MACRO IS STM (Canon Inc., Tokyo, Japan) or D200 (Nikon Corp., Tokyo, Japan) with AT-X M100 PRO D (Kenko Tokina Co. Ltd., Tokyo, Japan). Male and female genitalia were boiled in a 7% KOH solution for 5–10 min and dissected and observed under a Leica M 50 stereomicroscope (Leica Microsystems, Wetzlar, Germany) or SMZ745T (Nikon, Corp., Tokyo, Japan). Morphological terminology for adult and larval structures used in this study follows Holloway (2009), Kobayashi (1977), Komai et al. (2011), Roepke (1941), Varley (1962) and Watabiki (2022).

DNA barcoding

A total of 14 individuals of *Aedia* spp. from Japan were utilized for molecular analyses. They are registered in GenBank under the accession numbers “PX551881–PX551894” and in the Barcode of Life Data Systems (BOLD Systems) under the sequence IDs “AEDJP0xx-25”. DNA was extracted from dried hind legs of each specimen using a DNeasy Blood & Tissue Kit (Qiagen N.V., Hilden, Germany), and polymerase chain reaction (PCR) amplifications were conducted for a 658 bp region of the mitochondrial cytochrome oxidase I (COI) gene with the primers LCO1490: (5'-GGTCAACAAATCATAAAGATATTGG-3') and HCO2198: (5'-TAAACTTCA GGGTGACCAAAAAATCA-3') (Folmer et al. 1994). The PCR reaction was carried out using TaKaRa Ex Taq or Ex Taq HS (TaKaRa Bio Inc., Tokyo, Japan). The amplified products were purified using ExoSAP-IT™ (Thermo Fisher Scientific Inc., Waltham, Ma., USA) for a part of samples. Resulting PCR products were processed using a Big Dye Terminator v3.1 Cycle sequencing kit and an ABI 3730-XL genetic analyzer (Applied Biosystems Inc., California, USA) by TaKaRa Bio Inc. (Tokyo, Japan) or Macrogen Japan Corp. (Tokyo, Japan). In addition, 21 public sequences of *Aedia* spp. registered in the BOLD Systems were analyzed. Of these, 17 were identified as *A. acronyctoides*, three as *A. leucomelas*, and one as *A. funesta* in the database. Furthermore, two sequences registered in GenBank, *Amphipyra surnia* Felder and Rogenhofer, 1874 (PQ334901) and *Amphipyra horiei* Owada, 1996 (PQ334896) were used as outgroup species. The GenBank accession numbers and BOLD Systems sequence IDs of these sequences are shown in Fig. 7. These sequences were edited with MEGA-12 software (Kumar et al. 2024) to align nucleotide sequences and to construct a maximum likelihood (ML) tree under the Tamura-Nei model, maximum parsimony (MP) tree, and neighbor-joining (NJ) tree using the p-distance model. To estimate the confidence for each internal branch, the bootstrap method (Felsenstein 1985) was performed with 1,000 replicates for each analysis.

Results

Our morphological and molecular analyses revealed that the Japanese population of *A. leucomelas* (“Nakajiro-shitaba”) consists of two distinct species: *A. leucomelas* and *A. limitaris* (Walker, [1863] 1864) sp. rev. The latter species has previously been treated as a junior subjective synonym of *A. acronyctoides* (Guenée, 1852) (Holloway 2009), whose type locality is Australia. Here, we provide a redescription of *A. limitaris* and present the morphological and genetic

diagnostic features, information on the distribution and host plants of the three Japanese *Aedia* species. Moreover, a list of diagnostic characters of adult Japanese *Aedia* species is provided for precise identification (Table 1).

Morphological study

Taxonomy

Genus *Aedia* Hübner, [1823]

(Type species: *Noctua funesta* Esper, 1786)

Anophia Guenée, 1841; *Premusia* Walker, 1858; *Idicara* Walker, 1863; *Dysedia* Rogenhofer, 1874; *Herchunda* Swinhoe, 1900; *Catephiona* Hampson, 1926; *Eucatephia* Hampson, 1926; *Melanephia* Hampson, 1926 (junior homonym of *Melanephia* Le Cerf, 1922, Erebidae); *Lipatephia* Hampson, 1926; *Syagrana* Wiltshire, 1980; *Simonettania* Berio, 1985; *Renatia* Berio, 1985.

Diagnosis. In male genitalia, the presence of coremata at the outer basal part of the valva (Holloway 2011) and catena sensu Roepke (1941) (radula-like structure sensu Holloway 2011) on the dorsal side of the aedeagus are characteristic features of the genus *Aedia*.

Aedia limitaris (Walker, [1863] 1864) sp. rev.

(Japanese name: Ryukyu-nakajiro-shitaba)

Anophia limitaris (Walker, [1863] 1864): 171.

Aedia sp.: Higashihirachi, 1962: 168, fig. 9.

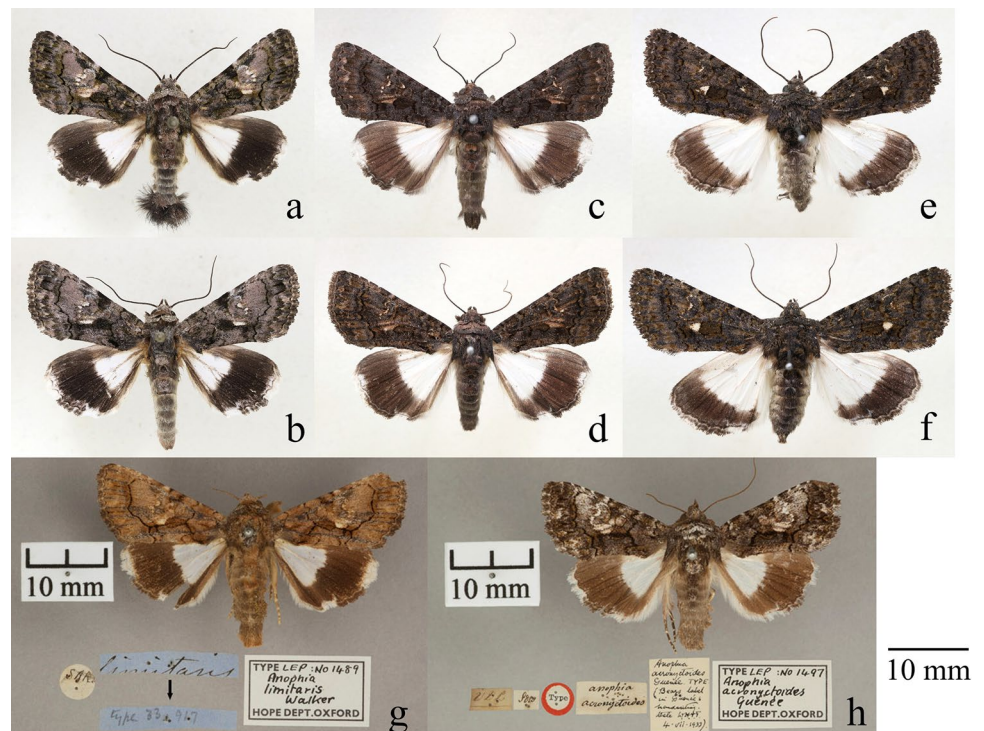
Aedia sericea: Takara and Azuma, 1968: 20.

Aedia leucomelas: Holloway, 1976: 33, fig. 204; Sugi, 1982: 870, pl. 216: 33–34; Eda, 2011: 291, pl. 68: 30–32; Kononenko and Pinratana, 2013: 270, pl. 36: 44.

Aedia acronyctoides: Holloway, 2009: 50, pl. 2: 24, fig. 57; Haruta, 1994: 148, pl. 90: 7; Kononenko and Pinratana, 2013: 271, pl. 36: 45.

Specimens examined. [Holotype] ♂, Sarawak, Borneo Is. with four labels, “SAR”, “limitaris”, “type 33 917”, “TYPE LEP: No 1489/*Anophia limitaris* Walker, HOPE DEPT. OXFORD” (OUMNH) (Fig. 1g); [Hokkaido Pref.] 1♀, Asahikawa, 3. Sep. 1976, S. Sakurai leg. (S. Sakurai Coll., NIAES); [Kanagawa Pref.] 1♀, Funako, Atsugi, 7. Sep. 2024, S. Arai leg. (TUA); 1♂, Same locality, 23. Sep. 2024, S. Arai leg. (PX551888 (AEDJP010-25), TUA); 2♂, Same locality, 28. Sep. 2024, S. Arai leg. (TUA); 1♂, Same locality, 3. Oct. 2024, S. Arai leg. (TUA); 1♂, Same locality, 16. Oct. 2024, S. Arai leg. (TUA); 1♂, Same locality, 18. Oct. 2024, S. Arai leg. (TUA); 1♂, Same locality, 18. Nov. 2024, S. Saitô leg. (TUA); 1♂, Same locality, 9. May. 2025, S. Saitô leg. (TUA); 1♂, Same locality, 5. Jun. 2025, T. Kakuhiro leg. (TUA); 1♂, Same locality, 14. Jul. 2025, S. Arai leg. (TUA); 1♀, Same locality, 6. Aug. 2025, S. Arai leg. (DWOL20250806, TUA);

Fig. 1 *Aedia* spp. **a** *A. limitaris* sp. rev., male. **b** Ditto, female. **c** *A. leucomelas*, male. **d** Ditto, female. **e** *A. kumamotoensis*, male. **f** Ditto, female. **g** Holotype of *A. limitaris*. **h** Holotype of *A. acronyctoides*. **g–h** © Oxford University Museum of Natural History (OUMNH), Oxford



- 1♂, Same locality, 12. Aug. 2025, S. Arai leg. (TUA); 2♂, Same locality, 20. Aug. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 22. Aug. 2025, T. Kakuhira leg. (TUA); 2♂, Same locality, 21. Sep. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 24. Sep. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 26. Sep. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 30. Sep. 2025, T. Kakuhira leg. (TUA); 4♂, Same locality, 3. Oct. 2025, T. Kakuhira leg. (TUA); 2♂, Same locality, 6. Oct. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 7. Oct. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 8. Oct. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 10. Oct. 2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 16. Oct. 2025, D. Watabiki leg. (TUA); [Yamanashi Pref.] 1♀, Fujigane, Fujikawaguchiko, 21. Aug. 2024, K. Watanabe leg. (PX551890 (AEDJP014-25), TUA); [Kagoshima Pref.] 1♀, Imuta, Shimokoshiki-jima Is., 2. Sep. 1975, K. Yoshida leg. (TUA); 2♀, Aose, Shimokoshiki-jima Is., 3. Sep. 1975, K. Yoshida leg. (TUA); 1♀, Same locality, 4. May. 1975, K. Yoshida leg. (TUA); 2♂1♀, Uchinokawauti, Shimokoshiki-jima Is., 5. Sep. 1975, K. Yoshida leg. (TUA); 2♀, Uchinokawauti, Shimokoshiki-jima Is., 6. Sep. 1975, K. Yoshida leg. (TUA); 1♂, Miyanoura, Yaku-shima Is., 10. Jul. 1968, T. Suga leg. (S. Sugi Coll., NIAES); 3♂, Anbo, Yaku-shima Is., alt. 210 m, (N 30°19'45", E 130°38'27"), 21. Aug. 2013, D. Watabiki & Y. Yamashita leg. (General Coll., PX551881 (AEDJP001-25), PX551882 (AEDJP002-25), NIAES); 2♂, Anbo, Yaku-shima Is., alt. 70 m, (N 30°19'14", E 130°38'36"), 11. May. 2015, S. Yoshimatsu & D. Watabiki leg. (General Coll., PX551883 (AEDJP003-25), NIAES); 1♂, Anbo, Yaku-shima Is., alt. 580 m, (N 30°19'05", E 130°36'34"), 15. May. 2015, S. Yoshimatsu & D. Watabiki leg. (General Coll., NIAES); 1♂, Hara, Yaku-shima Is., alt. 120 m, (N 30°15'20", E 130°35'08"), 12. May. 2015, S. Yoshimatsu & D. Watabiki leg. (General Coll., NIAES); 1♀, Kurio, Yaku-shima Is., alt. 40 m, (N 30°16'55", E 130°25'27"), 16. May. 2015, S. Yoshimatsu & D. Watabiki leg. (General Coll., NIAES); 1♂, Koseda, Yaku-shima Is., alt. 210 m, (N 30°22'30", E 130°37'34"), 18. May. 2025, S. Yoshimatsu & D. Watabiki leg. (TUA); 4♂, Miyanourarindou, Miyanoura, Yaku-shima Is., alt. 130 m, 18–20. May. 2016, D. Watabiki leg. (TUA); 1♂, North Kuromi-gawa River, Kurio, Yaku-shima Is., alt. 80 m, 22. May. 2016, D. Watabiki leg. (TUA); 1♀, Higashinakama, Amami-oshima Is., 25. Aug. 1964, K. Mori leg. (S. Sugi Coll., NIAES); 1♀, Mt. Ogawadake (300 m), Yamato-son, Amami-oshima Is., 30. Apr. 2006, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); 1♂, Akasaki-kouen Park, Naze, Amami-oshima Is., 18. Jun. 2016, Y. Nakatani leg. (TUA); 2♀, Yakugachi, Sumiyo, Amami, Amami-oshima Is., 1–3. Jul. 2016, D. Watabiki leg. (TUA); 1♀, N. Mt. Yuwan-dake, Yamato, Amami-oshima Is., alt. 600 m, 4. Jul. 2016, D. Watabiki leg. (TUA); [Okinawa Pref.] 1♂, Shuri, Okinawa-jima Is., 5. Jun. 1960, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♂, Same locality, 3. Jul. 1960, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 15. Jul. 1960, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♂, Same locality, 22. Oct. 1960, S. Higashihirachi leg. (S. Sugi Coll., SS-2570♂, NIAES); 1♂, Same locality, 14. Apr. 1963, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♂, Same locality, 10. Jul. 1963, S. Higashihirachi leg. (S. Sugi Coll., SS-3482♂, NIAES); 1♀, Nago, Okinawa-jima Is., 16. Sep. 1963, S. Higashihirachi leg. (S. Sugi Coll., SS-5046♀, NIAES); 1♀, Same locality, 18. Sep. 1963, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 2♂, the foot of Mt. Katsudake, Katsuyama, Nago, Okinawa-jima Is., 1. Oct. 2015, S. Yoshimatsu leg. (General Coll., PX551884 (AEDJP004-25), PX551885 (AEDJP005-25), NIAES); 5♂2♀, Koza, Okinawa-jima Is., 11. Aug. 1961, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 7. Sep. 1961, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♂, Yona, Okinawa-jima Is., 1. Apr. 1964, Y. Kishida leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 21. Oct. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 9. Apr. 1981, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♂, Nakijin, Okinawa-jima Is., 10. Nov. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 2♀, Same locality, 22. Oct. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 4. Apr. 1981, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♀, Yomitan, Okinawa-jima Is., 15. Aug. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♀, Ginama, Okinawa-jima Is., 18. May. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♂1♀, Same locality, 12. Aug. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♂, Same locality, 20. Oct. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♂, Same locality, 2. Apr. 1981, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♂, Oppa-dake, Naki-jin, Motobuhanto, Okinawa-jima Is., alt. 200 m, 19. Mar. 2004, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); 1♂, Hama, Kunigami, Okinawa-jima Is., 28. Mar. 2010, D. Watabiki leg. (TUA); 1♂, Hentona, Kunigami, Okinawa-jima Is., 1. Apr. 1975, Collector not stated (TUA); 1♀, Same locality, 16. Apr. 1975, Collector not stated (TUA); 1♂, Hiji, Kunigami, Okinawa-jima Is., 16–20. Jun. 2017, D. Watabiki & E. Tanaka leg. (TUA); 1♀, Taira, Miyako-jima Is., 24. Jun. 1963, S. Higashihirachi leg. (S. Sugi Coll., SS-2571♀, NIAES); 2♀, Kawahara, Ishigaki-jima Is., 9. Jun. 1963, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♂, Mt. Bannadake, Ishigaki-jima Is., 19–20. Jul. 1973, Collector not stated (TUA); 24♂16♀, Same locality, Collecting date and collector not stated (TUA); 1♂, Mt. Omoto, Ishigaki-jima Is., 2. Aug. 1982, T. Nagayoshi leg. (S. Sugi Coll., NIAES); 2♂, Same locality, 17. Mar. 1981, K. Deguchi leg. (S. Sugi Coll., NIAES); 2♂1♀, Same locality, 28. Mar. 1964, Y. Yanagita leg. (S. Sugi Coll., NIAES); 3♂1♀, Same locality, 30. Mar. 1964, Y. Kishida & Nagano leg. (S. Sugi Coll., NIAES); 1♀, Nosoko, Ishigaki-jima Is., 14. Mar. 2022, Y. Seshima leg. (PX551886 (AEDJP006-25), TUA); 2♂, Haimi, Taketomi, Iriomote-jima Is., alt. 40 m, 9. Mar. 2018, D. Watabiki & Y.

Nakatani leg. (TUA); 1♀, Uehara, Taketomi, Iriomote-jima Is., 20 m, 10. Mar. 2018, D. Watabiki & Y. Nakatani leg. (TUA); 1♀, Same locality, 13. Mar. 2018, D. Watabiki & Y. Nakatani leg. (TUA); 1♂1♀, Haiminaka, Taketomi, Iriomote-jima Is., alt. 40 m, 14. Mar. 2018, D. Watabiki, Y. Nakatani & Y. Yamanaka leg. (TUA); 1♂3♀, Same locality, (N 24°24'18.8", E 123°48'25.60"), 26. Feb. 2025, S. Saitô & A. Mouri leg. (PX551889 (AEDJP013-25), TUA); 3♂, Uehara (Mitorea Campsite), Taketomi, Iriomote-jima Is., (N 24°24'18.8", E 123°48'25.60"), 27. Feb. 2025, S. Saitô & A. Mouri leg. (TUA); 1♂, Same locality, (N 24°24'18.8", E 123°48'25.60"), 28. Feb. 2025, S. Saitô & A. Mouri leg. (TUA); 1♂, Same locality, (N 24°24'18.8", E 123°48'25.60"), 1. Mar. 2025, S. Saitô & A. Mouri leg. (TUA); 1♂, Urabu, Yonaguni-jima Is., 28. Mar. 1975, Collector not stated (TUA); 1♂1♀, Same locality, 29. Mar. 1975, Collector not stated (TUA); 1♂, Yonaguni, Yonaguni-machi, Yonaguni-jima Is., (N 24°26'34.18", E 122°58'10.61"), 7. Mar. 2024, A. Mouri leg. (TUA); 1♀, Same locality, (N 24°27'04.74", E 122°58'54.67"), 8. Mar. 2024, A. Mouri leg. (PX551887 (AEDJP007-25), TUA); 1♂, Mantabaru Forest Park, Yonaguni-jima Is., (N 24.4583688, E 122.9731065), 7. Mar. 2025, S. Arai leg. (TUA).

Diagnosis. This species is similar to *A. leucomelas*, but it can be distinguished by the following characters. The forewings of *A. leucomelas* are uniformly blackish brown, whereas those of *A. limitaris* are more greyish with each fascia being more conspicuous than in *A. leucomelas* except for old specimens, whose forewings sometimes become faded and brownish (Fig. 1g). Additionally, the posterior end of the reniform stigma and its surrounding area in *A. limitaris* is whiter and more conspicuous than in *A. leucomelas*. Differences in male and female genitalia between *A. limitaris* and *A. leucomelas* will be mentioned in the diagnosis of the next species. The forewing coloration and maculation of *A. limitaris* are also similar to those of *A. acronyctoides* which is endemic to Australia, but they can be separated by the hindwing maculation. The distal margin of the white area on the basal half of the hindwing in *A. limitaris* is nearly straight, or slightly distorted inward between the veins CuA1 and CuA2, whereas in *A. acronyctoides* (Fig. 1h) it is slightly curved outward.

Redescription. **Male** (Fig. 1a). Forewing length 15.75–18.50 mm (average 17.10 mm; n = 10). Head: labial palpi dark grey speckled with reddish dark brown scales; clypeus and vertex olive grey usually sparsely mixed with dark grey and reddish dark brown scales, sometimes whitish overall; antenna ciliate with dark grey and reddish dark brown scales. Thorax: tegulae olive grey usually sparsely mixed with dark grey and reddish dark brown scales; fore-, mid- and hind-legs usually dark grey with creamy white band on the marginal end of each segment of tarsus, bearing

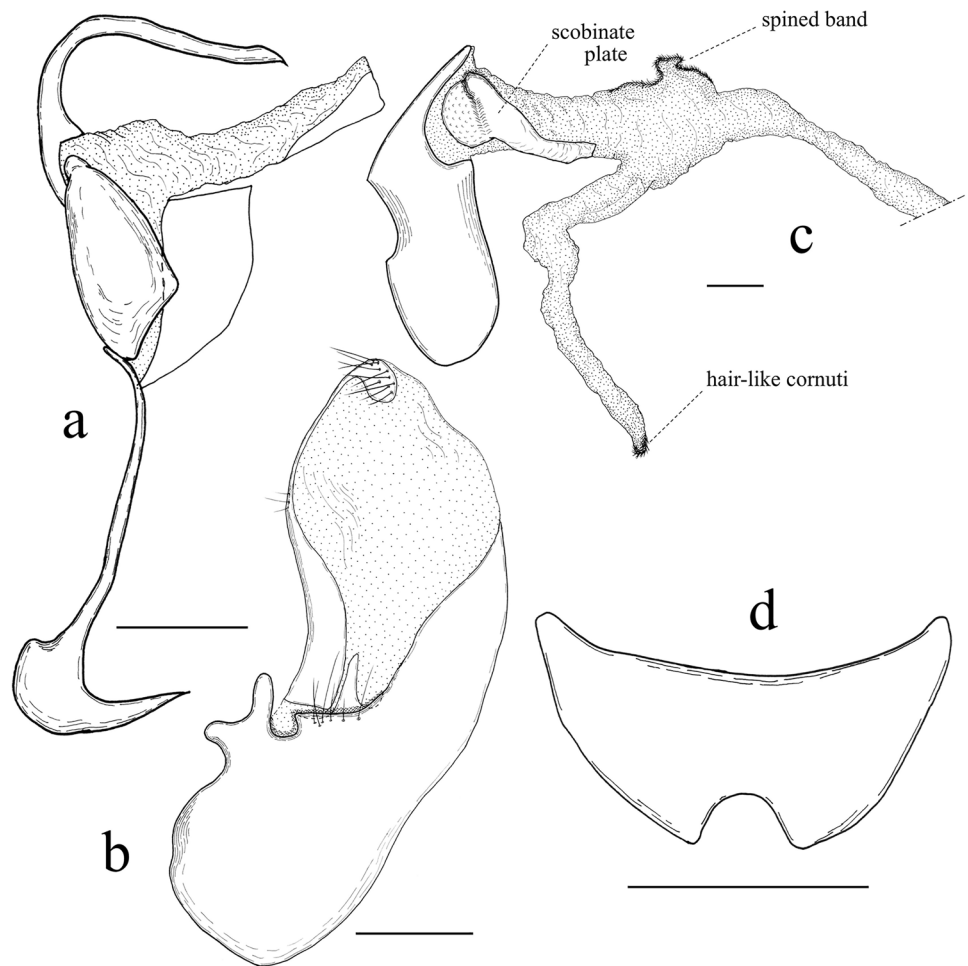
reddish dark brown long hairs especially on femora and tibiae. Abdomen: charcoal grey often mixed with olive grey scales with brush-organs arising from the second abdominal segment, eight abdominal segment with dark brown hairs. Forewing: dark grey, densely covered with olive grey and reddish dark brown scales; basal, subbasal and antemedial line black, often indistinctly speckled; orbicular spot usually filled with reddish grey and/or olive grey, sometimes inconspicuous; reniform stigma usually filled with reddish grey and/or olive grey, edged with white, markedly concave at the distal margin, with conspicuous white spot along the posterior margin; postmedial line serrated on each vein, black and conspicuous; subterminal line black shading, diffuse and inconspicuous, often absent; cilia uniformly dark grey. Hindwing: uniformly silky white on basal half and uniformly dark brown on distal half, distal margin of the silky white area nearly straight, or slightly distorted inward between the veins CuA1 and CuA2; cilia dark brown at veins M2–CuA2, white at veins RS–M2 and CuA2–1A + 2A.

Female (Fig. 1b). Forewing length 15.9–18.2 mm (average 16.80 mm; n = 11). Generally similar to the male, but with the eight abdominal segment lacking dark brown hairs, white edging of the reniform stigma is obscure, and the white spot along the posterior margin of the stigma is less conspicuous than in the male.

Male genitalia (Fig. 2a–d). Uncus moderately long and slender, slightly concave at the middle and hook-shaped apically; socius absent. Tegumen moderate; vinculum narrow and U-shaped in ventral view; saccus weakly sclerotized, protruded and tapering posteriorly; tuba analis well-developed with weakly sclerotized subscaphium; catena sensu Roepke (1941: fig. 1b) well-developed. Valva symmetrical, membranous at the distal margin, rounded apically, with relatively short coronal setae densely; costal process bifid into two projections, with the outer projection longer than the inner one; ampulla and harpe absent; coremata bearing single lobe with hair tufts. Aedeagus short and nearly straight, rostellum sclerotized, sharpened and pointed at the apex; vesica with scobinate plate at the basal, and with spined band and elongate lobe at the middle, the lobe dense hair-like cornuti apically. Juxta inverted-triangle-shaped, extended sharply at both sides and rounded depression at the ventral margin centrally.

Female genitalia (Fig. 3a). Apophyses posteriores and apophyses anteriores moderate in length. Lamella ante-vaginalis sclerotized, rectangular, with a longitudinal depression in the middle. Ductus bursae long, sclerotized and nearly straight on posterior half, sclerotized and spiraled 1.5 times on anterior half; ductus seminalis arises from the right side of the middle of ductus bursae. Corpus bursae rounded; signum absent.

Fig. 2 Male genitalia of *Aedia limitaris* sp. rev. **a** Ring in left lateral view (catena sensu Roepke (1941) removed). **b** Right valva in inner view. **c** Aedeagus in left lateral view. **d** Juxta in ventral view. Scale bars = 0.5 mm



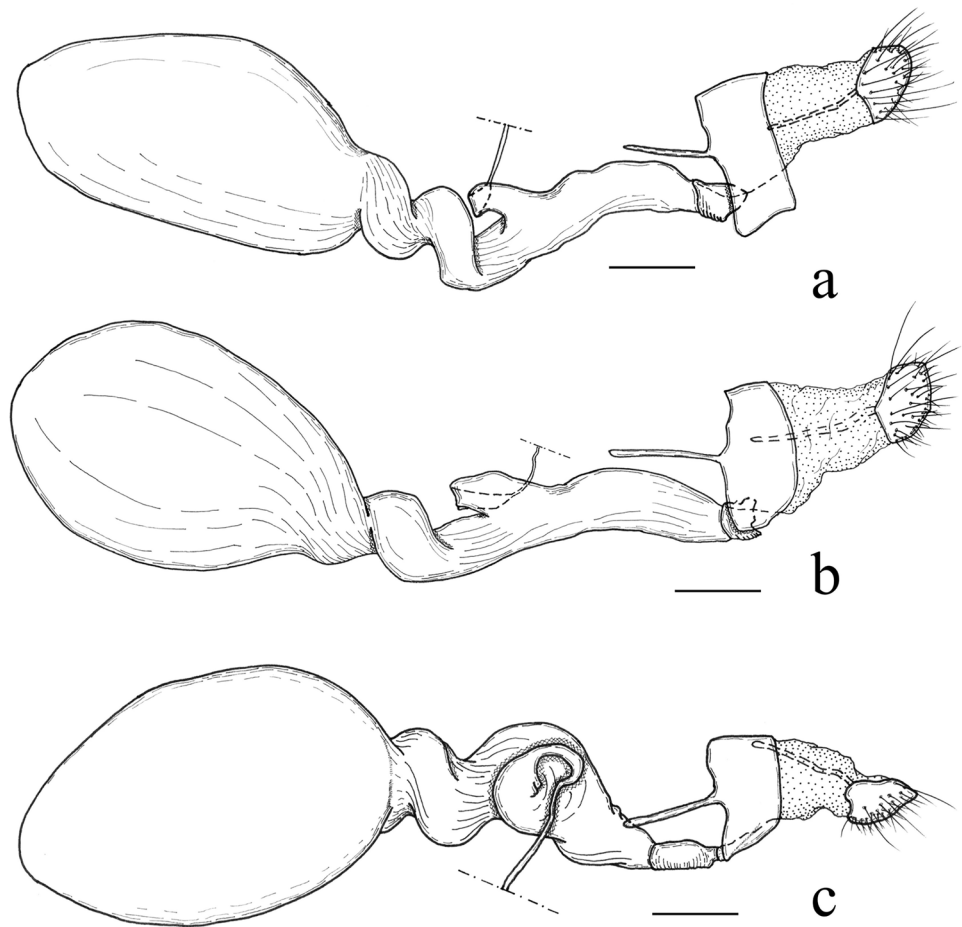
Last instar larvae (Fig. 4a, d). Many first instar larvae (exact number unknown) hatched from eggs laid by a female (Specimen ID: DWOL20250806). Although many of them were preserved as larval specimens, 26 larvae were reared through all instars using the leaves of sweet potato (*Ipomoea batatas* cv. Beniazuma), and all successfully pupated. Subsequently, nine individuals died due to unsuccessful pupation or emergence, whereas 17 individuals emerged successfully. Morphological comparison of these larvae with those of *A. leucomelas* examined by Watabiki (2022) revealed that the two species can be distinguished by the following characters: (1) The spiracles on each segment are generally black in *A. limitaris*, whereas they are light brown in *A. leucomelas*, except in individuals immediately after molting. (2) In *A. limitaris*, the black spots located anterior to the spiracles (at the bases of the SD2 setae) are distinctly large and conspicuous on the A1 (first abdominal segment), while those on A2–A8 are almost indistinct. In contrast, in *A. leucomelas*, the black spot on A1 is slightly larger than those on A2–A8, but there is no remarkable difference in size among the spots across A1–A8, as seen in *A. limitaris*. *A. limitaris* shows

almost no individual variation in larval coloration at least in the present study.

Distribution. This species has been collected from Kanagawa, Yamanashi, Kagoshima and Okinawa Prefectures in Japan. Although its distribution may extend from the Kanto region of Honshu to Okinawa Prefecture, no specimens were found in western Honshu, Shikoku and mainland Kyushu in this study. Additionally, a single individual from Hokkaido was obtained as mentioned in material examined. In neighboring and nearby countries, Malaysia (Borneo Island) is the holotype locality for this species, and Taiwan, Papua New Guinea and Australia are reliable distributed countries based on the result of DNA barcoding in this study (Fig. 7). Furthermore, two specimens from Thailand (Kononenko and Pinratana (2013): pl. 36, fig. 44 as *A. leucomelas*, fig. 45 as *A. acronyctoides*) and a specimen from Nepal (Haruta (1994): pl. 90, fig. 7 as *A. acronyctoides*) are also probably *A. limitaris* based on their external features.

Host plants. *Ipomoea batatas* (sweet potato) is probably a suitable host plant for this species because the larvae successfully grew and emerged while feeding on the leaves of

Fig. 3 Female genitalia of *Aedia* spp. in left lateral view. **a** *A. limitaris* sp. rev. **b** *A. leucomelas*. **c** *A. kumamotonis*. Scale bars = 1.0 mm



the plant under rearing conditions. Additionally, Tominaga (2001) collected and figured a larva feeding on *Ipomoea indica* (Burm.) Merr. in Okinawa Prefecture and recorded it as *Aedia leucomelas*, but the larva probably represents *A. limitaris*.

Remarks. This species occurs widely from South Asia to Australia, whereas the close relative, *A. acronyctoides* is found only in its type locality, Australia. The holotype of *A. acronyctoides* is illustrated in Fig. 1h (♂, Van Diemen's Land with six labels, "VDL", "[illegible words]", "Type", "anophia/acronyctoides", "Anophia/acronyctoides/Guenée. TYPE/(Bears label/ in Guenée's/handwriting/[illegible words])/4. VII. 1933)"). Regarding the Japanese population of *A. limitaris*, it had previously been treated as *Aedia* sp. (Higashihirachi 1962) or misidentified as *A. sericea* (Butler, 1882) (Takara and Azuma 1968), and the Japanese name "Ryukyu-nakajiro-shitaba" was used in these papers; therefore, we propose to use the same Japanese name for this species hereafter in order to maintain consistency with these previous studies.

Aedia leucomelas (Linnaeus, 1758)

(Japanese name: Nakajiro-shitaba)

Phalaena Noctua leucomelas Linnaeus, 1758: 578.
Catephia ramburii Boisduval, 1829: 7.
Noctua adepta Geyer, 1832: pl. 168, Figs. 792, 793.
Anophia olivescens Guénee, 1852: 48.
Anophia epundoides Walker, 1865: 917.
Anophia rufimixta Warren, 1913: 376.
Anophia leucomelas thomae Prout, 1927: 223.
Anophia leucomelas albodiscalis Roepke, 1932: 92.
Aedia leucomelas diluta Roepke, 1941: 22, pl. 2: 6.
Aedia leucomelas: Higashihirachi, 1962: 168, fig. 8; Takara and Azuma, 1968: 20; Kuroko, 1969: 657, fig. 4A; Holloway, 1976: 33, fig. 208; Sugi 1982: 870, pl. 216: 31–32; Haruta, 1993: 69, pl. 52: 17; Kononenko et al. 1998: 94, fig. 216; Goater et al., 2003: 43, pl. 1: 18–22, genit. figs.: 4, 102; Kononenko and Han, 2007: 84, pl. 78: 4, pl. 229: 4; Holloway, 2009: 49, pl. 2: 23, figs 58, 61; Eda, 2011: 291, pl. 68: 28–29; Eda, 2018: 67, pl. 19: 2.

Fig. 4 Last (six) instar larvae of *Aedia* spp. **a, d** *A. limitaris* sp. rev. **b, e, g** *A. leucomelas*. **c, f** *A. kumamotonis*. **a–c** Body in left lateral view. **d–f** Head in frontal view. **g** Larval appearance variation of *A. leucomelas*



Aedia acronyctoides: Kononenko and Pinratana, 2005: 95, pl. 22: 27–28.

Anophia leucomelas: Ronkay et al., 2024: 62, pl. 36: 19–20.

Specimens examined. [Ibaraki Pref.] 1♂, Akiba-touge, Yuduri, Ishioka, 30. Sep. 2017, D. Watabiki leg. (TUA); 1♂, Kamisaya, Kasumigaura, alt. 160 m, 25. May. 2016, E. Tanaka & D. Watabiki leg. (TUA); 2♂2♀, Mt. Yamizo-san, Daigo, 3. Sep. 2016, Y. Nakatani leg. (TUA); [Saitama Pref.] 1♂, Miyoshi, Fujikubo, 12. Oct. 2013, D. Watabiki leg. (General Coll., NIAES); 1♀, Ohi, Fujimino, 31. Jul. 2007, D. Watabiki leg. (TUA); [Tokyo Pref.] 3♂, Sokodo, Hachijo-jima Is., 20. Jun. 1976, A. Kawabe leg. (S. Sugi Coll., NIAES); 3♂, Hachijo-jima Is., 17. Sep. 1968, S. Maruyama leg. (S. Sakurai Coll., NIAES); 1♂, Sato,

Mikura-jima Is., 13. Jun. 1959, T. Maenami leg. (TUA); 1♀, Utsugi, Hachijo-kojima Is., 19. Jul. 1958, Y. Nagashima leg. (TUA); [Kanagawa Pref.] 1♂1♀, Funako, Atsugi, (N 35°25'56.7", E 139°20'45.1"), 5. Jun. 2024, S. Arai leg. (PX551893 (AEDJP008-25), PX551894 (AEDJP009-25), TUA); 1♀, Same locality, 26. Jun. 2024, E. Asai leg. (TUA); 1♂, Same locality, 18. Aug. 2024, E. Asai leg. (TUA); 2♂, Same locality, 20. Aug. 2024, S. Saitô leg. (TUA); 1♂, Same locality, 4. Sep. 2024, S. Saitô leg. (TUA); 1♂, Same locality, 7. Sep. 2024, S. Arai leg. (TUA); 17♂3♀, Same locality, 24. Sep. 2024, S. Saitô leg. (TUA); 1♂, Same locality, 25. Sep. 2024, S. Saitô leg. (TUA); 1♂1♀, Same locality, 28. Sep. 2024, S. Arai leg. (TUA); 7♂, Same locality, 17. Oct. 2024, D. Watabiki leg. (TUA); 1♂, Same locality, 11. May. 2025, S. Arai leg. (TUA); 1♂1♀, Same locality, 14. May. 2025, S. Arai leg. (TUA); 1♂, Same locality, 15. May.

2025, T. Kakuhira leg. (TUA); 1♂, Same locality, 20. Apr. 2025, S. Arai leg. (TUA); 1♂, Same locality, 8. Oct. 2025, T. Kakuhira leg. (TUA); 1♂, Hinata, Isehara, 17. Aug. 2023, D. Watabiki leg. (TUA); 1♂, Kawawa, Ninomiya, larva collected on 12. Oct. 2024 from *Calystegia hederacea* Wall. and adult emerged on Nov. 2024, D. Watabiki leg. (TUA); 1♂, Kurokawa, Kawasaki, 21. Sep. 1977, Kanbe leg. (TUA); 1♂, Same locality, 29. Oct. 1977, Kanbe leg. (TUA); [Chiba Pref.] 1♀, Makuhari, 16. Sep. 1960, M. Kogure leg. (S. Sugi Coll., NIAES); [Shizuoka Pref.] 2♀, Nashimoto, S. Izu, 2–4. Aug. 1957, S. Sugi leg. (S. Sugi Coll., NIAES); 1♂, Odaru, S. Izu, 24. Aug. 1953, S. Sugi leg. (S. Sugi Coll., SS-628♂, NIAES); 1♀, Ohnohara, Higashifuji, Susono, alt. 540 m, 4. Jun. 2011, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); [Wakayama Pref.] 1♀, Mt. Nachi, 24–25. Jul. 1951, M. Aoyanagi leg. (S. Sugi Coll., NIAES); [Osaka Pref.] 1♀, Mt. Izumi-katsuragi, Kaizuka, Kii-hanto, alt. 650 m, 18. Aug. 1994, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); [Fukuoka Pref.] 1♀, Yoshii, Ukiba-gun, 6. Sep. 1954, N. Gytoku leg. (S. Sugi Coll., NIAES); 1♂, Same locality, 8. Oct. 1954, N. Gytoku leg. (S. Sugi Coll., NIAES); [Nagasaki Pref.] 1♀, Ohnohara-sogen, Higashisonogi-machi, alt. 430 m, 25. Sep. 2010, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); [Oita Pref.] 1♀, Furensfonyudo, Nozu-cho, 23. Aug. 1991, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); [Kumamoto Pref.] 1♂, Kukino-son, alt. 700 m, 5. Oct. 1991, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); [Miyazaki Pref.] 1♂, Mt. Shiratori, Kirishima, Ebino, alt. 1000 m, 25. Aug. 1992, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); [Kagoshima Pref.] 1♀, Aoto, 7. Aug. 1961, T. Kawanabe leg. (TUA); 1♀, Genkawa, 16. Jul. 1961, T. Kawanabe leg. (TUA); 2♀, Same locality, 31. Jul. 1961, T. Kawanabe leg. (TUA); 1♂, Hetsuka-pass, Satacho, alt. 600 m, 8. Sep. 1992, Y. Yanagita leg. (Y. Yanagita Coll., NIAES); 1♂, Ôdomari, 4. Jul. 1968, T. Suga leg. (S. Sugi Coll., NIAES); 1♀, Imuta, Shimokoshiki-jima Is., 1. Sep. 1975, K. Yoshida leg. (TUA); 1♂, Uchinokawauti, Shimokoshiki-jima Is., 6. Sep. 1975, K. Yoshida leg. (TUA); 3♂2♀, Hara, Yaku-shima Is., (N 30°15'20", E 130°35'11"), 12. May. 2015, S. Yoshimatsu & D. Watabiki leg. (General Coll., NIAES); 1♂2♀, Hara, Yaku-shima Is., (N 30°15'05", E 130°35'26"), 27. Aug. 2010, D. Watabiki leg. (TUA); 1♂, Kurio, Yaku-shima Is., alt. 40 m, (N 30°16'55", E 130°25'27"), 16. May. 2015, S. Yoshimatsu & D. Watabiki leg. (General Coll., NIAES); 2♀, Noma, Tanega-shima Is., 30. V. 1960, S. Asahina leg. (S. Sugi Coll., NIAES); 1♀, Ketokina, Tokuno-shima Is. (at light), 21. Jul. 1970, T. Shirozu leg. (S. Sugi Coll., NIAES); 1♂, Omonawa, Isen-cho, Tokuno-shima Is., Oshima, 16. Jun. 1995, A. Tanaka leg. (Y. Yanagita Coll., NIAES); [Okinawa Pref.] 1♂1♀, A pond in Ôno Forest, Hirara, Miyako-jima Is., (N24.8024117, E125.3175718), 21. Oct. 2024, S. Arai leg. (PX551892 (AEDJP011-25), TUA); 1♂, Ginama, Okinawa-jima Is., 23. Jul. 1980, K. Deguchi leg. (S. Sugi Coll.,

NIAES); 1♂, Nakijin, Okinawa-jima Is., 10. Nov. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 21. May. 1980, K. Deguchi leg. (S. Sugi Coll., NIAES); 1♂1♀, Okawa dam, Nase, Amami-oshima Is., 13. X. 1991, S. Sugi leg. (S. Sugi Coll., NIAES); 1♀, Shuri, Okinawa-jima Is., 25. Apr. 1960, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 11. Jun. 1960, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 1♀, Same locality, 1. Sep. 1960, S. Higashihirachi leg. (S. Sugi Coll., NIAES); 2♂, Zaisho, Minami-daito-jima Is., 23–30. Jun. 1972, Y. Izumi leg. (TUA); 1♂, Same locality, 1–3. Jul. 1972, Y. Izumi leg. (TUA).

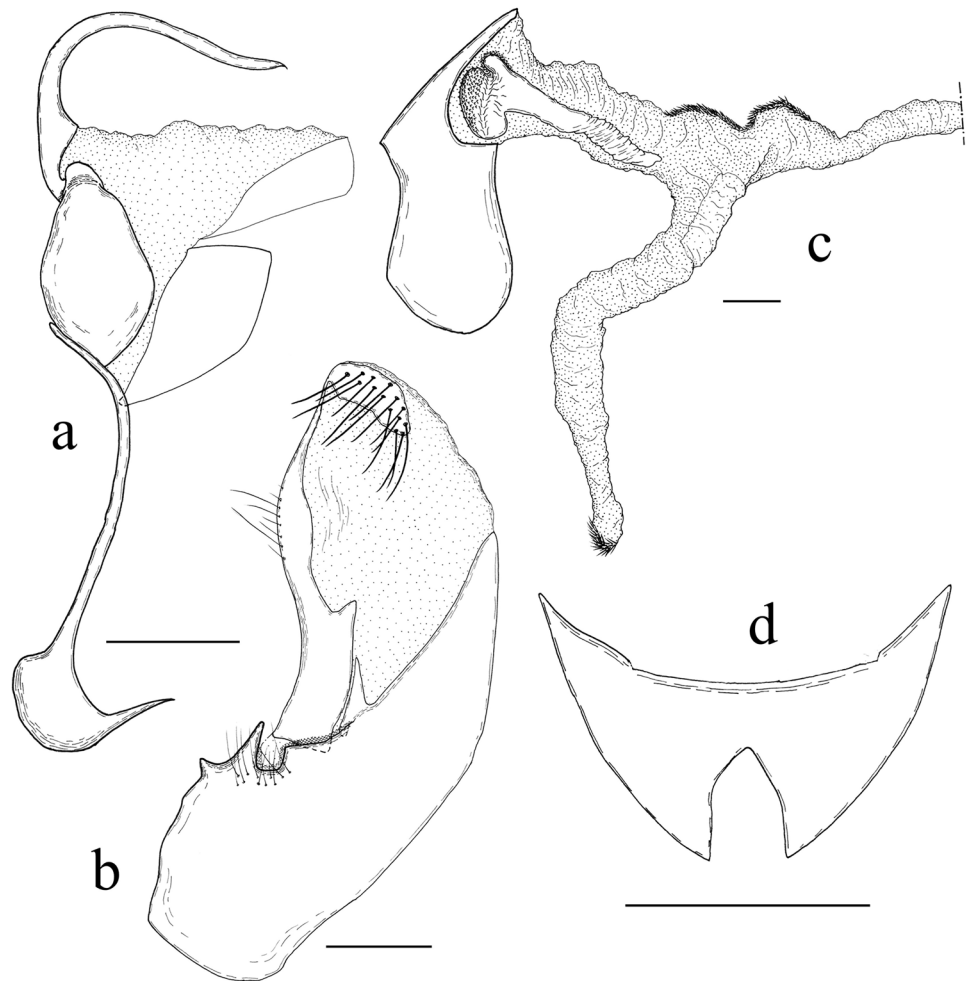
Diagnosis. Forewing length 14.90–17.15 mm (average 16.20 mm; n = 11) in male (Fig. 1c), 14.65–17.70 mm (average 16.50 mm; n = 11) in female (Fig. 1d). This species is similar to *A. limitaris* but can be distinguished by its forewing maculation, as mentioned in the *Diagnosis* of *A. limitaris*. In male genitalia (Fig. 5a–d), the depression at the ventromedial margin of the juxta is deeper than that of *A. limitaris*. Additionally, the apical end of the valva bears 8–15 long coronal setae (average 12; n = 10) in *A. leucomelas*, whereas in *A. limitaris* it bears 5–10 relatively short coronal setae (average 7; n = 9). In the female genitalia (Fig. 3b), these two species can be distinguished by the number of coils on anterior half of the ductus bursae. In *A. leucomelas*, there is a single coil, whereas in *A. limitaris* there are 1.5 coils.

Last instar larvae (Fig. 4b, e, g). The larvae of *A. leucomelas* are illustrated in Watabiki (2022), which also presents the morphological differences from *A. kumamotonis*. The morphological differences between *A. leucomelas* and *A. limitaris* are discussed in the previous species section. The larvae of *A. leucomelas* show considerable individual variation in body coloration and patterning even within a full-sib family (Fig. 4g).

Distribution. This species is distributed from Honshu to Okinawa Prefecture, and a single individual from Hokkaido was obtained (Hori and Sakurai 2015). In neighboring countries, it has been reliably recorded from South and Central Europe (Goater et al. 2003), Nepal (Haruta 1993), China (Guangdong) (Eda 2018), Korea (Kononenko et al. 1998; Kononenko and Han 2007), Thailand (Kononenko and Piratana 2005) and Malaysia (Borneo Is.; Holloway 2009). Furthermore, Holloway (2009) doubted the occurrence of this species in Australia, and we were also unable to confirm any reliable previous records from that country in this study.

Host plants. *Ipomoea batatas*, *Argyrea involucrata* C. B. Clarke, *Merremia dissecta* (Jacq.) Hallier f., *Convolvulus* sp. and *Quamoclit coccinea* (L.) have been recorded for this species (Murasu 2011; Robinson et al. 2002). Additionally, *Calystegia hederacea* Wall. is recorded as an exact host plant of this species based on an adult specimen obtained in this study. The specimen was obtained by rearing a larva that had been collected while feeding on the leaves of this plant in Kanagawa Prefecture.

Fig. 5 Male genitalia of *Aedia leucomelas*. **a** Ring in left lateral view (catena sensu Roepke (1941) removed). **b** Right valva in inner view. **c** Aedeagus in left lateral view. **d** Juxta in ventral view. Scale bars = 0.5 mm



Remarks. Previous records regarding this species such as distribution, host plants and pest status may have been confused with those of *A. limitaris*, but there is no doubt that this species, at least, has long been and continues to be a pest of sweet potato in Japan (Mochida 2003; Tsutsui 1957; Watabiki 2022).

Aedia kumamotonis (Matsumura, 1926)

(Japanese name: Kumamoto-nakajiro-shitaba)

Catephia kumamotonis Matsumura, 1926: pl. 1, fig. 10.

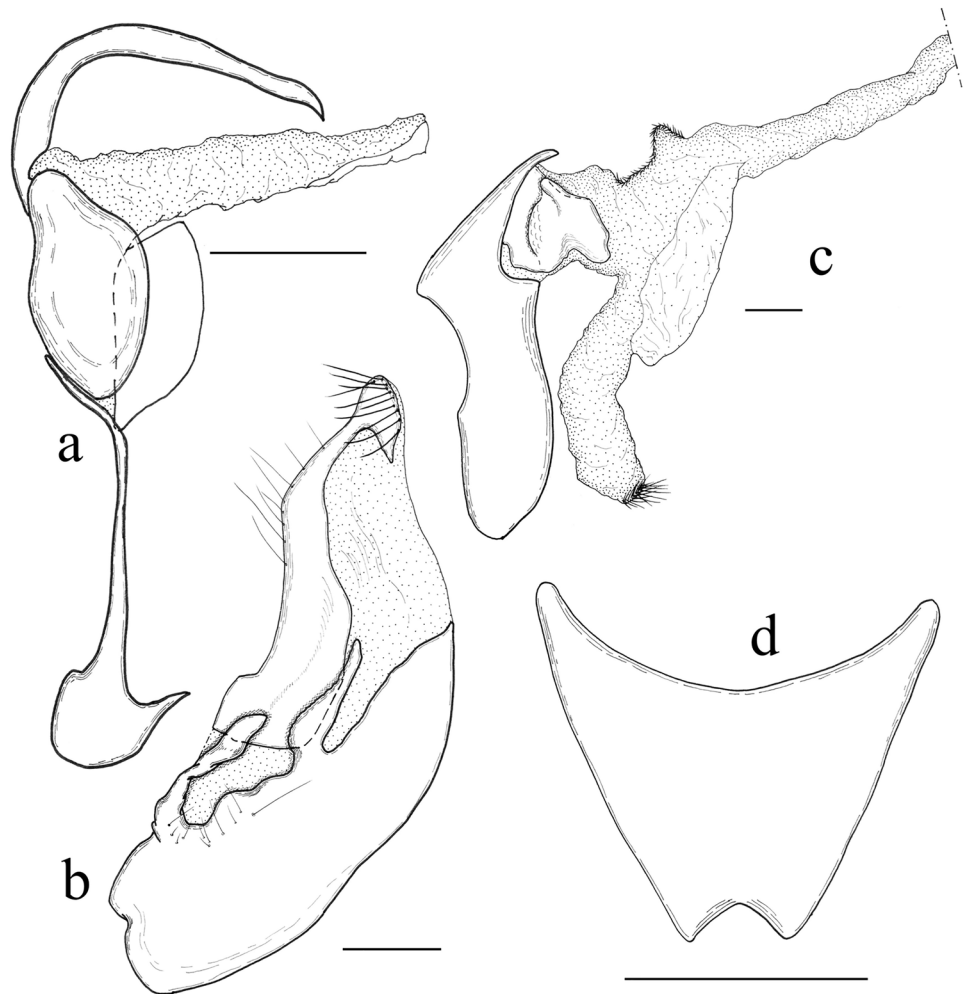
Aedia kumamotonis: Kuroko, 1969: 657, fig. 1–3, 4B; Sugi 1982: 870, pl. 216: 29–30; Eda 2011: 291, pl. 68: 33–34.

Specimens examined. [Hokkaido Pref.] 1♀, Honsawa, Kuriyama, 6. Jun. 2019, D. Watabiki leg. (General Coll., DWOL20190606, PX551891 (AEDJP012-25), NIAES); [Niigata Pref.] 1♀, Sen-nou, Nou-machi, Niigata Pref., 26. May. 2004, S. Sakurai leg. (S. Sakurai Coll., NIAES); [Saitama Pref.] 4♂2♀, Sannai-Ishizawa, Honjou, 10. Jun.

1974, A. Sasaki leg. (S. Sugi Coll., SS-2572♂, SS-2573♀, NIAES); 1♀, Same locality, 17. Jun. 1974, A. Sasaki leg. (S. Sugi Coll., NIAES); 2♂, Same locality, 31. May. 1975, A. Sasaki leg. (S. Sugi Coll., NIAES); 2♀, Same locality, 31. May. 1975, A. Sasaki leg. (S. Sugi Coll., NIAES); [Saga Pref.] 1♀, Shimo-togawa, Ushidu, 18. Apr. 1996, M. Furukawa leg. (Y. Yanagita Coll., NIAES); 1♀, Same locality, 21. Apr. 1996, M. Furukawa leg. (Y. Yanagita Coll., NIAES); 1♂, Same locality, 7. Apr. 1997, M. Furukawa leg. (Y. Yanagita Coll., NIAES).

Diagnosis. Forewing length 16.35–17.20 mm (average 16.80 mm; n = 7) in male (Fig. 1e), 16.35–18.45 mm (average 17.20 mm; n = 9) in female (Fig. 1f). This species can be easily distinguished from the other two species by the hindwing coloration. In this species, the silky white area on the basal half of the hindwings extends to the inner margin, while in *A. leucomelas* and *A. limitaris* the inner margin is dark brown. In addition, the morphology of male and female genitalia is also readily distinguishable from the other two species. In male genitalia (Fig. 6a–d), the costal process is clearly longer than that of *A. leucomelas* (Kuroko 1969).

Fig. 6 Male genitalia of *Aedia kumamotonis*. **a** Ring in left lateral view (catena sensu Roepke (1941) removed). **b** Right valva in inner view. **c** Aedeagus in left lateral view. **d** Juxta in ventral view. Scale bars = 0.5 mm



and *A. limitaris*. In female genitalia (Fig. 3c), the ductus seminalis is relatively short and opens on the structurally left side in this species, whereas it opens on the right side in *A. leucomelas* and *A. limitaris*.

Last instar larvae (Fig. 4c, f). This species is easily distinguished from *A. leucomelas* by the obviously larger black spots on its head, which are smaller in *A. leucomelas* (Watabiki 2022). This character can also be used to distinguish this species from *A. limitaris*.

Distribution. This species is an endemic species in Japan and is distributed from Hokkaido, Honshu and mainland Kyushu (Eda 2011; Takahashi 2024).

Host plants. *Calystegia pubescens* Lindl. *F. major* (Makino) Yonek. and *C. hederacea* are recorded for this species (Eda 2011; Kogi 1980; Kuroko 1969; Watabiki 2022).

Remarks. The female genitalia of this species are illustrated here for the first time. In addition, the specimen identified as *A. kumamotonis* from Thailand by Kononenko and Pinratana (2005) (pl. 22: 25 in the literature) is clearly different in external features from *A. kumamotonis* and

should be regarded as a distinct species. Specifically, its forewing markings around the reniform stigma are paler compared to *A. kumamotonis*, and the white area on the basal half of the hindwing extends to the outer margin between veins CuA2 and 1A + 2A. However, the taxon may have no appropriate scientific name and thus may be an undescribed species.

DNA barcoding

In the ML, MP, and NJ trees, among the three Japanese species of the genus *Aedia*, the respective nodes corresponding to *A. leucomelas* and *A. limitaris* showed bootstrap values ≥ 99 , strongly supporting the monophyly of both species. *A. leucomelas* was placed in the same clade as the European populations of *A. leucomelas*. *A. limitaris* matched sequences registered on BOLD systems as *A. acronyctoides*, but the *A. acronyctoides* sequences were divided into three distinct clades (Fig. 7; Clade A–C). Based on the results of our morphological study, we identified the images of adult specimens for each sequence registered on BOLD systems.

Table 1 A List of diagnostic characters for adult Japanese *Aedia* species

Diagnostic characters	<i>A. limitaris</i>	<i>A. leucomelas</i>	<i>A. kumamotonis</i>
Forewings			
Ground color	More greyish, with each fascia more conspicuous	Uniformly blackish brown	Uniformly blackish brown
Reniform stigma	More conspicuous with white edge	Indistinct	Indistinct
Hindwings			
Inner margin coloration	Dark brown	Dark brown	Silky white
Male genitalia			
Juxta	Ventromedial margin depression rounded	Ventromedial margin depression deeper	Ventromedial margin depression shallow and triangular
Valva	5–10 relatively short coronal setae (average 7; n = 9) at apical end Costal process is short	8–15 relatively long coronal setae (average 12; n = 10) at apical end Costal process is short	9–10 relatively long coronal setae (n = 3) at apical end Costal process is clearly longer
Female genitalia			
Ductus bursae	The number of coils on anterior half is 1.5	The number of coils on anterior half is single	The number of coils on anterior half is single
Ductus seminalis	Relatively long and opens on the structurally right side	Relatively long and opens on the structurally right side	Relatively short and opens on the structurally left side
Larva			
Black spots on the Head	Small	Small	Obviously larger
Spiracles on each segment	Generally black	Generally light brown	Generally black
Black spots located anterior to the spiracles of A1	Distinctly larger than those on A2–A8	Subequal to or slightly larger than those on A2–A8	Subequal to or slightly larger than those on A2–A8

As a result, Clade A in Fig. 7 obtained from Japan, Taiwan, Papua New Guinea and Australia was identified as *A. limitaris*, while Clade C obtained only from Australia corresponded to *A. acronyctoides*. Although Clade B obtained only from Papua New Guinea formed a distinct clade, it has no appropriate scientific name, and further taxonomic study will be required.

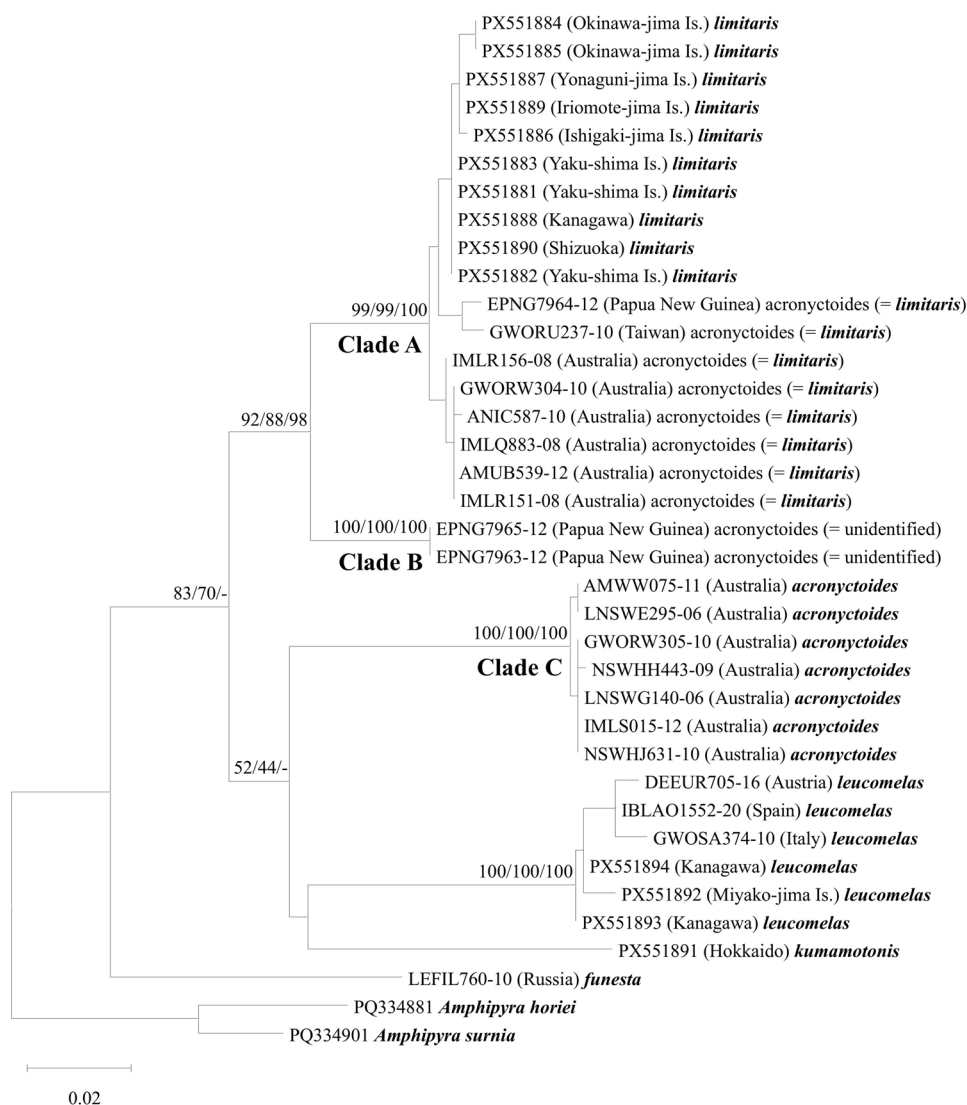
Discussion

In the present study, *A. limitaris* sp. rev. is newly recorded from Japan, and reliable diagnostic characters of the adults and larvae of the three Japanese *Aedia* species are clarified. However, the morphology of the eggs, early instars, pupae and their chaetotaxy has not been investigated. Therefore, further studies are needed to provide detailed descriptions of each immature stage of *A. limitaris*.

As mentioned in the Introduction, previous studies on the so-called “sweet potato leafworm” in Japan have long been conducted under the assumption that the taxon consists of a single species. However, the present study revealed that this taxon comprises two distinct species, *A. leucomelas* and *A. limitaris*, and that the larvae of both species can successfully feed and grow on the leaves of *Ipomoea batatas* as their diet. This finding suggests that previous records of *A. leucomelas*

may have been confused with *A. limitaris*. Comparison of the data from the ‘Specimens examined’ of both species indicates that *A. leucomelas* occurs commonly from Honshu to Okinawa region, while *A. limitaris* is relatively common south of the Kyushu region. In the Kanto region, adults of *A. limitaris* were collected monthly from May to October 2025 on the Atsugi Campus of Tokyo University of Agriculture (Funako, Atsugi City, Kanagawa Prefecture) often co-occurring with *A. leucomelas*. This observation suggests that *A. limitaris* is continuously present throughout the sweet potato cultivation period in the study area, and that both species are sympatric in the Kanto region. However, no specimens of *A. limitaris* collected from Honshu and Shikoku before 2023 were found in this study (except for an incidental specimen from Hokkaido collected on 3 September 1976). Thus, the occurrence of *A. limitaris* in Kanagawa Prefecture in 2024 and 2025 might have been transient. Actually, a review of publication concerning *Aedia* species as pests of sweet potato revealed that most references referred to *A. leucomelas*, and *A. limitaris* were not included (e. g., Emura 2012; Mochida 2003; Tsutsui 1957). In the Kyushu and Okinawa regions, where *A. limitaris* is common, both *A. leucomelas* and *A. limitaris* may occur as pests of sweet potato. For reference, Watabiki (2025) suggested that sweet potato is not a suitable host plant for *A. kumamotonis*, therefore the species is probably not present in fields cultivated with sweet potato.

Fig. 7 Maximum likelihood (ML) tree of the genus *Aedia* spp. based on 658 bp of the mitochondrial cytochrome oxidase I (COI) gene. Numbers on the nodes indicate the bootstrap values (ML/MP/NJ), and “-” indicate topological incongruence among the ML, MP, and NJ trees. *Amphipyra surnia* Felder and Rogenhofer and *A. horiei* Owada were utilized as outgroup species



A. leucomelas is designated as a kind of “plants and animals designated as harmful species” under the Plant Protection Act in Japan (MAFF 2023), and consequently, the species is also a target species of the Pest Forecasting Services. Therefore, based on the diagnostic features of adults and larvae clarified in the present study, nationwide surveys of the ecology, life history, and pest status of both species are required.

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Declarations

Conflict of interest The authors declare that they have no competing interests.

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References

- Beck H (1960) Die Larvalsystematik der Eulen (Noctuidae). Abh Larval-Syst Insekten 4:1–406
- Eda K (2011) Aediinae. In: Kishida Y (ed) Standard moths of Japan 2. Gakken Education Publishing, Tokyo, pp 291–292 (**in Japanese**)
- Eda K (2018) Aediinae. In: Wang M, Kishida Y, Eda K (eds) Moths of Guangdong Nanling National Nature Reserve Supplement. Hong Kong Lepidopterists' Society, Hong Kong, pp 67–68
- Emura K (2012) *Aedia leucomelas*. In: Emura K, Kubota S, Hirai K (eds) Guide to pest arthropods and beneficials in Japanese field. Hokuryukan Co. LTD, Tokyo, pp 101–102 (**in Japanese**)
- Felsenstein J (1985) Confidence limits on phylogenies: an approach using the bootstrap. *Evol* 39:783–791
- Folmer O, Black M, Hoeh W et al (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit i from diverse metazoan invertebrates. *Mol Mar Biol and Biotech* 3:294–299
- Goater B, Ronkay L, Fibiger M (2003) Noctuidae Europaeae 10, Catocalinae & Plusiinae. Entomological Press, Sorø
- Hampson GF (1894) The fauna of British India, including Ceylon and Burma, Moths, vol II. Taylor & Francis, London
- Haruta T (1993) Noctuidae: Catocalinae and Ophiderinae 1. In: Haruta T (ed) Moths of Nepal Part 2, Tinea 13 (Suppl 3). Japan Heterocerists' J, Tsukuba, pp 57–73
- Haruta T (1994) Noctuidae: Catocalinae and Ophiderinae. Moths of Nepal Part 3, Tinea 14 (Suppl 1). Japan Heterocerists' J, Tsukuba, pp 140–153
- Higashihirachi S (1962) Noctuidae of the Ryukyu Islands (Loochoos). *Jpn Heteroc J* (29):163–182 (**in Japanese**)
- Holloway JD (1976) Moths of Borneo with special reference to Mount Kinabalu. The Malayan Nature Society, Kuala Lumpur
- Holloway JD (2005) The moths of Borneo, Part 15 & 16: family Noctuidae, subfamily Catocalinae. *Malayan Nat J* 58:1–529
- Holloway JD (2009) The moths of Borneo, Part 13: Noctuidae, Pantheinae, Bagisarininae, Acontiinae, Aediinae, Eustrotiinae, Bryophilinae, Araeopterinae, Aentiinae, Eublemminae and further miscellaneous genera. *Malayan Nat J* 62:1–240
- Holloway JD (2011) The moths of Borneo, Part 2: families Phaudidae, Himantopteridae and Zygaenidae; revised and annotated checklist. *Malayan Nat J* 63:1–548
- Hori S, Sakurai M (2015) Butterfly and Moths in Hokkaido. The Hokkaido Shimbun Press, Sapporo (**in Japanese**)
- Keegan KL, Rota J, Zahiri R et al (2021) Toward a stable global Noctuidae (Lepidoptera) taxonomy. *Insect Syst Divers* 5:1–24
- Kobayashi Y (1977) Male abdominal brush-organs in Japanese noctuid moths (Lepidoptera, Noctuidae), I. Notes as a Taxonomic character. *Kontyu* 45:510–525
- Kogi H (1980) Two species of Noctuidae found from Hokkaido. *Jpn Heteroc J* 107:99–100 (**in Japanese with English summary**)
- Komai F, Hashimoto S, Yoshiyasu Y (2011) Morphology and biology, 1 morphology. In: Komai F, Yoshiyasu Y, Nasu Y et al (eds) A guide to the Lepidoptera of Japan. Tokai University Press, Kanagawa, pp 3–36 (**in Japanese**)
- Kononenko VS, Han HL (2007) Atlas genitalia of Noctuidae in Korea (Lepidoptera) (Insects of Korea 11). Korea Research Institute of Bioscience and Biotechnology & Center for Insect Systematics, Seoul
- Kononenko VS, Pinratana A (2005) Moths of Thailand 3, Noctuidae. Brothers of Saint Gabriel, Thailand
- Kononenko VS, Pinratana A (2013) Moths of Thailand 3, Part 2, Noctuoidea. Brothers of Saint Gabriel, Thailand
- Kononenko VS, Ahn SB, Ronkay L (1998) Illustrated catalogue of Noctuidae in Korea (Lepidoptera) (Insects of Korea 3). Korea Research Institute of Bioscience and Biotechnology & Center for Insect Systematics, Seoul
- Kumar S, Stecher G, Suleski M et al (2024) MEGA12: molecular evolutionary genetic analysis version 12 for adaptive and green computing. *Mol Biol Evol* 41:1–9
- Kuroko H (1969) Notes on *Aedia kumamotonis* (Matsumura) (Noctuidae). *Jpn Heteroc J* 57:657–659 (**in Japanese with English summary**)
- Lee GH, Paik CH, Kim DH, Choi MY, Na SY, Kim SS (2003) Morphological characteristics, developmental period, seasonal occurrence, and sweet potato consumption of *Aedia leucomelas* (L) (Lepidoptera: Noctuidae). *Korean J Appl Entomol* 42:1–7 (**in Korean with English abstract**)
- Ministry of Agriculture Forestry and Fisheries (MAFF) (2023). “About the Plants and animals designated as harmful species”. https://www.maff.go.jp/j/syoutan/syokubo/gaicyu/g_yosatsu/index.html. Accessed 7 Nov 2025 (**in Japanese**)
- Mochida O (2003) *Aedia leucomelas*. In: Umeza K, Okada T (eds) Agricultural insect pests in Japan. Zenkoku Noson Kyoiku Kyokai, Tokyo, pp 103–104 (**in Japanese**)
- Murase M (2011) Notes on the larval colour pattern and host plants of *Aedia leucomelas* (Linnaeus) (Noctuidae). *Jpn Heteroc J* 259:209–210 (**in Japanese**)
- Poole RW (1989) Lepidopterorum Catalogus (New Series) Fascicle 118, Noctuidae, Part 1–3. EJ Brill, Leiden
- Robinson GS, Ackery PR, Kitching JJ et al (2002) Host plants of the moth and butterfly caterpillars of the Oriental region. Natural History Museum, London
- Roepeke W (1941) On some new or little known Indo-Malayan noctuids (Lepidoptera heterocera, family agrotidae). *Zool Meded* 23:13–30
- Ronkay G, Ronkay L, Varga Z (2024) Fibigeriana supplement 4, Macrolepidoptera of Hungary, Third revised edition. Heterocera Press, Budapest
- Sugi S (1982) Noctuidae. In: Moths of Japan 1, 2. Kodansha, Tokyo, 1:699–935, 2:344–408 and 146–226 pls (**in Japanese**)
- Takahashi T (2024) A record of *Aedia kumamotonis* (Matsumura, 1926) (Noctuidae) from Ichikawa-chou, Kanzaki-gun, Hyogo Prefecture. *Jpn Heteroc J* 311:318 (**in Japanese**)
- Takara T, Azuma S (1968) Heterocera from the Iriomote Island, Ryukyus (Lepidoptera). *J Okinawa Agric* 7:17–27 (**in Japanese**)
- Tominaga S (2001) Larvae and host plants of four noctuid species in Okinawa. *Yugato* 163:1–3 (**in Japanese**)
- Tsutsui K (1957) An illustrated natural history of the injurious insects of Japan, vol 1. Asakura Publishing Co. Ltd, Tokyo (**in Japanese**)
- Varley GC (1962) A plea for a new look at lepidoptera with special reference to the scent distributing organs of male moths. *Trans Soc Brit Entomol* 15:29–40
- Watabiki D (2022) Description of the immature stages of *Aedia kumamotonis* (Matsumura) with notes on the morphological differences from the sweet potato leaf worm, *Aedia leucomelas* (Linnaeus) (Lepidoptera, noctuidae, aediinae). *Lepidoptera Sci* 73:147–152
- Watabiki D (2025) A brief experiment on the feeding habits of the larvae of *Aedia kumamotonis* (Matsumura) (Noctuidae: Aediinae). *Jpn Heteroc J* 313:365–366 (**in Japanese with English summary**)
- Yashiro H (1940) Notes on *Anophia leucomelas* Linnaeus, a pest of the sweet potato. part II. *Ouyoukonchu* 2:231–239 (**in Japanese**)

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