

A new genus of *Pexicopiini* (Lepidoptera: Gelechiidae) for “*Gelechia*” *acanthopis* Meyrick, 1932, with review of functional morphology of male genitalia in allied genera

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Abstract

The systematic status of *Gelechia acanthopis* Meyrick, 1932 is reviewed. The general and functional morphology of the male genitalia merits a new genus in *Pexicopiini*, *Sitotrogoides* **gen. nov.**, for *G. acanthopis*. The musculoskeletal apparatus of the male genitalia in *Sitotrogoides* is described for the first time and compared with allied genera. The taxonomic position of the genus *Sitotrogoides* is determined within the tribe *Pexicopiini*. The lack of the muscle m_3 is suggested as a characteristic associating *Sitotrogoides* with *Sitotroga* and differing from all other genera in *Pexicopiini*. The type species of *Sitotrogoides*, *Gelechia acanthopis* Meyrick is redescribed. Our new records of *Sitotrogoides acanthopis* from Korea suggest its extended distribution out of Japan.

Key words: Gelechiidae, functional morphology, *Harpagidia*, *Pexicopia*, *Platyedra*, *Sitotroga*, taxonomy

Introduction

The type genus of Gelechiidae, *Gelechia* Hübner, [1825] was established for the type species, *Tinea rhombella* [Denis et Schiffermüller], 1775, subsequently designated by Walsingham (1911). As more than 400 heterogeneous species had been placed into *Gelechia*, and the genus became a so-called “wastebasket” (Busck 1939). After nearly a century of revisions, *Gelechia* currently include about 150 species worldwide (Beccaloni *et al.* 2003). Efforts to eliminate non-monophyletic groups within *Gelechia* are still ongoing as these members are still present within the genus.

Gelechia acanthopis Meyrick, 1932 is one of the several species remaining in *Gelechia* without appropriate placement. Since its original description, based on one male specimen from Hokkaido, *G. acanthopis* has been considered an endemic to Japan (Sakamaki 2013). Despite Busck’s (1939) beliefs on the heterogeneity of *Gelechia*, the problem regarding the placement of *G. acanthopis* was not treated by him. Clarke (1969) examined and dissected the type specimen of *G. acanthopis* but retained it within *Gelechia*. Sakamaki (2013) was the first to raise a question concerning the assignment of *acanthopis* to *Gelechia*. He noticed its affinity with *Sitotroga* Heinemann, 1870 but did not transfer it to any other genus.

The purposes of this article are as follows: 1) to define the systematic position of *G. acanthopis* based on the features of its musculoskeletal apparatus and the comparative analysis of the functional morphology of the male genitalia in related genera; 2) to designate a new genus for *G. acanthopis*; and 3) to report the occurrence of the species in South Korea representing its first record outside Japan.

Material and methods

Specimens for this study were obtained from five collections as follows:

Natural History Museum, London, UK (NHMUK);

Mokpo National University, Mu-an, Republic of Korea (MPNU);

National Institute of Biological Resource, Incheon, Republic of Korea (NIBR);

Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia (ZINRAS)

Entomological Laboratory, Faculty of Agriculture, Kagoshima University, Kagoshima, Japan (KGU).

Genitalia slides were prepared following Clarke (1941) except that chlorazol black was used for staining and Euparal resin for permanent slide mounting. Functional morphology of male genitalia was examined from specimens fixed in 70% ethanol and from dried specimens. Dissection of specimens for functional morphology study followed Kuznetsov & Stekolnikov (2001). Flexibility in dry specimens was obtained by the method described in Ponomarenko (2005). Before dissection, all the specimens were stained in aqueous solution of eosin.

Pinned specimens were examined with a stereoscope, Leica EZ4 (Leica Microsystems, Wetzlar, Germany). Slide-mounted specimens were photographed using a digital camera, Nikon D40 (Nikon Corp., Tokyo, Japan) through an adaptor attached to a dissecting microscope, Leica MZ6. Musculoskeletal apparatuses in male genitalia were examined using the stereomicroscopes, Carl Zeiss and Nikon SMZ-10 under magnification ranging 120–160x. An image of each layer of a dissected specimen was sequentially taken using a digital camera, Nikon Coolpix 8700. Terminology follows Klots (1970) for genitalia, Kuznetsov & Stekolnikov (2001) for functional morphology of the male genitalia with changes after Ponomarenko (2005, 2009), and Wootton (1979) for wing venation.

Taxonomic accounts

Tribe Pexicopiini

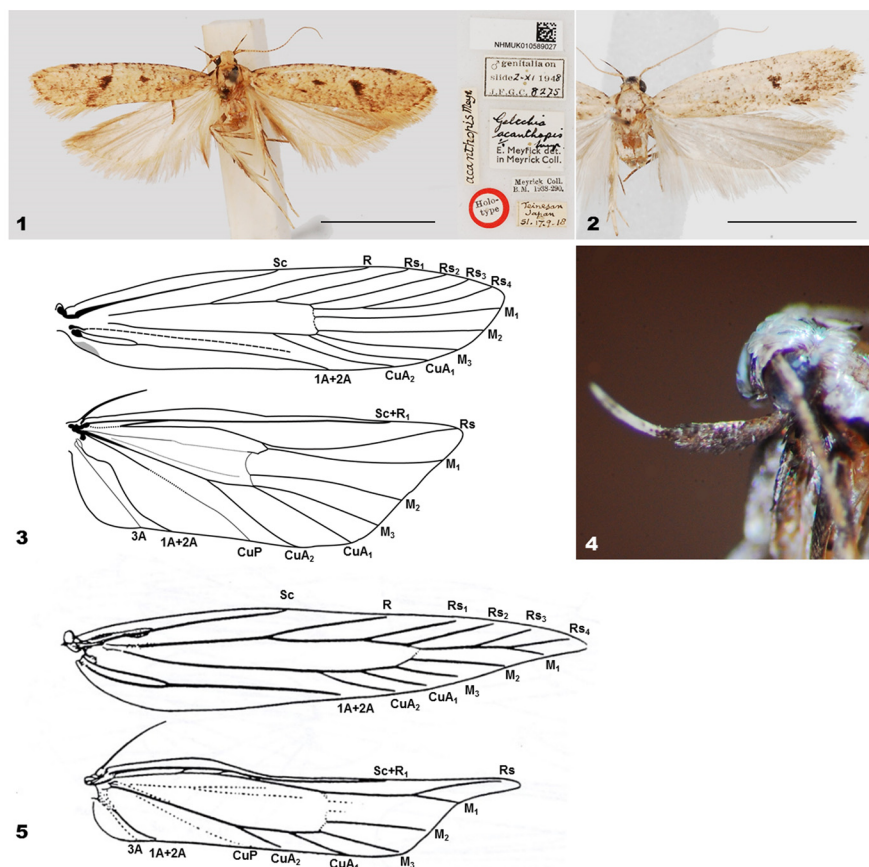
Genus *Sitotrogoides* gen. nov.

Type species: *Gelechia acanthopis* Meyrick, 1932.

Diagnosis. *Sitotrogoides* is similar to *Sitotroga* in having the valva with a semiseparated sacculus in the male genitalia (Figs 10, 15). The type species of both genera, *Sitotrogoides* and *Sitotroga*, possess the aedeagus with a long caecum (Figs 7, 10, 15) and lack the muscles m_3 in the musculoskeletal apparatus of the male genitalia. However, *Sitotrogoides* differs from *Sitotroga* by the presence of the separate forewing veins, Rs_4 and M_1 , the separate hindwing veins, Rs and M_1 (Figs 3, 5); an arrow-like medial plate in gnathos (Fig. 6), an elongate saccus, a setaceous valvella, the valva fused with the vinculum in the saccular area into an ankylosed sacculus +vinculum sclerite (Fig. 11), the widely-spaced proximal parts of muscles m_2 and m_4 (Figs 10, 11) in the male genitalia, and the shorter ovipositor (Fig. 9) in the female genitalia.

Description. *Head:* labial palpi $2.3\times$ longer than eye diameter; 2nd palpomere with dense scales; 3rd palpomere slender, acuminate apically. Antennae filiform in both sexes; scape without pecten.

Thorax: metatibia with dense scales. Forewing elongate, with narrowly-round apex. Forewing venation (Fig. 3) with Sc reaching margin at middle of costa; R arising from radius near midlength, nearly parallel to Rs_1 ; Rs_2 nearly parallel to Rs_1 ; Rs_3 and Rs_4 stalked at basal 1/3, curved to costa; M_1 nearly parallel to M_2 , closer to stem of Rs_3 and Rs_4 except distal 1/3; M_3 divergent from CuA_1 ; CuA_2 slightly convergent to CuA_1 in basal 2/3; CuP present as folder in basal 3/4; 1A+2A with basal fork 1/4 length. Hindwing venation (Fig. 3) with Sc+ R_1 reaching margin at distal 1/5 of costa, with oblique spur at basal 1/4; Rs stem arched at distal 1/3; Rs curved toward near wing apex; Rs and M_1 close in basal 1/6, divergent from each other; M_1 curved; M_2 slightly divergent from M_1 in distal half, closer to M_3 than to M_1 ; M_3 divergent from M_1 ; CuA_1 connate with M_3 ; CuA_2 slightly divergent from CuA_1 ; CuP closer to CuA_2 than to 1A+2A, incomplete medially; 1A+2A sinuous, with small basal fork; 3A close to 1A+2A, straight. Male sternite VIII (Fig. 8) emarginated medially on posterior margin.



FIGURES 1–5 *Sitotrogoides acanthopis* (Meyrick, 1932) and *Sitotroga cerealella* (Olivier, 1789). **1–4**, *Sitotrogoides acanthopis*: **1**, holotype, NHMUK, inset = specimen labels; **2**, male, Is. Wando, Korea, MPNU; **3**, wing venation; **4**, head vestiture and labial palpus. **5**, wing venation of *Sitotroga cerealella* (modified from Zimmerman 1978). Scale bars = 5 mm.

Male genitalia (Figs 6–7) with lobate uncus; semi-circular gnathal plate; elongate valva, with linear zone of strong setae along ventral margin; saccus elongate, subtriangular; straight aedeagus with elongate caecum.

Female genitalia (Fig. 9) with papillae anales elongate; apophyses slender; sclerotized band along ventral margin of ostium bursae fused with sclerotized ring of 8th abdominal segment; ductus bursae narrow, with sclerotization near ostium bursae; corpus bursae with two signa.

Description of male and female genitalia specific details see under the type species re-description.

Description of functional morphology of male genitalia. Musculoskeletal apparatus (Figs 10–12) comprising seven paired muscles (m_1 , m_2 , m_4 , m_{5a} , m_{5b} , m_6 , m_{22}) and two unpaired muscle (m_{21} , m_{28}):

m_1 (musculus tergalis intersegmentalis 9–10) muscle from the lateral surface of the anterior part of tegumen to sclerotized semiseparate plate at the base of uncus;

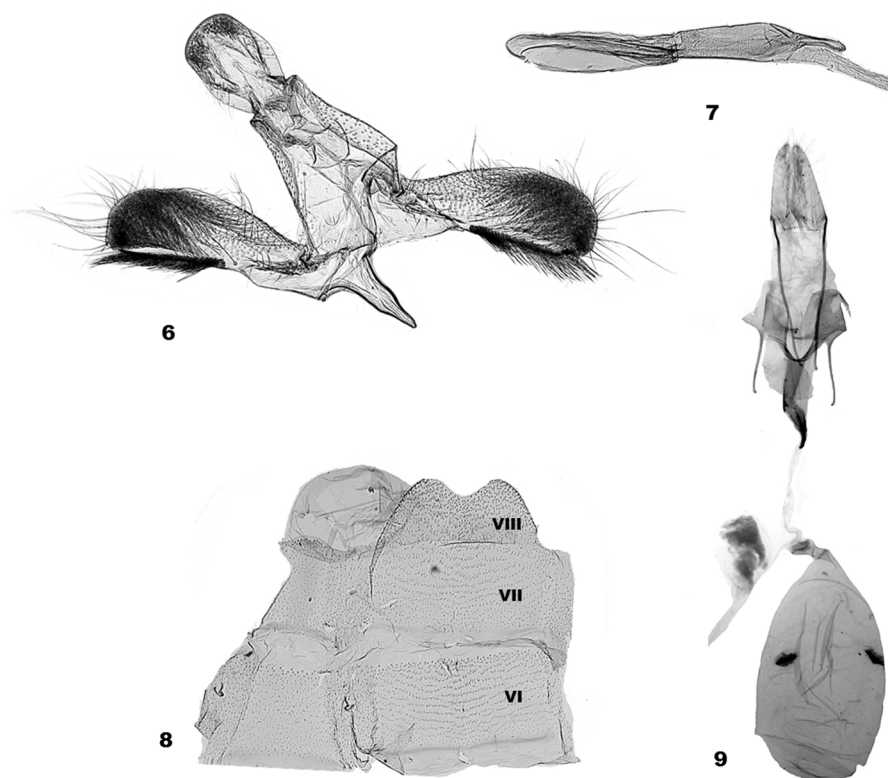
m_2 (musculus gonopodalis externus dorsolateralis) muscle from the dorsal part of tegumen to the dorso-basal angle of valva and attached to the place of joining of the valva with tegumen;

m_4 (musculus gonopodalis externus dorsomedialis) muscle attached to the medial surface of anterodorsal margin of widened anterior part of tegumen and stretched to the medial side of saccular part of valva and to base of valvella;

m_{5a} (musculus phallicus externus posterior) muscle from the joined sclerite saccus+vinculum to the lateral margin of the aedeagus caecum;

m_{5b} (musculus phallicus externus posterior) muscle from ventral surface of saccus to the apex of aedeagus caecum;
 m_6 (musculus phallicus externus anterior) muscle stretched from the lateral margin of the saccus to the ventral surface of aedeagus;
 m_{21} (musculus phallicus internus longitudinalis) muscle placed within inflated basal part of the aedeagus;
 m_{22} (musculus tergosternalis intrasegmentalis 9) muscle from anterior margin of vinculum to external surface of anterodorsal angle of tegumen;
 m_{28} (musculus phallicus internus transverses) muscle of the balbus of ejaculatory ductus aedeagus.

Etymology. The generic name is derived from a similar genus, *Sitotroga* with a Greek suffix, ‘-oides’, meaning “like”.



FIGURES 6–9. Genitalia and abdominal segments of *Sitotrogoides acanthopis* (Meyrick, 1932). **6**, male genitalia, ventral view; **7**, aedeagus; **8**, abdominal segment VI–VIII, terga in left, sterna in right; **9**, female genitalia.

***Sitotrogoides acanthopis* (Meyrick, 1932) comb. nov.**

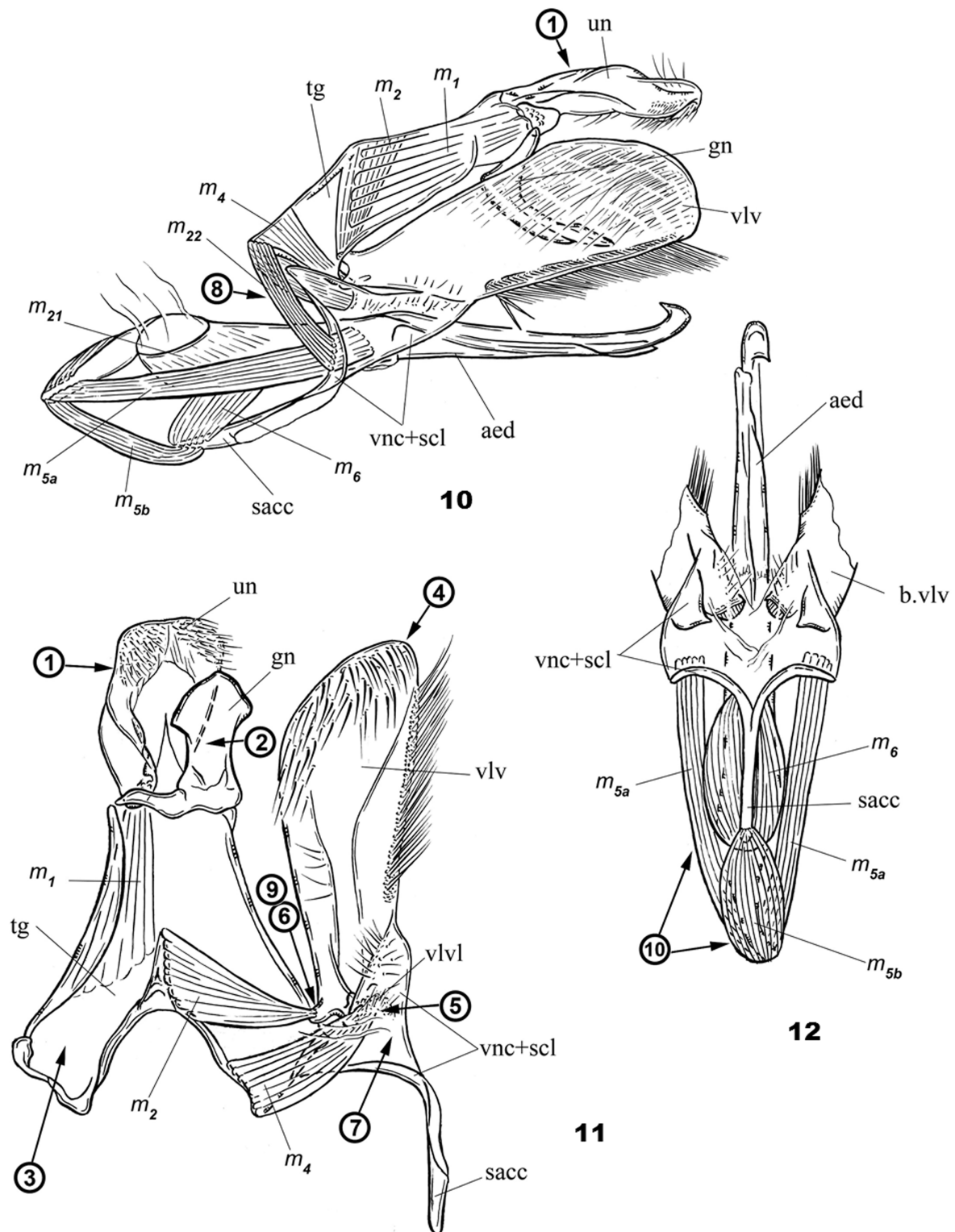
(Figs 1–4, 6–12)

Gelechia acanthopis Meyrick, 1932: 195. Type locality: Teinesan [Hokkaido, Japan].

Gelechia acanthopis—Gaede, 1937: 144; Clarke, 1969: 107; Moriuti, 1982: 278.

“*Gelechia*” *acanthopis*—Sakamaki, 2013: 270.

Diagnosis. *Sitotrogoides acanthopis* is similar to *Pexicopia malvella* (Hübner, [1805]) in wing pattern, but differs from the latter by the presence of large, black discal spot on the forewing. The male genitalia of *Sitotrogoides acanthopis* are most similar to those of *Sitotroga psacasta* (Meyrick, 1908) and *S. pseudopsacasta* Ponomarenko et Park, 2007 in having strong spines on the medial side of the valva along the ventral margin. *Sitotrogoides acanthopis* differs from them by the lack of a distal process on the sacculus, the presence of a well-developed caecum in the aedeagus, and an elongate saccus.



FIGURES 10–12. Musculoskeletal apparatus of male genitalia in *Sitotrogoides acanthopis* (Meyrick, 1932). **10**, lateral view; **11**, uncus, tegumen, valva, position of muscles m_1 , m_2 and m_4 , medial view; **12**, phallic muscles, ventral view, valvae removed partly. Arrows and numbers in circles indicate diagnostic characters of the tribe Pexicopiini (see the main text). Abbreviations: m_1 , m_2 , m_4 , m_{5a} , m_{5b} , m_6 , m_{21} , m_{22} —muscles; aed—aeagus, b.vlv—base of valva, c—caecum, gn—gnathos, vlv—valva, vlvI—valvella, vnc—vinculum, sacc—saccus, scl—sacculus, tg—tegumen, un—uncus.

Re-description of external and genital morphology. *Head* (Figs 1, 2, 4). Vertex pale yellowish gray, intermixed with dark yellowish gray scales laterally and anteriorly; frons dark brown. Labial palpi with 1st palpomere dark purplish brown, 1/6 as long as 2nd palpomere; 2nd palpomere dark purplish brown, as long as 3rd palpomere; 3rd palpomere pale grayish yellow, tinged with dark brown basally and at apical 1/4. Antenna 2/3 as long as forewing; scape pale grayish yellow, intermixed with dark brown scales; flagellum pale grayish yellow, sparsely intermixed with dark brown scales.

Thorax. Patagium, tegula and mesonotum pale grayish yellow, sparsely intermixed with dark grayish yellow and dark brown scales. Foreleg with coxa dark brown, intermixed with brownish white scales apically; femur dark purplish brown dorsally, yellowish gray ventrally; tibia and tarsomeres dark purplish brown, with brownish white apical ring. Midleg with coxa and femur dark purplish brown; tibia dark brown, with brownish white band at middle and apically; tarsomeres dark brown, with brownish white apical ring. Hindleg with coxa and femur dark purplish brown; tibia dark brown, with pale grayish yellow band at middle and apically; tarsomeres dark brown dorsally, pale grayish yellow ventrally, with brownish white apical ring. Forewing length 7.5–9.5 mm, brownish white, irrorated with dark brown, densely intermixed with dark purplish brown scales on apical 1/3; dark brown spot at middle of discal cell; dark brown dash at distal end of discal cell; fringe yellowish gray. Hindwing pale grayish yellow; fringe pale grayish yellow.

Abdomen. Two proximal terga pale grayish yellow; remaining terga dark brownish gray, tinged with pale brownish gray apically; sterna dark brown, each tinged with pale grayish yellow apically. Posterior margin of sterna viii emarginated (Fig. 8).

Male genitalia (Figs 6–7, 10–12). Uncus long, sub-hexagonal, with zone of dense short setae laterodistally and sparsely long setae lateromedially. Tegumen widened basally, gradually narrowed apically, emarginated mediobasally, deeply hollowed on anterior margin, with widened anterolateral apodemes for two pairs of muscles, m_4 and m_{22} . Gnathos as long as uncus; gnathal arm about 1/2 length of medial plate; medial plate arrowhead-like, narrowly round apically. Valva broadened to a rounded apex, with relatively broad neck and almost right ventral corner distally; costa gradually tapered beyond 3/5, with linear zone of needle-like setae along distal half of ventral margin of valva; setaceous valvella present on medial side basally; sacculus semi-separated from cucullus, joined with vinculum into ankylosed sclerite (vinculum+ sacculus), which is V-shaped in ventral view; saccus narrow and long, about same length as aedeagus. Aedeagus nearly straight, with hook-like, dorsally-curved apex and narrow sclerotized lobe of anellus in apical half, nearly reaching apex; caecum narrow, long.

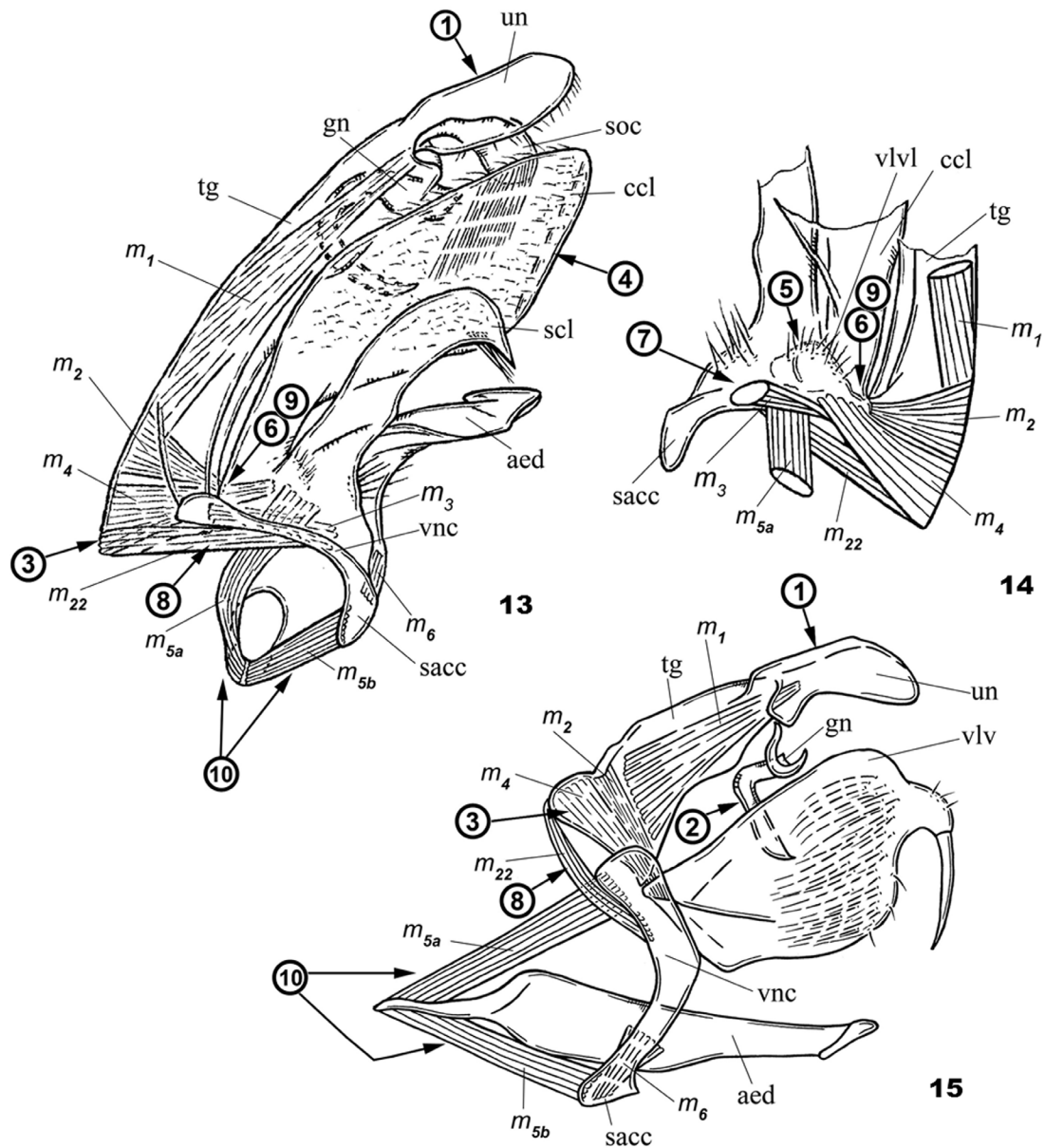
Female genitalia (Fig. 9): Papillae anales elongate, subconical, setose. Apophysis posterioris 2.2× longer than apophysis anterioris. Ostium bursae surrounded by sclerotized band ventrally. Ductus bursae 3× longer than papillae anales; anterior 2/5 sclerotized, tapered anteriorly; posterior 3/5 narrow, slightly enlarged near corpus bursae. Ductus seminalis arising at posterior 1/6. Corpus bursae obovate; two signa in middle of bursae small, sclerotized, elliptically shaped, horizontally emarginated at middle, with subtriangular internal plate.

Type. Holotype: male, “Holo- | type” [round white label with red margins], “Teneisan | Japan | SI. 17.9.18” [hand-writing], “*acanthopis* Meyr.” [hand-writing], “*Gelechia* | *acanthopis* | 1/1 Meyr. | E. Meyrick det. | in Meyrick Coll.”, “Meyrick Coll. | B. M. 1928-290.”, “♂ genitalia on | slide 2.XI 1948 | J.F.G.C. 8275” [label with black marginal lines], “NHMUK010589027” [label with unique identifier barcode], NHMUK.

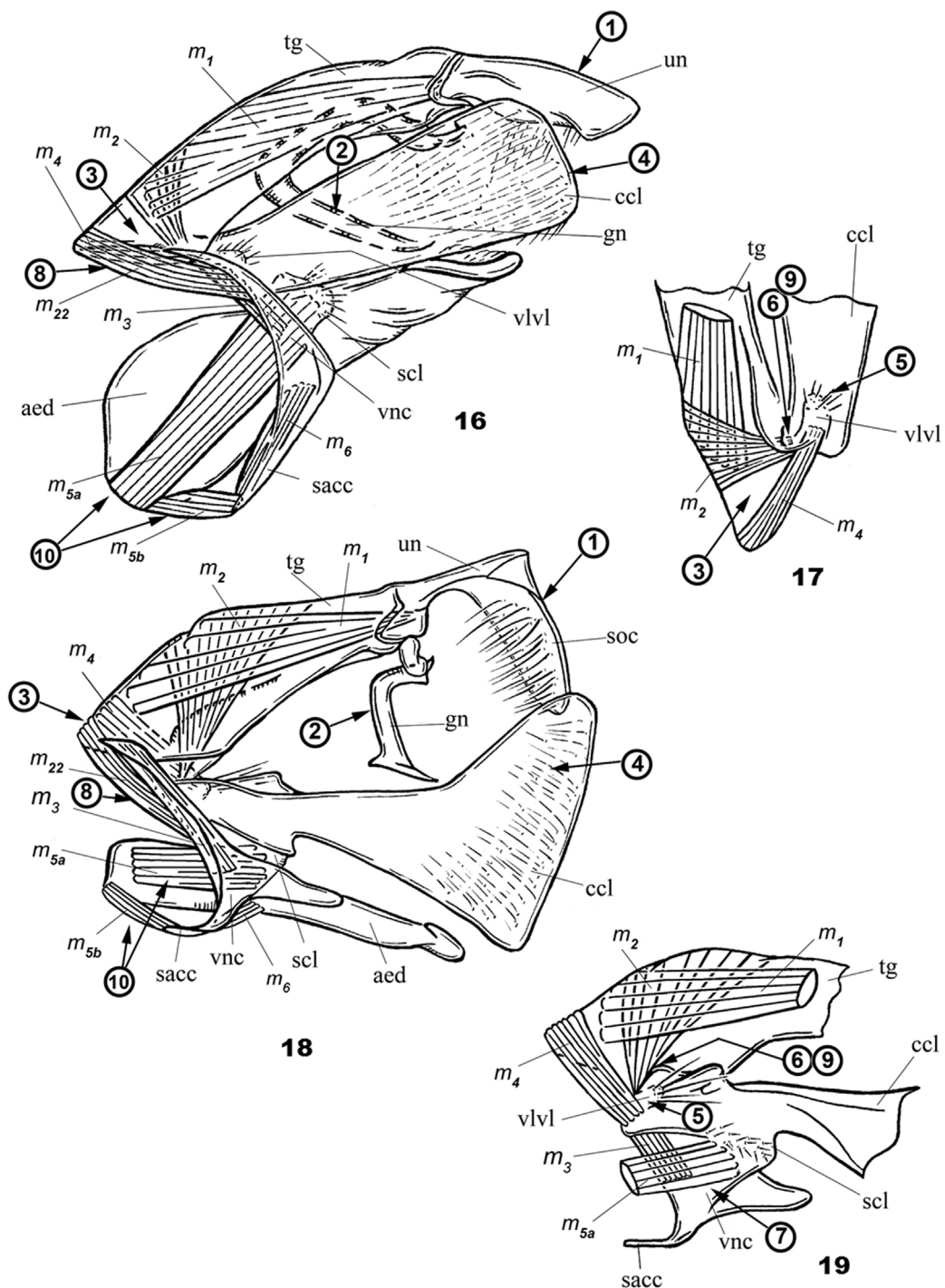
Material examined. 11♂, 1♀. Korea: 1♂, Jeonnam Prov., Haenam-gun, Mt. Duryunsan, 24 x 2003 (MNU), [GSN] SJC-973, MPNU; 5♂, Jeonnam Prov., Muan-gun, Mt. Seungdalsan (34°54'N, 126°27'E, ele. 150 m), 30 x 2006 (SW Choi, M Park, JS An, SK Kim), MPNU & NIBR; 1♂, Jeonnam Prov., Muan-gun, Cheonggye-myeon, Dorim-ri (34°54'54"N 126°26'59", ele. 92 m), 10 vi 2008 (J Lee), MPNU; 2♂, Jeonnam Prov., Muan-gun, Mongtan-myeon, Dalsan-ri (34°54'56"N 126°27'20"E, ele. 123 m), 20 x 2008 (J Lee & JS An), MPNU & NIBR; 1♂, Jeonnam Prov., Gurye-gun, Toji-myeon, Mt. Jirisan (35°18'12"N 127°33'34", ele. 1318 m), 26 viii 2008 (SW Choi), MPNU; 1♂, Jeonnam Prov., Wando-gun, Gunoe-myeon, near Wando Arboretum, 5 xi 2015 (SS Kim), MPNU. Japan: 1♀, Oumeitei, Nasu-Town, Tochigi-Pref. Honshu, 1 ix 2007 Y. (Y Arita), KGU.

Distribution. Korea (new record), Japan.

Remarks. In the NHMUK's card index and its computerized and updated version (Beccaloni *et al.* 2003) and on the website "Lepidoptera and Some Other Life Forms" (Savela 2001), *Gelechia acanthopis* was assigned to *Harpagidia* Ragonot, 1895. We consider this generic transfer invalid, since it has not been proposed in any formal publication.



FIGURES 13–15. Musculoskeletal apparatus of the male genitalia. **13**, *Platyedra subcinerea* (Haworth, 1828), lateral view; **14**, ditto, basal part of tegumen and valva with attached muscles, medial view; **15**, *Sitotroga cerealella* (Olivier, 1789), lateral view. Arrows and numbers in circles indicate diagnostic characters of the tribe Pexicopiini (see the main text). Abbreviations: m_j —muscles, ccl—cucullus, soc—socii; others as in Figures 10–12.



FIGURES 16–19. Musculoskeletal apparatus of the male genitalia. **16**, *Harpagidia magnetella* (Staudinger, 1871), lateral view; **17**, ditto, basal part of tegumen and valva with attached muscles, medial view; **18**, *Pexicopia malvella* (Hübner, 1805), lateral view; **19**, ditto, basal part of tegumen and valva with attached muscles, medial view. Arrows and numbers in circles indicate diagnostic characters of the tribe Pexicopiini (see the main text). Abbreviations as in Figures 10–15.

Discussion

Examination of the musculoskeletal apparatus of male genitalia allowed the description of a new monotypic genus *Sitotrogoides*, based on *Gelechia acanthopis*. The new genus *Sitotrogoides* is associated with the tribe Pexicopiini, based on its musculoskeletal apparatus of the male genitalia typical for the group. The tribe Pexicopiini was treated as a monophyletic taxon by Ponomarenko (2005, 2006), and defined by following diagnostic characters (Figs 10–19, shown by arrows with numbers in the rings): 1) the presence of a large lobe-like uncus; 2) a strongly sclerotized large hook-like gnathos; 3) the widened anterolateral parts of tegumen, which are the apodemes for the muscles m_4 and m_{22} ; 4) the valva with a wide cucullus, the well sclerotized thick neck; 5) a setaceous valvella; 6) the dorsobasal angle joined with anterior part of the tegumen; 7) the base of valva joined with the vinculum until integration into single sclerite; 8) the presence of the muscle m_{22} ; 9) the muscle m_2 attached to the place of joining of valva with tegumen; and 10) the muscles protractor of the aedeagus represented by two bundles, m_{5a} and m_{5b} .

Among the genera of Pexicopiini, the genus *Sitotrogoides* is closely related to *Sitotroga*. *Sitotrogoides acanthopis* possesses an aedeagus with a long caecum same as the type species of the genus *Sitotroga*, *S. cerealella* (Olivier, 1789). Furthermore, *Sitotrogoides acanthopis* is lacking the muscles m_3 in musculoskeletal apparatus of the male genitalia same as *Sitotroga cerealella* (Figs 10, 15). However, *Sitotrogoides acanthopis* differs from *Sitotroga cerealella* by six characteristic features: a) the absence of antennal pecten; b) the nearly straight outer margin of hindwing; c) in the forewing, Rs_4 and M_1 veins separate (Figs 3 vs. 4); d) in the hindwing, Rs and M_1 veins separate (Figs 3 vs. 4); e) in the male genitalia, the presence of the setaceous valvella; f) an integrated sclerite formed by the fusion of sacculus and vinculum.

Sitotrogoides is similar to the genera *Aspasiodes* Janse, 1958 and *Lacistodes* Meyrick, 1921, but differs from both genera in having a long aedeagus with a well-developed caecum. Beccaloni *et al.* (2003) indicated that *Gelechia acanthopis* Meyrick was associated with *Harpagidia*, there treated as a genus in Dichomeridinae. Our examination of the genital musculature in the species *acanthopis* reveals that it differs from the type species of *Harpagidia*, *Harpagidia pallidibasella* Ragonot, 1895 (= *magnetella* Staudinger, 1871) by three characters: a) a long and relatively narrow aedeagus with a long caecum, which is the apodeme for phallic musculature; b) the presence of a sacculus+vinculum complex; c) and the absence of muscle m_3 . The musculoskeletal apparatus of *H. magnetella* is characterized by the lack of the caecum in the aedeagus, the presence of the phallic musculature attached directly to the inflated base of the aedeagus, and the presence of the well-developed muscles m_3 (Figs 16, 17).

Sitotrogoides acanthopis differs from the type species of the genus *Platyedra*, *Gelechia vilella* Zeller, 1847 (= *subcinerea* Haworth, 1828) (Figs 13, 14), and from *Pexicopia malvella* (Figs 18, 19) by the same characters as listed above for the diagnostic differences from genera *Aspasiodes*, *Lacistodes* and *Harpagidia*. The musculoskeletal apparatuses of the *Harpagidia magnetella*, *Pexicopia malvella*, *Platyedra subcinerea* and *Sitotroga cerealella* were described in Ponomarenko (2005, 2009).

At present, the tribe Pexicopiini includes 14 genera: *Anisoplaca* Meyrick, 1885; *Argophara* Janse, 1963; *Aspasiodes* Janse, 1958; *Harpagidia* Ragonot, 1895; *Lacistodes* Meyrick, 1921; *Lasiarchis* Meyrick, 1937; *Melitoxestis* Meyrick, 1921; *Pectinophora* Busck, 1917; *Pexicopia* Common, 1958; *Phrixocrita* Meyrick, 1935; *Platyedra* Meyrick, 1895; *Sitotrogoides* Sohn, Ponomarenko et Sakamaki, **gen. nov.**; *Sitotroga* Heinemann, 1870; *Symbatica* Meyrick, 1910.

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References

- Beccaloni, G., Scoble, M., Kitching, I., Simonsen, T., Robinson, G., Pitkin, B., Hine, A. & Lyal, C. (2003) *The Global Lepidoptera Names Index (LepIndex)*. Available from: <https://www.nhm.ac.uk/our-science/data/lepindex/> (accessed 13 May 2019)
- Busck, A. (1917) The pink bollworm, *Pectinophora gossypiella*. *Journal of agricultural research*, 9, 343–370.
- Busck, A. (1939) Restriction of the genus *Gelechia* (Lepidoptera: Gelechiidae), with descriptions of new genera. *Proceedings of the United States National Museum*, 86, 563–593.
<https://doi.org/10.5479/si.00963801.86-3064.563>
- Clarke, J.F.G. (1941) The preparation of slides of the genitalia of Lepidoptera. *Bulletin of the Brooklyn Entomological Society*, 36, 149–161.
- Clarke, J.F.G. (1969) *Catalogue of the Type Specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, Volume VII Gelechiidae (D–Z)*. Trustees of the British Museum (Natural History), London, 531 pp.
- Common, I.F.B. (1958) A revision of the Pink Bollworms of cotton (*Pectinophora* Busck (Lepidoptera: Gelechiidae) and related genera in Australia. *Australian Journal of Zoology*, 6 (3), 268–306.
<https://doi.org/10.1071/ZO9580268>
- Denis, J.N.C. & Schiffermüller, I. (1775) *Ankündigung eines systematischen Werkes von den Schmetterlingen der Wienergegend, herausgegeben von einigen Lehrern am k. k. Theresianum*. Verlegt Augustin Bernardi Buchhändler, Wien, 322 pp.
- Gaede, M. (1937) Gelechiidae. In: Wagner, H., Strand, E. & Bryk, F. (Eds.), *Lepidopterorum Catalogus, Pars 79*. W. Junk, Berlin, pp. 1–630.
- Haworth, A.H. (1828) *Lepidoptera Britannica*. (4). Veneunt apud J. Murray, London, 97 pp. [pp. 513–609]
- Heinemann, H. von (1870) Die Schmetterlinge Deutschlands und der Schweiz. 2. Abteilung, Kleinschmetterlinge. 2. Die Motten und Federmotten Schmett, Series 2, 2 (1), 1–388.
- Hübner, J. (1805) *Sammlung europäischer Schmetterlinge. VIII. Tineae. Schaben*. bey dem Verfasser zu Finden, Augsburg, 41 pls. 281 figs.
- Hübner, J. (1825) *Verzeichniss bekannter Schmettlinge*, 23–27, 415.
- Janse, A.J.T. (1958) Gelechiidae. *The Moths of South Africa*, 6 (1), 1–144, pls. 1–32.
- Janse, A.J.T. (1963) Gelechiidae. *The Moths of South Africa*, VI, 6 (3), 241–284, pls. 130–138.
- Klots, A.B. (1970) Lepidoptera. In: Tuxen, S.L. (Ed.), *Taxonomist's Glossary of Genitalia in Insects*. Munksgaard, Copenhagen, pp. 115–130.
- Kuznetsov, V.I. & Stekolnikov, A.A. (2001) [New approaches to the system of Lepidoptera of world fauna on the base of the functional morphology of abdomen]. Nauka, St. Petersburg, 462 pp. [in Russian]
- Meyrick, E. (1885) Descriptions of New Zealand microlepidoptera. Gelechiidae VIII. Tineina (part). *New Zealand journal of science*, 2 (12), 589–592.
- Meyrick, E. (1895) *A Handbook of British Lepidoptera*. Maomillan, London, 843 pp.
<https://doi.org/10.5962/bhl.title.67732>
- Meyrick, E. (1908) Descriptions of African Micro-Lepidoptera. *Proceedings of the Zoological Society of London*, 1908, 716–756.
<https://doi.org/10.1111/j.1469-7998.1908.tb07404.x>
- Meyrick, E. (1910) New South African Microlepidoptera. *Annals of the South African Museum*, 5, 411–417.
- Meyrick, E. (1921) Descriptions of South African Micro-Lepidoptera. Part 1. *Annals Transvaal Museum*, 8 (2), 49–148.
- Meyrick, E. (1932) Gelechiidae. In: Meyrick, E. (Ed.), *Exotic Microlepidoptera*, 4 (7–11), pp. 193–352.
- Meyrick, E. (1935) Gelechiidae. In: Meyrick, E. (Ed.), *Exotic Microlepidoptera*, 4 (18–19), pp. 545–608.
- Meyrick, E. (1937) Gelechiidae. In: Meyrick, E. (Ed.), *Exotic Microlepidoptera*, 5 (3–5), pp. 65–160.
- Moriuti, S. (1982) Gelechiidae. In: Inoue, H., Sugi, S., Kuroko, H., Moriuti, S., Kawabe, A. & Owada, M. [Eds.], *Moths of Japan. Vol. 1*. Kodansha, Tokyo, pp. 275–288.
- Olivier, G.A. (1789) *Encyclopédie méthodique. Histoire naturelle. Insectes, Paris*, 4, 121.
- Ponomarenko, M.G. (2005) Gelechiid moths of the Palaearctics: functional morphology of the male genitalia, phylogeny and taxonomy (Lepidoptera, Gelechiidae). *Meetings in Memory of N.A. Kholodkovsky*, 58, 139 pp. [in Russian]
- Ponomarenko, M.G. (2006) The subfamily Dichomeridinae (Lepidoptera, Gelechiidae): the phylogeny, classification and position in the system of the Gelechiidae. *Entomologicheskoe obozrenie*, 85, 375–384. [in Russian]
- Ponomarenko, M.G. (2009) *Gelechiid Moths of the Subfamily Dichomeridinae (Lepidoptera: Gelechiidae) of the World*. Dalnauka, Vladivostok, 389 pp., 4 pls.
- Ponomarenko, M.G. & Park, K.T. (2007) Two new species and a new record of Gelechiidae (Lepidoptera) from Korea. *Zootaxa*, 1437, 55–60.
- Ragonot, E.L. (1895) Microlépidopères de la haute Syrie, récoltés par M. Ch. Delagrange, et, et descriptions de 27 espèces nouvelles. *Bulletin de la Société entomologique de France*, 1895, xciv–cix.
- Sakamaki, Y. (2013) Gelechiidae. In: Hirowatari, T., Nasu, Y., Sakamaki, Y. & Kishida, Y. (Eds.), *The Standard of Moths in Japan III*. Gakken Education Publishing, Tokyo, pp. 262–316.
- Savelle, M. (2001) *Lepidoptera and Some Other Life Forms*. Available from: <http://www.nic.funet.fi/> (accessed 13 May 2019)
- Staudinger, O. (1871) *Beschreibung neuer Lepidopteren des europäischen faunengebiets*, 14 (3/4), 273–330.
- Walsingham, L. (1911) Gelechiidae. In: Godman, F.D. & Salvin, O. (Eds.), *Biologia Centrali Americana, Zoology: Insecta*,

- Lepidoptera-Heterocera. Vol. 4. Tineina, Pterophorina, Orneodina, Pyralidina, and Hepialina.* Private Publishing by R. H. Porter, London, pp. 18–112.
- Wootton, R.J. (1979) Function, homology and terminology in insect wings. *Systematic Entomology*, 4, 81–93.
<https://doi.org/10.1111/j.1365-3113.1979.tb00614.x>
- Zeller, P.C. (1847) Bemerkungen über die auf einer Reise Nach Italien und Sicilien Beobachteten Schmetterlingsarten. *Isis von Oken*, 11, 801–859.
- Zimmerman, E.C. (1978) Microlepidoptera. *Insects Hawaii*, 9, 1–1903.