

A Revision of Taiwanese Species in the Genus *Psammoecus* Latreille (Coleoptera, Silvanidae)

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Takahiro Yoshida, Michael Karner, and Toshiya Hirowatari (2018) This study revises the taxonomy of Taiwanese species in the genus *Psammoecus* Latreille, 1829. A new species, *P. taiwanensis* sp. nov., is described, and six species from Taiwan are recoded for the first time: *P. harmandi*, Grouvelle, 1912, *P. dentatus* Grouvelle, 1883, *P. trimaculatus* Motschulsky, 1858, *P. triguttatus* Reitter, 1874, *P. labyrinthicus* Yoshida and Hirowatari, 2014 and *P. hiranoi* Yoshida and Hirowatari, 2013. The following taxonomic synonyms are proposed: *P. delicatus* Grouvelle, 1908 = *P. x-notatus* Grouvelle, 1912 syn. nov. = *P. nitidior* Grouvelle, 1919 syn. nov. = *P. raffrayi* Grouvelle, 1919 syn. nov.; *P. harmandi*, Grouvelle, 1912 = *P. boreas* Yoshida and Hirowatari, 2014 syn. nov.; *P. dentatus* Grouvelle, 1883 = *P. scitus* Yoshida and Hirowatari, 2014 syn. nov.; *P. simonis* Grouvelle, 1892 = *P. stultus* Grouvelle, 1912 syn. nov. A key to Taiwanese *Psammoecus* species, a redescription of *P. delicatus*, and notes on the variability of *P. harmandi* are provided.

Key words: Taxonomy, Cucujoidea, New species, Synonymy, Taxonomic key.

BACKGROUND

The family Silvanidae Kirby 1837 (Coleoptera, Cucujoidea) is composed of two subfamilies, 61 genera, and approximately 500 species (Thomas and Leschen 2010; Thomas 2011; Karner et al. 2015; Yoshida et al. 2017). The Silvanidae include some important pests of stored grain products (e.g. *Ahasverus advena* (Waltl, 1834), *Cathartus quadricollis* (Guérin-Méneville, 1844) and *Oryzaephilus surinamensis* (Linnaeus, 1758)) (Halstead 1986). Outside of its pest species, the biology of silvanids is poorly studied (Thomas and Leschen 2010). The genus *Psammoecus* Latreille, 1829 (Brontinae, Telephanini) includes about 80

described species and is the second largest genus in Silvanidae (Thomas and Leschen 2010). Most *Psammoecus* species were described between the mid-19th and early 20th century; according to the common practice of those times, these studies did not include illustrations or descriptions of male genitalia (e.g. Reitter 1874; Grouvelle 1919). Recent studies revealed that the male genital structures bear useful diagnostic characters, while body coloration-including the elytral maculae-and size, arrangement and shape of lateral pronotal teeth are variable among conspecific individuals (Karner 2012; Yoshida and Hirowatari 2014). Recently, the *Psammoecus* of India (Pal 1985), Africa (Karner 2012 2014) and Japan (Yoshida

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and Hirowatari 2014) were taxonomically revised. *Psammoecus* from other areas have been poorly studied, and comprehensive taxonomic revisions are required. Some *Psammoecus* species have also been found in stored products (Lu and Han 2006) and foods (Hayashi 1992); taxonomic studies on this genus may provide information for pest control.

The fauna of Taiwanese Silvanidae is not well known, and only one taxonomic study has been published (on Brontini; Yoshida and Hirowatari 2016). In Taiwan, only two endemic *Psammoecus* species, *P. stultus* Grouvelle, 1912 and *P. x-notatus* Grouvelle, 1912, have been recorded, and no taxonomic and faunistic studies on Taiwanese *Psammoecus* have been published since Grouvelle (1912). Compared to the species diversity of *Psammoecus* in Japan - 10 species (Yoshida and Hirowatari 2014) - the number of species recorded from Taiwan appears small, and this suggests that Taiwan actually has more species that are still undocumented.

MATERIALS AND METHODS

Observations and dissections were performed under a stereomicroscope (Olympus SZX10) according to the methods described by Yoshida and Hirowatari (2014). Photographs were taken using a digital camera (Canon EOS 7D) with a macro lens (Canon MP-E 65 mm). Composite images were produced using the image processing software Combine ZM. Images were retouched using Photoshop 6.0 (Adobe Systems Inc.).

Morphological terminology follows Lawrence et al. (2010) and Lawrence et al. (2011).

Abbreviations and measurements are as follows: BL: HL + PL + EL. PL: length of pronotum measured along the median line. PW: greatest width of pronotum, excluding teeth. EW: greatest combined width of elytra. HL: length from anterior margin of clypeus to imaginary line between posterior margins of temples in dorsal view measured along the median line. HW: greatest width of head across eyes. IE: narrowest width of interspace between eyes.

Depositories of the examined specimens are as follows: BMNH: Natural History Museum, London, United Kingdom. ELKU: Entomological Laboratory, Kyushu University, Fukuoka, Japan. EUMJ: Ehime University Museum, Matsuyama, Japan. FSCA: Florida State Collection of Arthropods, Florida Department of Agriculture and

Consumer Services, Gainesville, USA. HNHM: Hungarian Natural History Museum, Budapest, Hungary. KUM: Kyushu University Museum, Fukuoka, Japan. MHNG: Muséum d'Histoire Naturelle, Geneva, Switzerland. MNHN: Muséum National d'Histoire Naturelle, Paris, France. MSNG: Museo Civico di Storia Naturale di Genova, Genoa, Italy. NMNS: National Museum of Natural Science, Taichung, Taiwan. RMNH: Naturalis Biodiversity Centre [new name of the former Rijksmuseum van Natuurlijke Historie, Leiden], Netherlands. SDEI: Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany. TARI: Taiwan Agricultural Research Institute, Taichung, Taiwan. ZMHB: Museum für Naturkunde der Humboldt-Universität, Berlin, Germany.

RESULTS

TAXONOMY

Psammoecus taiwanensis sp. nov.

(Figs. 1A, 2, 3 and 4A-C)

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Type series: Holotype: male, Sungkang, Jing Ying Village, Ren-ai Township, 2-VII-2014, T. Yoshida leg. (NMNS, male genitalia illustrated). Paratypes: TAIWAN: [New Taipei City] 1 female & 1 ex., Wulai District, 4-VI-1970, Y. Hori leg. (EUMJ). [Yilan County] 2 exs, Fushan Botanical Garden, Yuanshan Township, 25-27-IX-2000, L. Papp, L. Peregovits & L. Ronkay leg., at light (HNHM; studied by MK); 2 exs, Cueifong Lake, Nan-ao Township, alt. 1950 m, 1-IV-2004, T. Kurihara leg. (ELKU). [Nantou County] 1 ex., Gaofeng, 7-8-V-2009, J. Aoki leg. (ELKU); 3 males, 1 female & 2 exs, Tun-yuan-trail, Jing Ying Village, Ren-ai Township, 1-VII-2014, T. Yoshida leg. (ELKU); 3 exs, same locality, 6-VII-2014, T. Yoshida leg. (ELKU); 10 exs, same data as holotype. (ELKU); 1 male, Tsiufeng, Ren-ai Township, 10-VII-1966, H. Kamiya leg. (KUM). [Chiayi County] 1 ex., Alishan, Alishan Township, 1-VIII-1968, K. Y. leg. (ELKU); 1 ex., Fenchihu, Zhuqi Township, 22-VII-1966, H. Kamiya leg. (KUM); 2 exs, same locality, 23-VII-1966, H. Kamiya leg. (KUM); 1 ex., same locality, 24-VII-1966, H. Kamiya leg. (KUM); 1 ex., same locality, 22-VI-1968, M. Tomokuni leg. (EUMJ). [Kaohsiung City] 1 ex., Shanping, Liouguei District, 20-21-III-1980, T. Niisato leg. (EUMJ); 1 ex., Mt. Su-shan (Shi Shan) near Liouguei, Taoyuan



Fig. 1. *Psammoecus* species of Taiwan, habitus. (A) *P. taiwanensis* sp. nov. (B) *P. delicatus* Grouvelle (C) *P. harmandi* Grouvelle (D) *P. dentatus* Grouvelle (E) *P. trimaculatus* Motschulsky (F) *P. triguttatus* Reitter (G) *P. labyrinthicus* Yoshida and Hirowatari (H) *P. simonis* Grouvelle (I) *P. hiranoi* Yoshida and Hirowatari. Scale bar = 1.0 mm.

District, 25-IV-1986, K. Baba leg. (KUM).

Etymology: The specific name is derived from Taiwan, the type locality of the new species.

Diagnosis: This species resembles *P. piceus* Grouvelle, 1882; it is distinguished by the distal portions of parameres bearing dense short pubescence, in comparison with distal portions of parameres bearing only two apical setae in *P. piceus*. This species also resembles *P. harmandi* but is easily distinguished by the presence of a row of long erect setae along each lateral elytral margin, the expanded anterior angles of pronotum and the stick-shaped and elongate parameres (cone-shaped and stout in *P. harmandi*) (Figs. 3 and 4).

Description: Body length: 2.83-3.43 mm ($n = 20$).

Coloration: (Figs. 1A and 2). Head and pronotum dark brown. Elytra somewhat lighter colored, with a quadrate black macula on each elytron at middle, connected by narrow horizontal band at posterior 1/3, round maculae at posterior 1/4, connected to lateral margins, darkened around humeri and end of elytra. Antennae dark brown, 7th and/or 8th to 10th antennomere darker, 11th (apex) yellowish-brown.

Head: (Fig. 2A and B). Wide, HW/HL 1.28-1.43; IE/HL 0.86-0.98. Temples somewhat enlarged behind eyes, narrowed gradually toward basis. Eyes of moderate size, slightly prominent. Dorsal surface with coarse punctation. Antennae long; antennomeres with pubescence of moderate to large length; distal portion of 7th to 10th and entire 11th antennomeres with short pubescence, very

dense on 8th to 11th antennomeres; approximate ratios of antennomere lengths of holotype as follows: 2.6 : 1.0 : 1.2 : 1.3 : 1.3 : 1.5 : 1.4 : 1.2 : 1.1 : 1.0 : 1.7.

Pronotum: (Figs. 2A, B and 4B). Subquadrate, widest near anterior margin, straightly narrowed toward base, lateral margins slightly flattened; lateral areas of basis somewhat flattened, PW/PL 1.18-1.27. Punctuation on pronotal disk as on vertex; pubescence composed of numerous setae of moderate length, very long setae on teeth of lateral margins and anterior and posterior angles (Fig. 4B). Anterior angle with two small teeth and few small tubercles; lateral margin with some very small teeth, anterior tooth largest; posterior angle with small tooth (Fig. 4B).

Elytra: (Figs. 2A and 4C). Elongate-oval, EW/BL 0.40-0.45. Rows of punctures wider than interstices. Pubescence composed of numerous semi-erect setae of medium length, some very long, erect setae along each lateral margin, longer toward humeral swelling, with some long setae on lateral margin (Fig. 4C).

Male genitalia: (Fig. 3). Spiculum gastrale (Fig. 3A) with long and very thin strut, diverging widely around apex; branches slightly widened, connected by membrane; lateral sclerites elongate, curved inwards around apices, with short and thin strut. Parameres (Fig. 3B) stick-shaped, elongate, depressed at base, protruding dorsally at inner basal angles, narrowed at basal 1/3 to 2/3, dorsally densely punctate, punctures of various size on basal 1/3, with a short seta on each inner margin of basal 1/3, dorsally densely with short setae on



Fig. 2. *Psammoecus taiwanensis* sp. nov. in dorsal view (A) and ventral view (B). Scale bar = 1.0 mm.

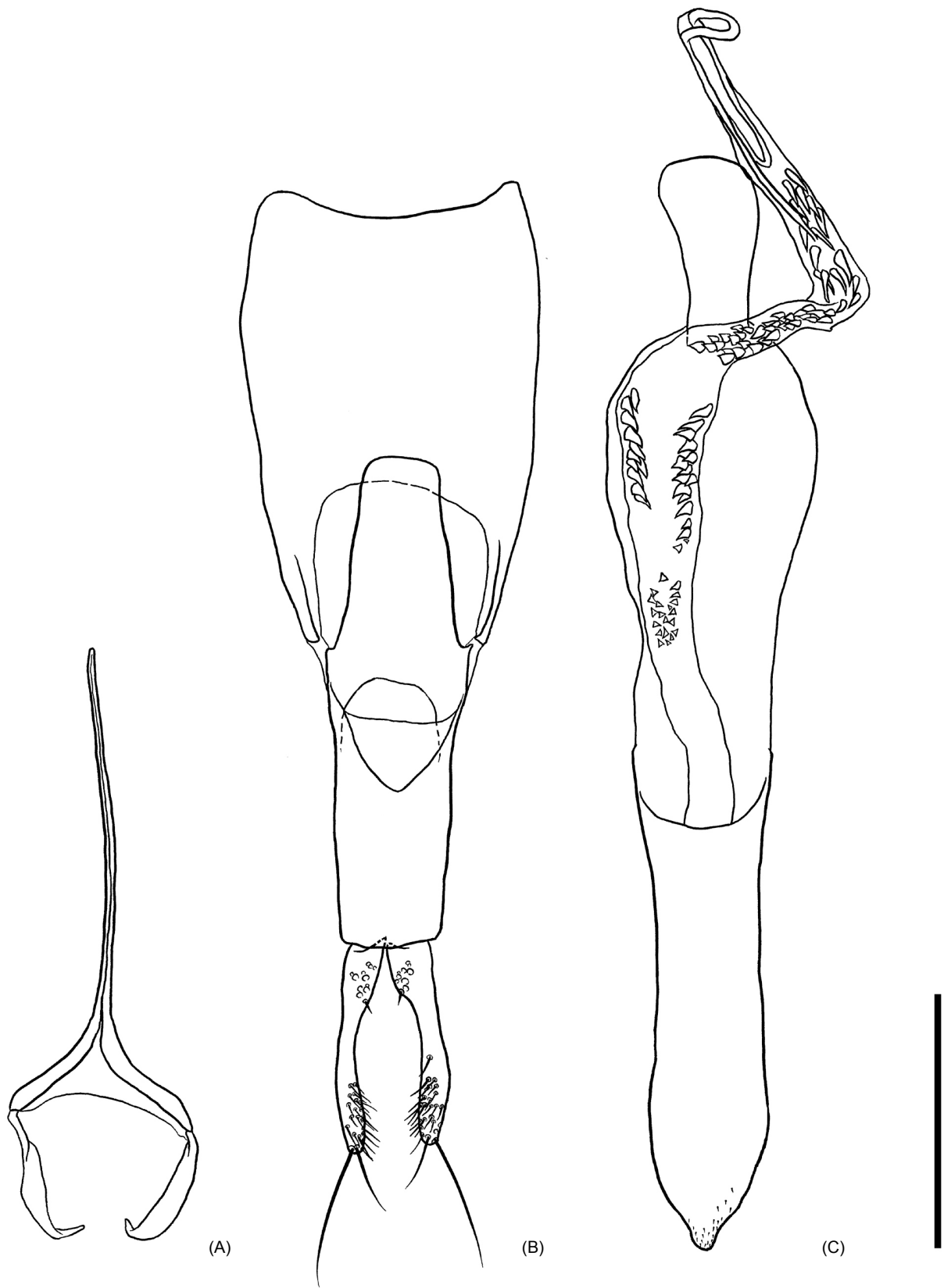


Fig. 3. Male genital organs of *Psammoecus taiwanensis* sp. nov., holotype. (A) spiculum gastrale (B) tegmen (C) penis. Scale bar = 0.2 mm.

distal 1/2 or 1/3 to apices, with a long seta and a very long seta on each apex. Phallobase (Fig. 3B) long, upper layer deeply and widely incised at distal 1/3, with incision covered by a membrane, lower layer thin, extending toward base. Penis (Fig. 3B) long, sub-parallel, gradually narrowed around apex, with rounded protrusion at apex, finely punctate near apex. Internal sac recurved around apex, with a thin ringed structure and a thin apical strut, densely armed with numerous spines on apical half near space of the ringed structure, with two spinous parallel armed lines around middle, with dense, minute spines near middle.

Distribution: Taiwan.

Remarks: This new species is distributed in high altitudes of Taiwan and occurs sympatrically with *P. harmandi*. On Tun-yuan-trail, the species was collected from dead leaves of broad-leaved trees.

***Psammoecus delicatus* Grouvelle, 1908**
(Figs. 1B, 5 and 6)

Psammoecus delicatus Grouvelle, 1908: 477. Type locality: Sri Lanka; Type examined. - Pal 1985: 21, fig. 6. - Sen Gupta and Pal 1996: 172, fig. 243.

Psammoecus x-notatus Grouvelle, 1912: 84. Type locality:

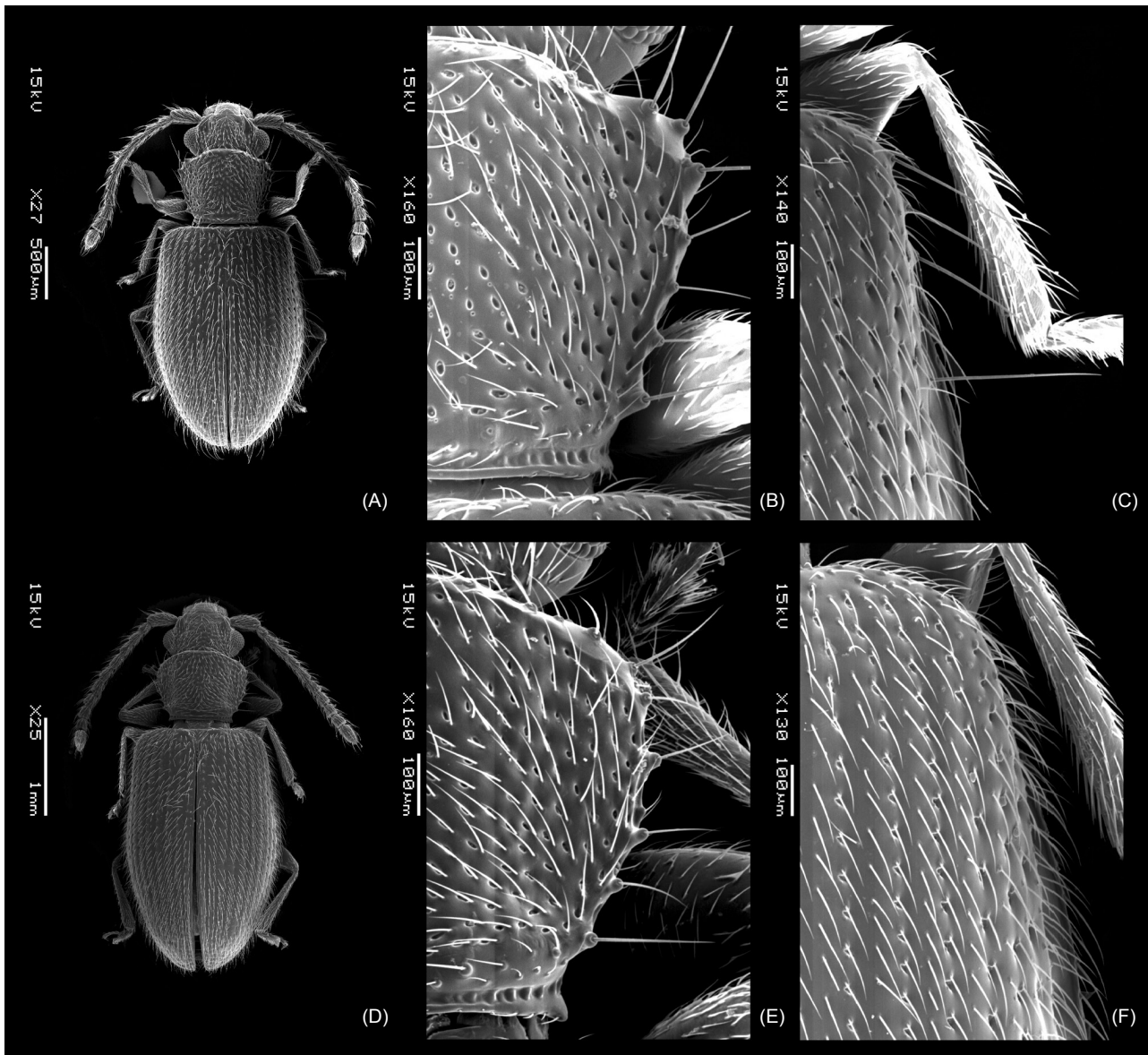


Fig. 4. SEM images of *Psammoecus taiwanensis* sp. nov. (A-C) and *Psammoecus harmandi* Grouvelle (D-F). A and D habitus B and E pronotum C and F anterolateral elytron.

Taiwan: Akau (= Pingtung City, Pingtung County) for lectotype (3 paralectotypes were collected from Kosempo (= Jiashian District, Kaohsiung City)); Type examined. syn. nov.

Psammoecus nitidior Grouvelle, 1919: 18. Type locality: Indonesia (Java); Type examined. syn. nov.

Psammoecus raffrayi Grouvelle, 1919: 28. Type locality: Singapore; Type examined. syn. nov.

Type series: Lectotype: male, "Ceylan | Horn."; "Type" [red label]; "Museum Paris | Collection | Grouvelle"; "*Psammoecus* | *delicatus* | ty. | Grouv" [Grouvelle's hand] (MNHN; studied by MK in 2015, here designated). Paralectotypes: 4 females, "Sumatra | Palembang"; "*delicatus*" [printed label] (MNHN; studied by MK in 2015, deposited in the collection of Grouvelle and Horn). Lectotype of *P. nitidior* syn. nov.: male, "Java"; "Type" [red label]; "*nitidior* | ty. Grouv". (MNHN; studied by TY in 2017, here designated). Paralectotypes of *P. nitidior* syn. nov.: 6 exs, same label data as the lectotype. (MNHN; studied by TY in 2017, here designated). Lectotype of *P. raffrayi* syn. nov.: female, "Singapore"; "Type" [red label]; "*Raffrayi* | ty. A. Grouv". (MNHN; studied by TY in 2017, here designated). Lectotype of *P. x-notatus* syn. nov.: male, "H. | Sauter. | Akau | Formosa | 1-10.12.07 [round label]"; "*Psammoechus* [sic] | *x-nigrum* | type. Grouv." [not Grouvelle's hand]; "Museum Leiden. | *Psammoe* | *cus* | *x notatus* | Det: Grouv"; "type" [blue label]; "Cat. No | 5" (RMNH; studied by MK in 2014, here designated). Paralectotypes of *P. x-notatus* syn. nov.: 2 exs, same label data as the lectotype. (MNHN; studied by TY in 2017, here designated); 1 female, "H. | Sauter. | Kosempo | Formosa | Jan. 08" [round label]; "*Psammoecus* | *x nigrum* | G. Grouv" [Grouvelle's hand]; "type"; "Museum Leiden. | *Psammoecus* | *x notatus* | Det: Grouv"; "type" [blue label]; "Type" [red label] (RMNH; studied by MK in 2014, here designated); 1 male and 1 ex., same label data. (MNHN; studied by TY in 2017, here designated).

Specimens examined: TAIWAN: [Miaoli County] 1 male (Catalog No. NMNS ENT 3235-1443), Sanyi, 14-16-VI-1999, C. S. Lin & W. T. Yang leg., UV Light. (NMNS). [Taichung City] 2 exs, Wufeng, Wufeng District, 24-IV-1992, Smetana leg. (MHNG; studied by MK); 1 ex., Fengyuan, 22-IV-1990, Smetana leg. (MHNG; studied by MK). [Nantou County] 1 male (Catalog No. NMNS ENT 1602-131), Chushan (= Zhushan Township), 8-9-XI-1993, C. S. Lin & W. T. Yang leg., UV Light. (NMNS); 1 ex. (Catalog No. NMNS ENT 3513-284), Lienhuachih, Yuchi Township, 6-VII-12-

VIII-1998, C. S. Lin & W. T. Yang leg., Malaise Trap (NMNS); 1 ex., NW Yuchi, Yuchi Township, 8-X-2009, Dányi & Lazányi leg. (HNHM; studied by MK); 1 ex. (Catalog No. NMNS ENT 1582-328), Fenghuangku, Lugu Township, 20-22-IX-1993, C. S. Lin & M. L. Chan leg., UV Light (NMNS); 1 male (Catalog No. 1337-5), Shih-tzu-tou, 6-IX-1987, I. C. Hsu leg., Sweeping Net. (NMNS). [Chiayi County] 1 ex., Chuchi, Zhuqi Township, 20-VII-1966, H. Kamiya leg. (KUM). [Kaohsiung City] 7 exs, Kosempo (= Jiashian District), I-1908, H. Sauter leg. (ZMHB, HNHM; studied by MK); 1 male and 4 exs, same label data. (SDEI); 1 ex., Mt. Ta Yuen Shan near Liouguei, 5-VI-1989, K. Baba leg. (KUM); 1 ex., Liu Kui (= Liouguei), 2-VIII-1989, K. Baba leg. (KUM); 1 ex., same locality, 30-III-1986, K. Baba leg. (EUMJ); 1 ex., Shanping Forest Recreation Area, near Liukuei, 19-21-XI-2009, Ronkay & Merkl leg. (HNHM; studied by MK). [Taitung County] 8 exs, Pilam (= Taitung), II-1908, H. Sauter leg. (HNHM; studied by MK). [Pingtung County] 11 exs, Akau (= Pingtung City), 1-10-XII-1907, H. Sauter leg. (HNHM; studied by MK); 7 exs, same locality, 1-10-XII-1907, H. Sauter leg. (ZMHB; studied by MK); 2 males and 8 exs, same locality, XII-1907, H. Sauter leg. (SDEI); 1 ex. (Catalog No. NMNS ENT 6920-303), Nanjenshan, Manzhou Township, 1-19-IV-2009, M. L. Jeng & T. R. Chen leg., SLAM Trap. (NMNS); 1 ex. (Catalog No. NMNS ENT 6920-82), same locality & same period, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 2 exs (Catalog No. NMNS ENT 6469-40 & 48), same locality, 21-VI-4-VII-2009, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 1 male & 1 ex. (Catalog No. NMNS ENT 6469-486 & 503), same locality, 4-14-VII-2009, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 1 ex. (Catalog No. NMNS ENT 6674-322), same locality, 27-IX-12-X-2009, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 1 male (Catalog No. NMNS ENT 6632-57), Manchou (= Manzhou) Lite Chulaoshushan, 30-VIII-14-IX-2009, M. L. Jeng & T. R. Chen leg., Malaise Trap. (NMNS); 1 ex. (Catalog No. NMNS ENT 6579-378), same locality, 12-26-IX-2009, M. L. Jeng & T. R. Chen leg., Malaise Trap. (NMNS); 1 male (Catalog No. NMNS ENT 6525-85), Manchou (= Manzhou) Lite No: 169 Hsien Rd. 3.7 km, 19-IV-1-V-2009, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 1 ex., Sichongxi, Checheng Township, 1-I-1986, K. Baba leg. (EUMJ); 1 male. (Catalog No. NMNS ENT 6632-57), Manchou (= Manzhou) Lite Chulaoshushan, 30-X-14-IX-2009, M. L. Jeng & T. R. Chen leg., Malaise Trap. (NMNS).

Diagnosis: This species differs from the other Taiwanese species by the very long and slender teeth on lateral margins of its pronotum, the pattern of these teeth, the pubescence composed of moderate and long setae on head, pronotum and elytra, and its large, strongly protruding eyes. *Psammoecus delicatus* is related to *P. complexus* Pal, 1985, but can easily be distinguished by the different shape of the lateral pronotal teeth (see Pal 1985).

Description: Body length: 2.38-2.98 mm ($n = 16$).

Coloration: (Figs. 1B and 5). Head and pronotum yellowish-brown. Elytra yellowish-brown with variable x-shaped blackish-brown maculae covering posterior 2/3 (Fig. 5A and B); posterior half of maculae in lighter color specimen obscure or absent; sometimes posterior 1/3 of elytra darkened (Fig. 5C). Antennae yellowish-brown basally, 7th to 10th antennomere sometimes darkened, 11th antennomere lighter colored, rarely also 10th antennomere lighter colored (Fig. 5C).

Head: (Fig. 5). Wide, HW/HL 1.34-1.47; IE/HL 0.79-0.89. Temples gradually narrowed toward bases. Eyes large, well prominent. Dorsal surface punctation sparse and weak, pubescence composed of moderate and long setae. Antennae long; antennomeres with moderate and long, erect setae; distal portion of 7th to 10th and entire 11th

antennomere covered with short pubescence, dense on 8th to 11th; approximate ratios of antennomere lengths of lectotype as follows: 3.0 : 1.0 : 1.3 : 1.4 : 1.4 : 1.5 : 1.2 : 1.2 : 1.2 : 1.2 : 2.4.

Pronotum: (Fig. 5). Wide, point of greatest width variable, between anterior 1/3 and middle, distinctly narrowed toward base; lateral areas slightly flattened, PW/PL 1.32-1.42. Punctuation on dorsal surface denser and slightly stronger than on vertex. Pubescence composed of numerous moderate and fewer long setae, long seta on each tooth and tubercle on anterior, lateral and posterior margins and anterior and posterior angles. Anterior angle with a few large tubercles; lateral margin with some dorso-laterally bent short to long teeth; posterior angle with a very small tooth and a small tubercle.

Elytra: (Fig. 5). Oval, EW/BL 0.39-0.44. Rows of punctures slightly wider than interstices. Pubescence composed of many semi-erect moderate setae, most of interstices with rows of long erect setae, very long erect setae in a row along lateral margins, setae longer toward humeral swelling, anterior setae on small tubercles, with some long setae on lateral margin.

Male genitalia: (Fig. 6). Spiculum gastrale (Fig. 6A) with short and thick strut, enlarged around base, diverging widely near middle; branches obscure and thin, connected by membrane; lateral



Fig. 5. Habitus of *Psammoecus* spp. synonymized with *Psammoecus delicatus* Grouvelle. (A) *Psammoecus x-notatus* Grouvelle, paralectotype, male (B) *Psammoecus nitidior* Grouvelle, lectotype, male (C) *Psammoecus raffrayi* Grouvelle, lectotype, female. Scale bar = 1.0 mm.

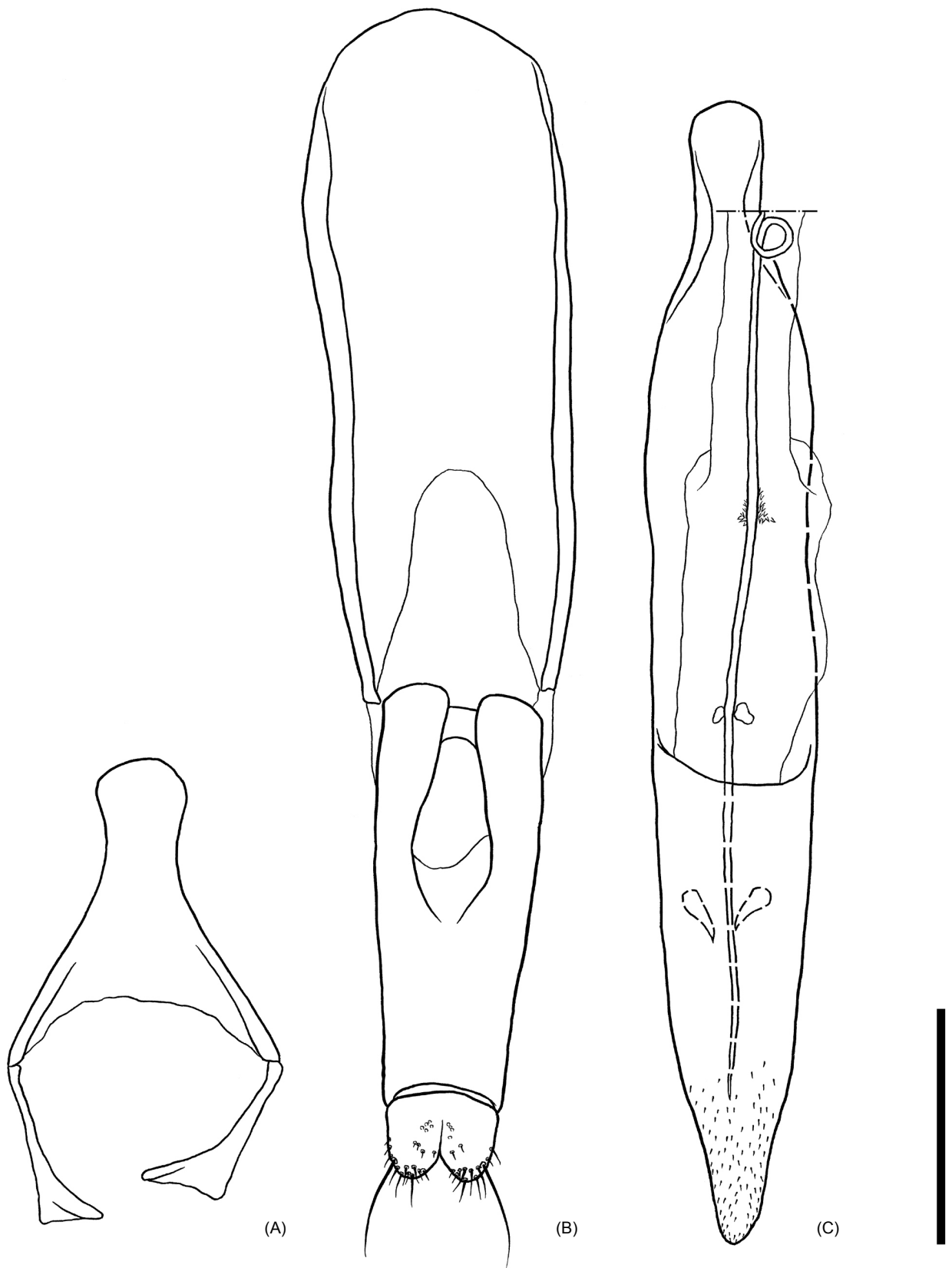


Fig. 6. Male genital organs of *Psammoecus delicatus* Grouvelle, paralectotype of *Psammoecus x-notatus* Grouvelle. (A) spiculum gastrale (B) tegmen (C) penis. Scale bar = 0.2 mm.

sclerites elongate triangular, enlarged inwards near anterior 1/3. Parameres (Fig. 6B) small and stout, fused basally, rounded at apices, apex sometimes somewhat angular, dorsally with some small punctures around middle of inner margins, densely covered with setae of various length near apices, dorsally with some short, sparse setae near inner margins of apical 1/3, with a long apico-lateral seta. Phallobase (Fig. 6B) long, subparallel, basal half of upper layer diverging, the branches widening distally, with membrane between bases of the branches, lower layer narrow, exposed around base. Penis (Fig. 6C) long, gradually narrowed toward apex, somewhat rounded at apex, with fine dense punctation around apex. Internal sac with very long and thin structure partly ringed around apex, with a pair of small spines near middle (sometimes absent), with a pair of large spines around base.

Distribution: Taiwan; India; Sri Lanka; Singapore; Indonesia.

Remarks: The external morphological characters as well as the male genital structures of *P. x-notatus* and *P. nitidior* type specimens show the typical morphology of *P. delicatus*. Hence, we conclude that these species are junior synonyms of *P. delicatus*. Although Grouvelle's description of *P. raffrayi* suggests that at least two syntypes should be present, only one female specimen could be found and studied. Since *P. delicatus* is well characterized by its external morphological characters, we have no doubt that *P. raffrayi* is a junior synonym.

The unusual morphology of the spiculum gastrale is remarkable compared to that of other *Psammoecus*. This may indicate that this species belongs to a distinct species group. Studies of extensive material from the Oriental region revealed numerous closely related yet undescribed species.

***Psammoecus harmandi* Grouvelle, 1912**
(Figs. 1C, 4D-F and 7)

Psammoecus harmandi Grouvelle, 1912: 413. Type locality: India (Darjeeling). - Pal 1985: 19, figs 5, 32. - Sen Gupta and Pal 1996: 170, figs 242, 269.

Psammoecus boreas Yoshida and Hirowatari, 2014: 413. Type locality: Japan; Type examined. syn. nov.

Psammoecus triguttatus: Nakane 1963: 195, fig. 16 in pl. 98.

Psammoecus sp. 3, Hirano 2009: 63, 66, 67, fig. 8. - Hirano 2010: 12, 16.

Specimens examined: JAPAN: 1 male, Yoshin, Tanzawa, Kanagawa Prefecture, 26-V-

1989, Y. Hirano leg. (EUMJ; formerly holotype of *Psammoecus boreas*). TAIWAN: [Yilan County] 1 male & 1 ex., Taipingshan, Datong Township, alt. 1950 m, 1-IV-2004, T. Kurihara leg. (EUMJ). [Hualien County] 1 ex., Piluhsi For. Rec. Area, 22-V-1999, 2150 m, S. E. Halbert & C. W. L. O'Brien leg., Night Beating (FSCA). [Nantou County] 1 ex., Pi Lu Chieh, alt. 2400 m, 6-IX-1986, K. Baba leg. (EUMJ); 1 ex., Gaofeng, 7-8-V-2009, J. Aoki leg. (ELKU); 4 exs, Wushe, Ren-ai Township, 16-III-1983, H. & M. Townes leg. (FSCA); 2 exs, Meifeng, Ren-ai Township, 3-V-1983, Henry K. Townes leg., Insect Flight Trap. (FSCA); 2 males, 1 female & 16 exs, Tun-yuan-trail, Jing Ying Village, Ren-ai Township, 5-VII-2014, T. Yoshida leg. (ELKU); 1 male & 4 exs, same locality, 6-VII-2014, T. Yoshida leg. (ELKU); 1 ex., N24°02'53.0" E121°12'55.5", Ren-ai Township, 6-VIII-2008, Barclay, Mendel & Ewers leg. (BMNH; studied by MK). [Chiayi County] 1 ex., Fenchihu, Zhuqi Township, 10-VII-1966, H. Kamiya leg. (KUM); 5 exs, same locality, 16-VII-1966, H. Kamiya leg. (KUM); 2 exs, same locality, 23-VII-1966, H. Kamiya leg. (KUM); 7 exs, same locality, 24-VII-1966, H. Kamiya leg. (KUM); 1 ex., same locality, 27-VII-1966, H. Kamiya leg. (KUM); 1 ex., same locality, 28-VII-1966, H. Kamiya leg. (KUM). [Taitung County] 5 exs, Taimali-shan (Mt.), Jinfeng Township, alt. ca. 1300 m, 22°38'N 120°57'E, 23-VI-2015, J. Yamasako leg. (ELKU). [Kaohsiung City] 1 male, vic. Fujieda (= Tengzhi) nr. Taoyuan, Taoyuan District, at light, 6-IV-1976, K. Ushijima leg. (EUMJ).

Diagnosis: This species resembles *P. taiwanensis* sp. nov. but is easily distinguished by the absence of a row of long erect setae along each lateral elytral margin, the weak anterior angles of pronotum and the cone-shaped and stout parameres (see Yoshida and Hirowatari 2014). This species also resembles *P. trimaculatus* and other closely related species, but it differs from them by the shorter lateral teeth of its pronotum.

Coloration: (Figs. 1C and 7). Head and pronotum yellowish-brown. Elytra sometimes a little lighter colored, with variable black maculae near posterior 1/3; round maculae around middle of each elytron, another round one near posterior 1/3 close to elytral suture (Fig. 7C): maculae sometimes connected to each other (Fig. 7A) or forming a wide v-shaped covering posterior half of elytra (Fig. 7D). Antennae yellowish-brown basally, 9th and 10th antennomere black, 11th yellowish-brown, sometimes darkened.

Distribution: Taiwan; Japan; Thailand (new record); Nepal; India.

Remarks: This species occurs sympatrically with *P. taiwanensis* sp. nov.

Psammoecus boreas, now synonymized with *P. harmandi*, was described from Japan based on diagnostic differences from *P. harmandi* according to a redescription of *P. harmandi* by Pal (1985). Yoshida and Hirowatari (2014) pointed out that *P. harmandi* differed from *P. boreas* by its shorter antennae and slightly transverse 10th antennomere. Although we could not examine the type of *P. harmandi*, we had an opportunity to examine a male specimen of *P. harmandi* from

northern India and found these two species to be indistinguishable.

This species is widely distributed; specimens from Japan, Taiwan, Thailand, Nepal, and India have been studied. Except for Hokkaido (Japan) where the northern limit of its distribution might be reached, they are exclusively distributed in high altitudes.

Compared to the coloration described by Pal (1985), the Taiwanese specimens show considerable intraspecific variation. We have not seen specimens outside of Taiwan with strongly



Fig. 7. Habitus of *Psammoecus harmandi* Grouvelle in dorsal (A, C and D) and in ventral (B). (C) lighter colored specimen (D) darker colored specimen. Scale bar = 1.0 mm.

enlarged black maculae that cover the posterior half of the elytra (Fig. 7D). Examples for the variability are given in figure 7.

***Psammoecus dentatus* Grouvelle, 1883**

(Fig. 1D)

Psammoecus dentatus Grouvelle, 1883: 290. Type locality: New Guinea. Type examined.

Psammoecus quadrimaculatus: Hirano 2009: 64, 65, 82, fig. 4. - Hirano 2010: 12, 14. (misidentification)

Psammoecus scitus Yoshida and Hirowatari, 2014: 18, figs. 1A, 3, 13A-C. Type locality: Japan; Type examined. - Yoshida and Hirowatari 2015: 92-94. syn. nov.

Type series: Lectotype: male, "N. Guinea | Hatam VII | Beccari 1875"; "SYNTYPUS | *Psammoecus* | *dentatus* | Grouvelle, 1882" (MSNG; studied by MK in 2015 and TY in 2017, here designated). Paralectotypes: 1 male and 1 female, same label data as lectotype. (MSNG; studied by MK in 2015, here designated).

Specimens examined: JAPAN: 1 male, Kûra, Ishigaki Island, Okinawa Prefecture, 22-IX-2012, T. Yoshida leg. (EUMJ; formerly holotype of *P. scitus*). TAIWAN: [Hualien County] 1 ex., Liyuchih, 14-VIII-1966, H. Kamiya leg. (KUM); 2 exs, same locality, 15-VIII-1966, H. Kamiya leg. (KUM); 2 exs, Juisui (Naka spa) (= Ruisui Township), 27-XI-1962, K. Baba leg. (EUMJ); 2 exs, Fu Yuan For. Rec. Area, 28-V-1997, C. W. & L. B. O'Brien leg. (FSCA). [Nantou County] 1 male (Catalog No. NMNS ENT 1582-60), Fenghuangku, Lugu Township, 20-22-IX-1993, C. S. Lin & M. L. Chan leg., UV Light (NMNS). [Chiayi County] 1 ex. (Catalog No. NMNS ENT 425-406), Yungshing, Dapu Township, 15-XII-1988, K. W. Huang leg., Sweeping Net (NMNS). [Taitung County] 2 males & 3 exs, Doulan, Donghe Township, 9-IV-2012, J. Yamasako leg. (ELKU); 1 ex., Linchan, Daren Township, 6-VI-2013, S. Tsuyuki leg. (ELKU); 5 exs, Jhiben Hot Spring, Beinan Township, 24-V-1969, S. Hisamatsu leg. (EUMJ); 1 ex., Lutao (= Green Island), Green Island Township, 26-28-III-1998, M. Sato leg. (EUMJ); 3 exs, Island Lanyu (= Orchid Island), Lanyu Township, 8-IV-1978, Kôzô Murakami leg. (EUMJ); 15 exs, Yung Hsin Farm, Lanyu Island (= Orchid Island), Lanyu Township, 29-30-VII-2008, Mendel & Barclay leg. (BMNH; studied by MK). [Kaohsiung City] 1 ex., Kosempo (= Jiashian District), 1-1908, H. Sauter leg. (ZMHB; studied by MK); 1 ex., Paiyunshan (= Baiyunshan), near Chiashien (= Jiashian, Jiashian District, 21-III-1977, Yutaka Notsu leg. (EUMJ); 2 exs, Fa Kuo Shan, near Liu Kui (= Liouguei), alt. 800 m, 6-X-1986, K.

Baba leg. (EUMJ); 1 ex., Liu Kui (= Liouguei), 30-III-1986, K. Baba leg. (EUMJ); 1 ex., same locality, 2-IV-1986, K. Baba leg. (EUMJ); 1 ex., same locality, 4-VIII-1978, T. Niisato leg. (EUMJ). [Tainan City] 1 ex., Kantoushan, Dongshan District, 17-II-2013, W. -C. Liao leg. (TARI). [Pingtung County] 2 exs, Hengchun, 4-VIII-1966, H. Kamiya leg. (KUM); 1 ex. (Catalog No. NMNS ENT 6215-77), Chungchienlu, Mudan Township, 27-28-VII-2009, W. T. Yang & K. W. Huang leg., UV Light Trap (NMNS); 1 male & 1 female, Dong Yuan Forest Recreation Area, Dong Yuan Village, Mudan Township, Pingtung City, 10-VII-2014, T. Yoshida leg. (ELKU); 2 exs (Catalog No. NMNS ENT 6259-276 & 580), Chiupeng, Manzhou Township, 19-IV-1-V-2009, M. L. Jeng & T. J. Chen leg., Flight-intercept Net. (NMNS); 2 exs, Kenting, 4-IX-1983, J. B. Happner leg. (FSCA); 1 ex., Kenting Park, 17-VIII-1968, M. Nishikawa leg. (EUMJ); 1 ex., same locality, 17-III-1977, Yutaka Notsu leg. (EUMJ).

Diagnosis: This species can be distinguished from other Taiwanese *Psammoecus* species by the small, even-sized lateral teeth on its pronotum and the irregular distances between the adjacent teeth.

Distribution: Taiwan; Japan; New Guinea.

Remarks: This species was described as *P. scitus* by Yoshida and Hirowatari (2014).

This study examines many specimens in this species, including *P. dentatus* and *P. scitus* type specimens. We found no significant differences between these two species in their morphology, including their male genitalia; thus, *P. scitus* is synonymized with *P. dentatus*.

Specimens from an extremely large area have been studied in the course of related revisionary work. *Psammoecus dentatus* may be recorded from many more South East Asian localities.

***Psammoecus trimaculatus* Motschulsky, 1858**

(Fig. 1E)

Psammaechus [sic] *trimaculatus* Motschulsky, 1858: *Etud. Ent.* 7: 45. Type locality: Sri Lanka. (referring to Hetschko (1930))

Psammoecus trimaculatus: Waterhouse 1876: 124. - Reitter 1879: 509. - Grouvelle 1906: 125. - Grouvelle 1908: 476. - Hetschko 1930: 81. (catalogue) - Hisamatsu 1977: 21. - Hisamatsu 1982: 16. - Pal 1985: 41, figs 15-29. - Sato 1989: 377. - Sen Gupta and Pal 1996: 186, figs 252-265. - Sasaki et al. 2002: 224. - Halstead et al. 2007 - Hirano 2009: 66. - Hirano 2010: 15. - Karner 2012: 24. - Yoshida and Hirowatari 2014: 24, figs 1C, 5, 13G-I. - Karner 2014: 15.

Psammoecus triguttatus: Hirano 2009: 64, 65, 66. - Hirano 2010: 12, 14. (misidentification)

Specimens examined: TAIWAN: [Taichung City] 1 male, Wufeng, Wufeng District, 30-VI-2008, C. -F. Lee leg. (TARI). [Taitung County] 1 male, Lanyu (= Orchid Island), Lanyu Township, 4-IV-2011, Y. -T. Wang leg. (TARI). [Kaohsiung City] 1 male, Liu Kui (= Liouguei), 30-III-1986, K. Baba leg. (EUMJ); 1 male, same locality, 2-IV-1986, K. Baba leg. (EUMJ); 1 ex., Tsai Tie Ku, near Liu Kui (= Liouguei), 2-V-1986, K. Baba leg. (EUMJ). [Pingtung County] 1 ex., Akau (= Pingtung City), 1-10-XII-1907, H. Sauter leg. (ZMHB; studied by MK); 1 male (Catalog No. 1566-401), Yingdar, 19-20-V-1993, C. S. Lin & W. T. Yang leg., UV Light. (NMNS).

Diagnosis: This species is closely similar to *P. triguttatus* and *P. labyrinthicus*, and it is difficult to distinguish them by their external characters. This species can be distinguished from the former by the larger basis of parameres and the wider distance between the posterior margin of the phallobase and the deepest point of incision of the anterior margin of the phallobase, and from the latter by the larger bases of parameres and the wider protuberances on the inner margins of the branches of the anterior phallobase (see Yoshida and Hirawatari 2014).

Distribution: Taiwan; Japan (Yoshida and Hirowatari 2014); Russia (Kovalev 2016); Madagascar (Karner 2012); Mauritius, France (Réunion), South Africa, Tanzania, Uganda (Karner 2014); Nepal, India and Bhutan (Pal 1985).

Remarks: Pal (1985) provided a redescription of this species, Yoshida and Hirowatari (2014) provided a detailed description of male genital structures of this species.

Only male genitalia provide reliable diagnostic characters when separating *P. trimaculatus* from closely related species. Accordingly, Yoshida and Hirowatari (2014) only considered data from specimens that were determined by study of genital structures to be reliable. The same practice was applied in the present study.

***Psammoecus triguttatus* Reitter, 1874**
(Fig. 1F)

Psammoecus triguttatus [sic] Reitter, 1874: 524. Type locality: Japan; Type examined. (misspelling)

Psammoecus triguttata [sic]: Hisamatsu 1982: 16.

Psammoecus triguttatus: Hetschko 1930: 82. (catalogue) - Kamiya 1961: 18, pl. 5. - Sasaji 1985: 204, fig. 33 in pl. 32. - Halstead et al. 2007 - Yoshida and Hirowatari 2014: 26, figs 1D, 6, 13J-L.

Specimens examined: TAIWAN: [Taipei

City] 1 male (Catalog No. 123985), Mientien Shan, Beitou District, 2-VIII-1987, I. C. Hsu leg., Sweeping Net (NMNS). [Taoyuan City] 1 male (Catalog No. NMNS ENT 1637-928), Hotzuhu, 9-II-1991, I. S. Hsu leg., Sweeping Net (NMNS). [Nantou County] 5 males (Catalog No. NMNS ENT 1578-501, 563, 577, 608 & 642), Fenghuangku, Lugu Township, 16-18-VIII-1993, C. S. Lin & W. T. Yang leg., UV Light (NMNS); 1 male (Catalog No. NMNS ENT 1582-311), same locality, 20-22-IX-1993, C. S. Lin & M. L. Chan leg., UV Light (NMNS). [Nantou County?] 1 male, Nantow (Nankoson), C. FORMOSA, 21-XI-1962, K. Baba leg. (EUMJ). [Tainan City] 1 male, Kuantzuling, Baihe District, 28-V-1969, S. Hisamatsu leg. (EUMJ). [Kaohsiung City] 1 male, Liu Kui (= Liouguei), 2-IV-1986, K. Baba leg. (EUMJ); 1 male, same locality, 3-IV-1986, K. Baba leg. (EUMJ); 1 male, Fa Kuo Shan, near Liu Kui (= Liouguei), alt. 800 m, 8-IX-1986, K. Baba leg. (EUMJ).

Diagnosis: This species is closely similar to *P. trimaculatus* and *P. labyrinthicus* (see the diagnosis of *P. trimaculatus* and Yoshida and Hirawatari 2014).

Distribution: Taiwan; Japan.

Remarks: Yoshida and Hirowatari (2014) redescribed this species in detail using the male genital structure.

***Psammoecus labyrinthicus* Yoshida and Hirowatari, 2014**
(Fig. 1G)

Psammoecus labyrinthicus Yoshida and Hirowatari, 2014: 29, figs 1E, 7, 14A-C. Type locality: Japan; Type examined.

Specimens examined: TAIWAN: [Taoyuan City] 1 male, Pa Lon, 28-V-1989, K. Baba leg. (KUM). [Kaohsiung City] 2 males, Liu Kui (= Liouguei), 3-IV-1986, K. Baba leg. (EUMJ).

Diagnosis: This species is closely similar to *P. trimaculatus* and *P. triguttatus* (see the diagnosis of *P. trimaculatus* and Yoshida and Hirowatari 2014).

Distribution: Taiwan; Japan.

Remarks: Yoshida and Hirowatari (2014) redescribed this species in detail with the male genital structure.

***Psammoecus simonis* Grouvelle, 1892**
(Fig. 1H)

Psammoecus simonis Grouvelle, 1892: 287. Type locality: Philippine.

Psammoecus stultus Grouvelle, 1912: 81. Type locality: Taiwan:

Akau (=Pingtung City, Pingtung County); type examined. syn. nov.

Psammoecus simoni [sic]: Grouvelle 1908: 476, 488. - Hetschko 1930: 81. (catalogue) - Pal 1985: 31, fig. 11. - Sen Gupta and Pal 1996: 179, fig. 248. - Hirano 2009: 63, 65, 82, fig. 5. - Hirano 2010: 11, 14. - Karner 2012: 25, fig. 11. - Yoshida and Hirowatari 2014: 34, figs 2C, 10, 14J-L. - Karner 2014: 15. - Yoshida and Hirowatari 2015: 94-98.

Type series: Lectotype of *P. stultus* syn. nov.: male, "H. | Sauter. | Akau | Formosa | 1-10.12.07" [round label]; "*Psammoecus* [sic] | *stultus*, Grouv. | type." [not Grouvelle's hand]; "Museum Leiden. | *Psammoecus* | *stultus* | Det: Grouv." [not Grouvelle's hand]; "type" [blue label]; "Type" [red label] (RMNH; studied by MK in 2017, here designated). Paralectotypes of *P. stultus* syn. nov.: 1 male and 1 ex., same label data as the lectotype. (MNHN; studied by TY in 2017, here designated)

Specimens examined: TAIWAN: [Taoyuan City] 1 ex., Upper Plain, Fuxing District, 600 m, N24°41'12.1" E121°23'39.3", 11-IV-1988, Miller, Stange & Wang leg. (FSCA). [Taichung City] 6 exs, Wufeng, Wufeng District, 14-IV-1990, Smetana leg. (MHNG; studied by MK); 1 ex., same locality, 24-IV-1992, Smetana leg. (MHNG; studied by MK). [Penghu County] 1 ex. (Catalog No. NMNS ENT 3422-828), Makung (= Magong), 19-21-VI-2000, C. S. Lin & W. T. Yang leg., Sweeping Net. (NMNS); 1 ex. (Catalog No. NMNS ENT 3422-523), same date & locality, C. S. Lin & W. T. Yang leg., UV Light. (NMNS). [Taitung County] 2 exs, Pilam (= Taitung), II-1908, H. Sauter leg. (HNHM; studied by MK); 1 ex., Doulan, Donghe Township, 9-IV-2012, J. Yamasako leg. (ELKU); 4 exs, Nanlion, Green Island Township, alt. ca. 200 m, 4-IV-2004, T. Kurihara leg. (ELKU); 1 ex., 4km SE Yeh-Ying Village, Lanyu Island (= Orchid Island), Lanyu Township, 22-V-2007, Martin & Quicke leg. (BMNH; studied by MK); 8 exs, Yung Hsin Farm, Lanyu Island (= Orchid Island), Lanyu Township, 29-30-VII-2008, Mendel & Barclay leg. (BMNH; studied by MK). [Kaohsiung City] 2 ex., Kosempo (= Jiashian District), I-1908, H. Sauter leg. (HNHM, ZMHB; studied by MK); 1 ex., Liu Kui (= Liouguei), 4-VI-1989, K. Baba leg. (KUM); 1 ex., same locality, 30-III-1986, K. Baba leg. (EUMJ); 1 ex., same locality, at light, 4-VIII-1978, T. Niisato leg. (EUMJ); 1 ex., Minsheng Road, Liougui District, at light, 9-VI-1977, K. Ushijima leg. (EUMJ); 1 ex., Tsai Tie Ku, near Liu Kui (= Liouguei), 6-X-1986, K. Baba leg. (EUMJ); 1 ex., Kosempo (= Jiashian District), I-1908, H. Sauter leg. (SDEI); 4 exs, same locality, VIII-1909, H. Sauter leg. (MNHN; studied by MK in 2017); 1 male, 2 females and 6 exs,

same label data. (SDEI). [Pingtung County] 2 exs, Akau (= Pingtung City), 1-10-XII-1907, H. Sauter leg. (HNHM, ZMHB; studied by MK); 2 males and 5 exs, same locality, XII-1907, H. Sauter leg. (SDEI); 1 ex., Haikou, N22°06'10.4" E120°42'15.4", 24-XI-2001, L. Stange & H. Wang leg. (FSCA); 1 ex. (Catalog No. NMNS ENT 7063-354), Nanjenshan, Manzhou Township, 11-25-X-2009, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 1 ex. (Catalog No. NMNS ENT 6824-375), Manchou (= Manzhou) Lite Chulaoshushan, 11-25-X-2009, M. L. Jeng & T. R. Chen leg., Flight Interception Trap. (NMNS); 2 exs (Catalog No. 1566-192 & 262), Yingdar, 19-20-V-1993, C. S. Lin & W. T. Yang leg., UV Light. (NMNS); 3 exs (Catalog No. 1565-202, 218 & 238), Kenting, 17-18-V-1993, C. S. Lin & W. T. Yang leg., UV Light. (NMNS); 7 exs, same locality, 1-5-IX-1983, J. B. Happner leg. (FSCA); 1 ex. (Catalog No. 2695-5), Kenting Park, 25-26-VIII-1997, C. S. Lin & W. T. Yang leg., UV Light. (NMNS); 1 ex. (Catalog No. NMNS ENT 4388-539), Hengchun, Kenting Park, 7-8-IV-2004, C. S. Lin & W. T. Yang leg., UV Light Trap. (NMNS); 1 ex., Kenting Natural Reserve, 4-6-X-2000, Papp, Peregovits & Ronka leg. (HNHM; studied by MK); 1 ex. (Catalog No. NMNS ENT 6849-29), Sheting, Hengchun, 1-19-IV-2009, M. L. Jeng & T. R. Cheng leg., Flight Interception Trap. (NMNS); 1 ex. (Catalog No. NMNS ENT 4810-445), same locality, 16-17-II-2005, C. S. Lin & W. T. Yang leg., UV Light Trap. (NMNS).

Diagnosis: This species can be distinguished from other Taiwanese *Psammoecus* species by the short oval habitus and the black elytra with yellow maculae.

Distribution: Taiwan; Japan; Philippines; India; Sri Lanka; Malaysia; Indonesia; Madagascar; France (Réunion); Seychelles.

Remarks: Pal (1985) and Karner (2012) provided redescriptions of this species, and Yoshida and Hirowatari (2014) provided a detailed description of male genital structure of this species. In this study, we examined morphology-including male genitalia of *P. stultus* type specimens-and found *P. stultus* should be synonymized with *P. simonis*.

Grouvelle (1892) initially described this species as 'simonis', but later Grouvelle (1908) referred to it as 'simoni', and all subsequent authors have used the latter spelling (Hetschko 1930; Pal 1985; Sen Gupta and Pal 1996; Hirano 2009 2010; Karner 2012 2014; Yoshida and Hirowatari 2014 2015). According to Article 33 of the International Code of Zoological

Nomenclature, if the original spelling was changed without demonstrably intentional emendation, the subsequent spelling should be regarded as incorrect and not an available name except in the case that the subsequent spelling is in prevailing usage. Otherwise, Article 23.9.1 of the code states that prevailing usage of the junior synonym must be maintained when the senior synonym has not been used as a valid name after 1899, and the junior synonym has been used for a particular taxon as its presumed valid name in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years. In the case of this species, the subsequent spelling 'simoni' changed without demonstrably intentional emendation should be regarded as an incorrect spelling, and it has not been in prevailing usage like the requirement in the Article 23.9.1 of the code. Therefore, 'simonis' is deemed to be valid name of this species.

***Psammoecus hiranoi* Yoshida and Hirowatari,
2013
(Fig. 11)**

Psammoecus hiranoi Yoshida and Hirowatari, 2013: 86. Type locality: Japan. Type examined. - Yoshida and Hirowatari 2014: 38, fig. 2E. - Yoshida and Hirowatari 2015: 98-99.

Psammoecus sp. 1: Hirano 2009: 63, 66, 82, fig. 6. - Hirano 2010: 12, 15.

Psammoecus sp. 2: Hirano 2009: 63, 66, 82, fig. 7. - Hirano 2010: 12, 15.

Specimens examined: TAIWAN: [New Taipei City] 1 male, Kueishan (= Guishan) ~ Wulai, Wulai District, 5-VI-1970, Y. Hori leg. (EUMJ); 2 exs, Wulai, Wulai District, 4-VI-1970, Y. Hori leg. (EUMJ); 2 exs, Fushan, Wulai District, 10-IX-2001, J. & L. Stange leg. (FSCA); 3 exs, Fushan, Wulai District, alt. 450 m, 1-10-XI-2001, H. Wang leg., Malaise Trap in hardwood forest. (FSCA); 1 ex., Fushan, Wulai District, alt. 600 m, 28-III-2004, T. Kurihara leg. (ELKU); 1 ex., same locality, 29-III-2004, T. Kurihara leg. (EUMJ). [Taipei City] 2 exs, Yangmingshan, Beitou District, 24-VIII-1966, H. Kamiya leg. (KUM). [Yilan County] 1 ex., Fushan Botanical Garden, Yuanshan Township, 23-24-VII-2005, Galsworthy leg. (BMNH; studied by MK); 1 ex., Fushan Botanical Garden, Yuanshan Township, 25-27-IX-2000, L. Papp, L. Peregovits & L. Ronkay leg. (HNHM; studied by MK); 1 ex., Yuanshan, Yuanshan Township, 26-III-2009, H. -J. Chen leg. (TARI). [Nantou County] 1 ex., NW Lushan, Ren-ai Township, 8-VIII-2008, Barclay &

Mendel leg. (BMNH; studied by MK); 1 ex. (Catalog No. NMNS ENT 5237-5688), Chunyang, Ren-ai Township, 12-III-9-IV-2002, C. S. Lin & W. T. Yang leg., Malaise Trap (KCN) (NMNS); 1 male (Catalog No. NMNS ENT 5237-3268), same locality, 9-IV-7-V-2002, C. S. Lin & W. T. Yang leg. (NMNS); 1 female & 1 ex., Penpuchi, Ren-ai Township, 13-VII-1966, H. Kamiya leg. (KUM); 1 ex., same locality, 14-VII-1966, H. Kamiya leg. (KUM). [Chiayi County] 1 male, Fenchihu, Zhuqi Township, 21-III-1968, T. Okadome leg. (EUMJ). [Kaohsiung City] 2 exs (Catalog No. NMNS ENT 6574-447 & 457), Shanping, Liougui District, 5-6-XI-2010, W. T. Yang leg., UV Light Trap (NMNS). [Pingtung County] 3 males & 2 exs, Dong Yuan Forest Recreation Area, Dong Yuan Village, Mudan Township, Pingtung City, 12-VII-2014, T. Yoshida leg. (ELKU).

Diagnosis: This species is somewhat similar to *P. taiwanensis* sp. nov., and they share the following character states: the short lateral teeth on pronotum of identical size and the row of long erect setae along each lateral margin of elytra. This species can be easily distinguished from *P. taiwanensis* sp. nov. by the weakly curved anterior margin of pronotum and the not impressed dorsolateral pronotum.

Distribution: Taiwan; Japan.

Remarks: Yoshida and Hirowatari (2013) described this species in detail with the male genital structure. This species was originally described from the Nansei Islands, southeastern Japan. Yoshida and Hirowatari (2013) suggested that this species originated from the southern part of continental China, based on its distribution. The data presented here show that *P. hiranoi* is distributed throughout Taiwan.

DISCUSSION

We confirmed nine *Psammoecus* species, including one new species from Taiwan. Six scientific names are synonymized in this paper, and it is revealed that three species - *P. dentatus*, *P. harmandi* and *P. delicatus* - have wider distributions. These results imply that faunistics and taxonomy of *Psammoecus* in South East Asia are poorly studied and that there is a potentially high species diversity. Furthermore, the external morphological characters of *Psammoecus* are highly variable, which explains the numerous synonyms. It is essential for taxonomic studies of *Psammoecus* to examine male genital structures because they bear reliable diagnostic characters.

Six species of Taiwanese *Psammoecus* have also been recorded from the Ryukyu islands, southwestern Japan. Although *P. harmandi* is not recorded from the Ryukyu islands but from Hokkaido, Honshu and Kyushu, Japan, this species is also recorded from Taiwan, Thailand, Nepal and India, and it is suggested that the distribution of *P. harmandi* may be consistent with the marginal area of the Sino-Japanese floral region (Good 1974), which largely overlaps the Sino-Japanese realm of zoogeographic unit termed in Holt et al. (2013). Insect species or genera presenting this pattern of distribution are not uncommon. As for other species with wide distributions, such as *P. dentatus*, *P. delicatus*, *P. simonis* and *P. trimaculatus*, it may be difficult to determine the range of their natural distribution and provide zoogeographic discussion because they may have been transported through human activity. E.g. Lu and Han (2006) reported that *Psammoecus* were found on leather products in transit and *P. simonis* was found in a wooden pallet transported from Taiwan (Ouellette, unpublished). Very few faunistic data are available. In order to conduct biogeographic studies of this genus, further comprehensive taxonomic and faunistic work is required.

Key to species of the Genus *Psammoecus* of Taiwan (after Yoshida and Hirowatari 2014)

- 1. Teeth of lateral margins of pronotum relatively short and of identical size 2
- Teeth of lateral margins of pronotum relatively long. Posterior teeth longer than those of anterior margins 5
- 2. Distance between teeth of lateral margins of pronotum irregular *dentatus* Grouvelle
- Distance between teeth of lateral margins of pronotum regular 3
- 3. Anterior margin of pronotum weakly curved. Dorsolateral portions of pronotum with no impressions *hiranoi* Yoshida and Hirowatari
- Anterior margin of pronotum strongly curved. Dorsolateral portions of pronotum impressed lightly 4
- 4. A row of long erect setae along each lateral margin of elytra. Anterior angles of pronotum somewhat expanded ... *taiwanensis* sp. nov.
- No long seta on anterolateral margins of elytra. Anterior angles of pronotum not expanded *harmandi* Grouvelle
- 5. Black elytra with yellow maculae *simonis* Grouvelle
- Yellow elytra with black maculae or no maculae 6
- 6. Teeth of lateral margins of pronotum long and slender. Pubescence composed of setae of two types, moderate length and long, on head and pronotum. Punctuation weak and sparse *delicatus* Grouvelle
- Teeth of lateral margins of pronotum distinct, but shorter. Pubescence composed of mostly same length setae on head and pronotum. Punctuation somewhat strong and dense 7

- 7. Basis of parameres wide. Distance between posterior margin of phallobase and deepest point of incision of anterior margin broad *trimaculatus* Motschulsky
- Basis of parameres comparatively narrow 8
- 8. Distance between posterior margin of phallobase and deepest point of incision of anterior margin wide. Widened basal part of parameres rectangular *labyrinthicus* Yoshida and Hirowatari
- Distance between posterior margin of phallobase and deepest point of incision of anterior margin narrow. Widened basal part of parameres triangular *triguttatus* Reitter

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