

Taxonomic Notes on *Balmes formosa* (Kuwayama, 1927) (Insecta, Neuroptera, Psychopsidae), a Silky Lace-wing Species Found in Japan

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(Received 25 January 2011; accepted 11 April 2011)

Abstract *Balmes formosa* (Kuwayama, 1927) (Insecta, Neuroptera, Psychopsidae) is newly recorded from Japan on the basis of a female collected from Tsushima Islands, Nagasaki Prefecture, Kyushu, and is redescribed with comments on morphology which previous authors overlooked, especially on the 8th tergite, the sclerite surrounding spermatheca (sss), horn-shaped sacs (hs), the post-subgenitale sclerite (pss) and postgenitalia.

Key words: Neuroptera, Psychopsidae, *Balmes formosa*, new record, redescription, Tsushima Islands.

Introduction

Kuwayama (1927) described a new species, *Psychopsis (Orientichopsis) formosa* Kuwayama, 1927, on the basis of two female specimens (erroneously denoted as males) collected from Taiwan. The species was transferred to the genus *Balmes* in the Psychopsidae (Kimmins 1939; Oswald 1993). The extant family Psychopsidae is currently composed of five genera and 26 described species distributed in southern Africa, Australia and Southeast Asia. Of these, the genus *Balmes* has been recorded restrictively to Southeast Asia, and five rare species are known in the genus. Several years ago I found one female specimen collected in Tsushima Islands, Nagasaki Prefecture in 1959 in the Nakahara Collection of the National Museum of Nature and Science, Tokyo, Japan. According to the label, the late Dr. W. Nakahara identified the specimen with *Balmes formosa* (Kuwayama), but did not publish this record. Recently I got opportunities to investigate this specimen from Tsushima Isls. and identified it properly with *B. formosa* by a comparison with the photograph of the holotype and an examination of the paratype of this

species. In the present paper I report the new record of *B. formosa* to the Japanese fauna and redescribe it with comments on morphology which previous authors overlooked.

Materials and methods

Two female specimens from Tsushima Islands and Taiwan (the paratype of *Balmes formosa*) were available. The redescription is based on the specimen from Tsushima Isls., which is better in condition than the paratype. The photographs of the holotype were available for superficial identification.

The following abbreviations are used for depositories of the specimens: Section of Systematic Entomology, Faculty of Agriculture, Hokkaido University, Sapporo, Japan (HU); National Museum of Nature and Science, Tokyo, Japan (NMNS; the abbreviation of the collection: NSMT).

The examination of the specimens was made using OLYMPUS binocular stereoscopic microscope. The color was observed in sunlight. The general external structures were described and figured in the dried condition under magnifica-

tion $\times 10$ and $\times 40$ of the microscope, and the trichosors and the details of the wings were observed under magnification $\times 100$ of the microscope. The dissection was made only in the abdomen and other parts were not dissected. The abdomen was removed from the body, treated with 10% KOH solution, fully washed in water and stained in solution of 70% ethanol and Chlorozol Black. The gonapophyses laterales and genitalia were observed by partly incising the terminalia without being removed from the abdomen. The descriptions and figures of the 2nd to 3rd abdominal segments, terminalia and genitalia were made in 70% ethanol or glycerin under magnifications of $\times 25$ and $\times 63$.

The measurements of the external characters are as follows. Body length: distance between anterior margin of head and posterior margin of ectoproct excluding setae in lateral view (Fig. 2); head width: maximal transverse distance between outer margins of both eyes in frontal view (Fig. 3a); eye diameter: longitudinal diameter in lateral view (Fig. 3b); eye thickness: maximal transverse distance between outer and inner margins in frontal view (Fig. 3a); antennal length: distance from proximal base to distal apex in lateral view; wing length: distance from proximal base to distal marginal apex in dorsal view.

Expression of setal length is approximately shown as follows. Microscopic: ca. 0.1 mm or less; very short: ca. 0.1–0.2 mm; short: ca. 0.2–0.3 mm; moderate: ca. 0.3–0.7 mm; long: ca. 0.7–1.1 mm; very long: ca. 1.1–1.2 mm or more. The condition and number of the setae and spines are roughly figured; for example, those on the gonapophyses laterales cannot be exactly observed by this manner.

Nomenclature for the wing venation follows that of Tillyard (1919). Terminalia and genitalia terminology follows Tjeder (1960), New (1989 a, b) and Oswald (1993). Terminology for other external characters refers to Killington (1936) and New (1989b). The following terms are used for three characters which have hitherto been unknown in the Psychopsidae: sclerite surrounding spermatheca (sss), horn-shaped sac (hs) and post-

subgenitale sclerite (pss) (Figs. 6a–c, 9). The forewing markings are named for convenience of the description as follows:

Vena triplica markings: series of markings arranged along vena triplica, which was termed for the strengthened portion of the three parallel veins (viz. Sc, R and Rs) specialized in the Psychopsidae by Tillyard (1919).

Intraradial markings: series of markings arranged on basal four-fifths along nearly middle line of intraradial area.

Mediocubital markings: series of the markings arranged on basal two-thirds of medio-cubital area.

Marginal markings: series of the markings arranged at intervals along wing margin.

Balmes formosa (Kuwayama, 1927)

(Figs. 1–9)

Psychopsis (*Orientichopsis*) *formosa* Kuwayama, 1927: 123, fig.; Okamoto and Kuwayama, 1932: 1550, fig. 3061.

Psychopsis (*Orientichopsis*) *formosana* [sic]: Matsumura, 1931: 1166, fig.

Balmes formosana [sic]: Kimmins, 1939: 153.

Psychopsis formosa: Shiraki, 1954: 303, fig. 627; New, 1989a: 846, figs. 1–5, 24–30.

Balmes formosa: Oswald, 1993: 60.

Balmes formosus [sic]: Oswald, 1995: 95, figs. 2, 27; Wang and Bao, 2006: 847, fig. 16.

Redescription. Length of body ca. 10.5 mm, of forewing ca. 21 mm, of hindwing ca. 17 mm.

Head wholly pale brown, dimly lustrous, unmarked, with width of ca. 2.1 mm; postocular lobe well developed, largely dilated on both sides of epicranium (Fig. 3); a pair of lateral setiferous tubercles present, antero-median one absent; anterior tentorial pits upward, situated at about one-third from lower point of eyes in frontal view, very large, ovals open (Fig. 3a); postclypeus with indistinct transverse striae on lower half; genae very short, small (Fig. 3b); sutures indistinct, not exactly traceable except ante- and post-clypeal intervening suture and clypeolabral suture. Eyes blackish-gray, prominent, larger than half the distance between eyes in frontal view,

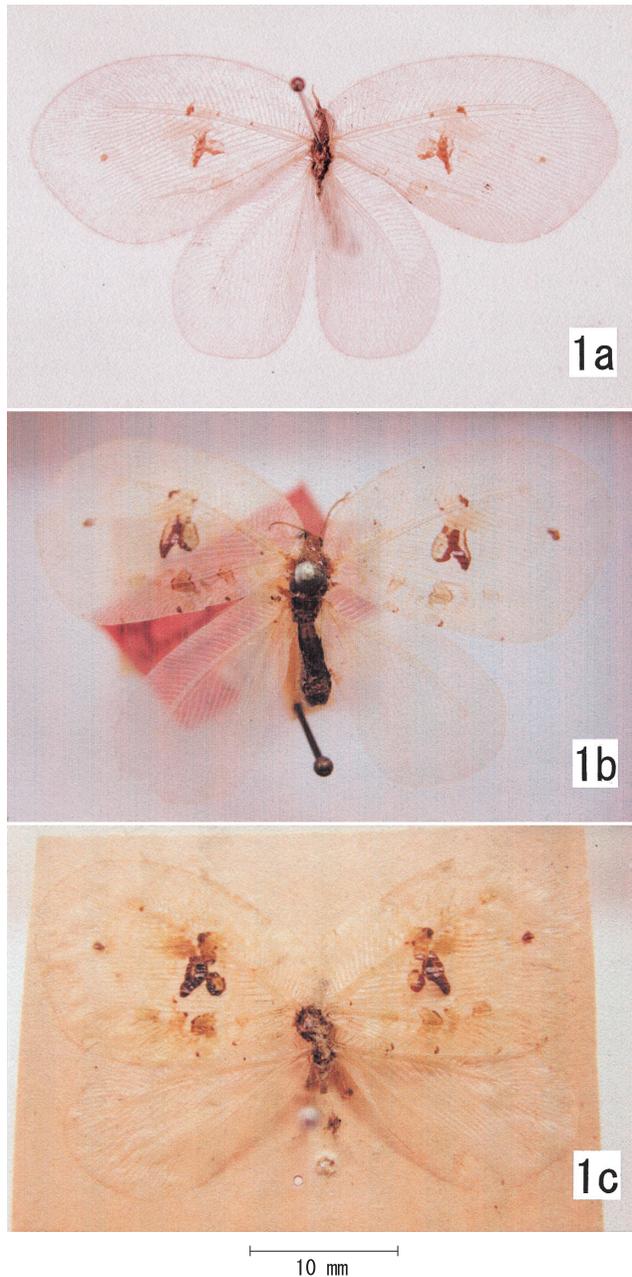
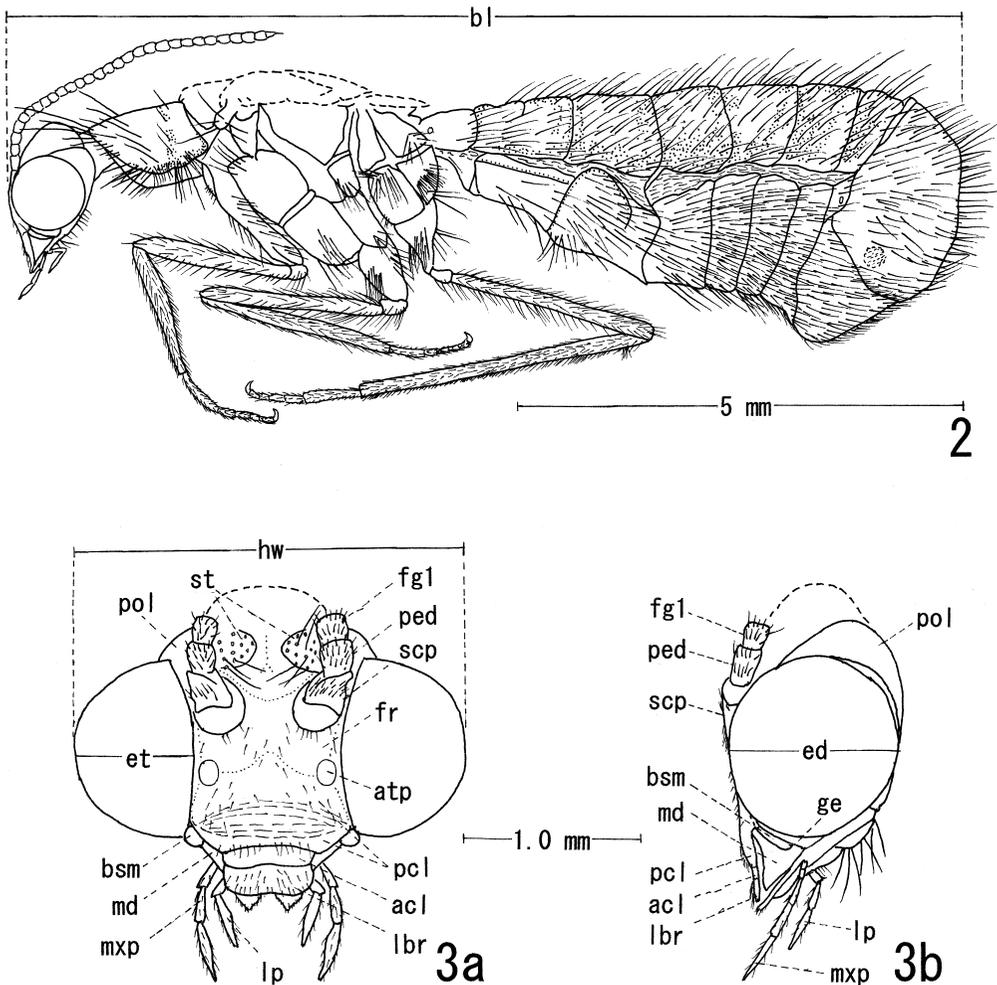


Fig. 1. *Balmes formosa* (Kuwayama, 1927), dorsal views, (a) female from Tsushima Islands, (b) holotype, (c) paratype.

with diameter of ca. 1.0 mm and thickness of ca. 0.6 mm. Antennae deep brown, moniliform, short, with length of ca. 4.5 mm, probably 30-subsegmented on flagella. Mouth parts and gular region almost wholly whitish, faintly tinged with

pale brown; basimandibulae distinctly dilated; mandibles margined with deep brown in lateral view; maxillary palpi 5-segmented; labial palpi 3-segmented; apices of palpi brown. Head setae usually translucent, whitish but somewhat brown-



Figs. 2–3. *Balmes formosa* (Kuwayama, 1927). —2, Lateral appearance; dorsal parts of pterothorax and wings omitted (bl, body length); 3, head, vertex invisible owing to adhesive matter except anterior area; (a) frontal view, (b) lateral view (acl, anteclypeus; atp, anterior tentorial pit; bsm, basimandibula; ed, eye diameter; et, eye thickness; fg1, 1st subsegment of flagellum; fr, frons; ge, gena; hw, head width; lbr, labrum; lp, labial palpus; md, mandible; mxp, maxillary palpus; pcl, postclypeus; ped, pedicel; pol, postocular lobe; scp, setiferous tubercles).

ish in some lights; length very short or microscopic on most parts, but short to moderate on epicranial setiferous tubercles, mentum and submentum.

Thorax wholly pale brown, dimly lustrous, longitudinally darkening on latero-dorsal and dorso-lateral areas (the darkening may be owing to discoloration); pronotum obscurely mottled with dark brown near posterior one-third and along lateral margin; meso- and metathoracic

markings invisible or untraceable. Legs faintly tinged with pale brown; tibial apical spurs with microscopic spines along dorsal and ventral margins; tarsal claws lustrous, brown, without basal dilation. Wings very broad, with expanded costal area and broadly rounded marginal apex, without pterostigma, wholly covered with dense microtrichia, with one trichosor between each marginal veinlet entirely (Figs. 4a, b); membrane translucent, faintly tinged with white, wholly iri-

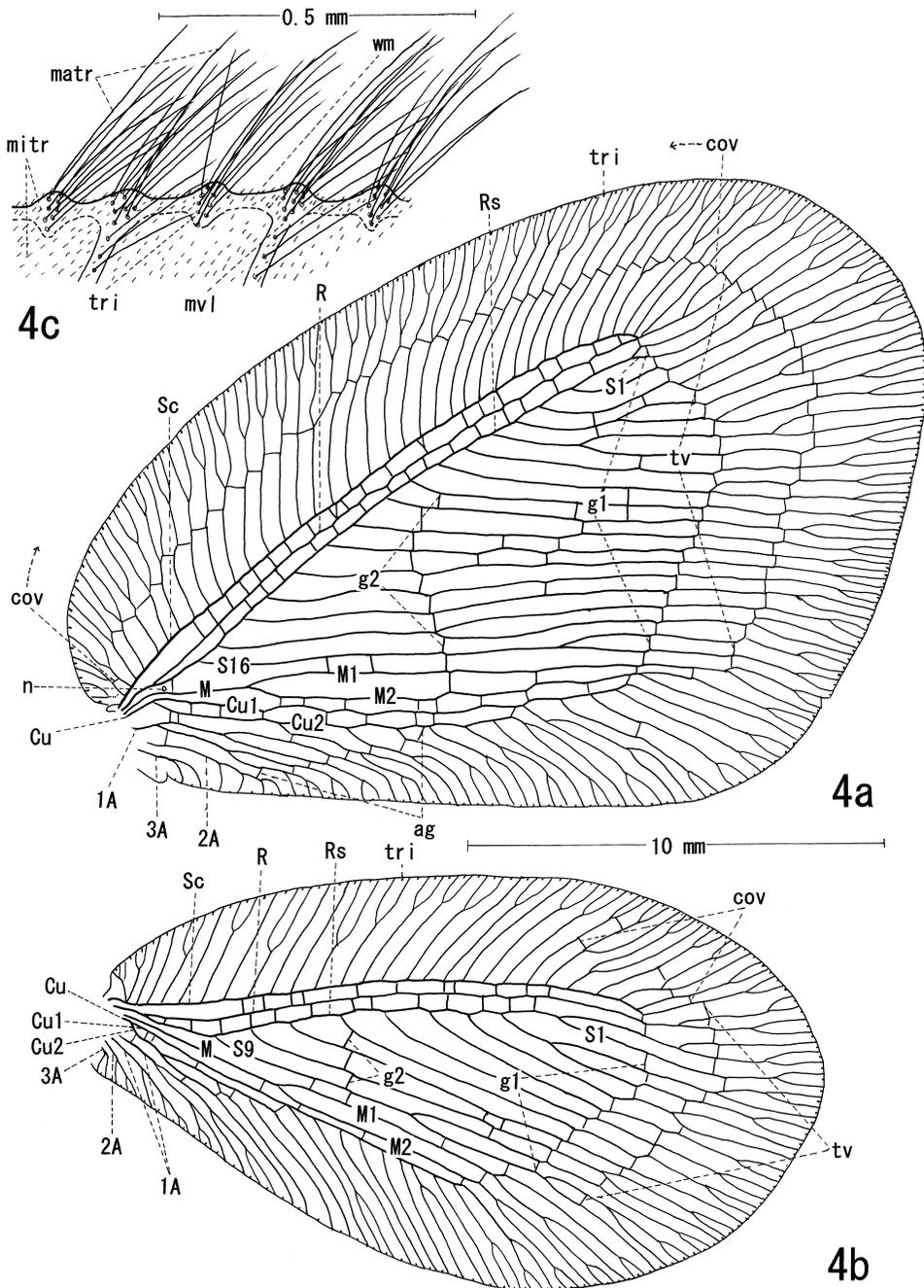


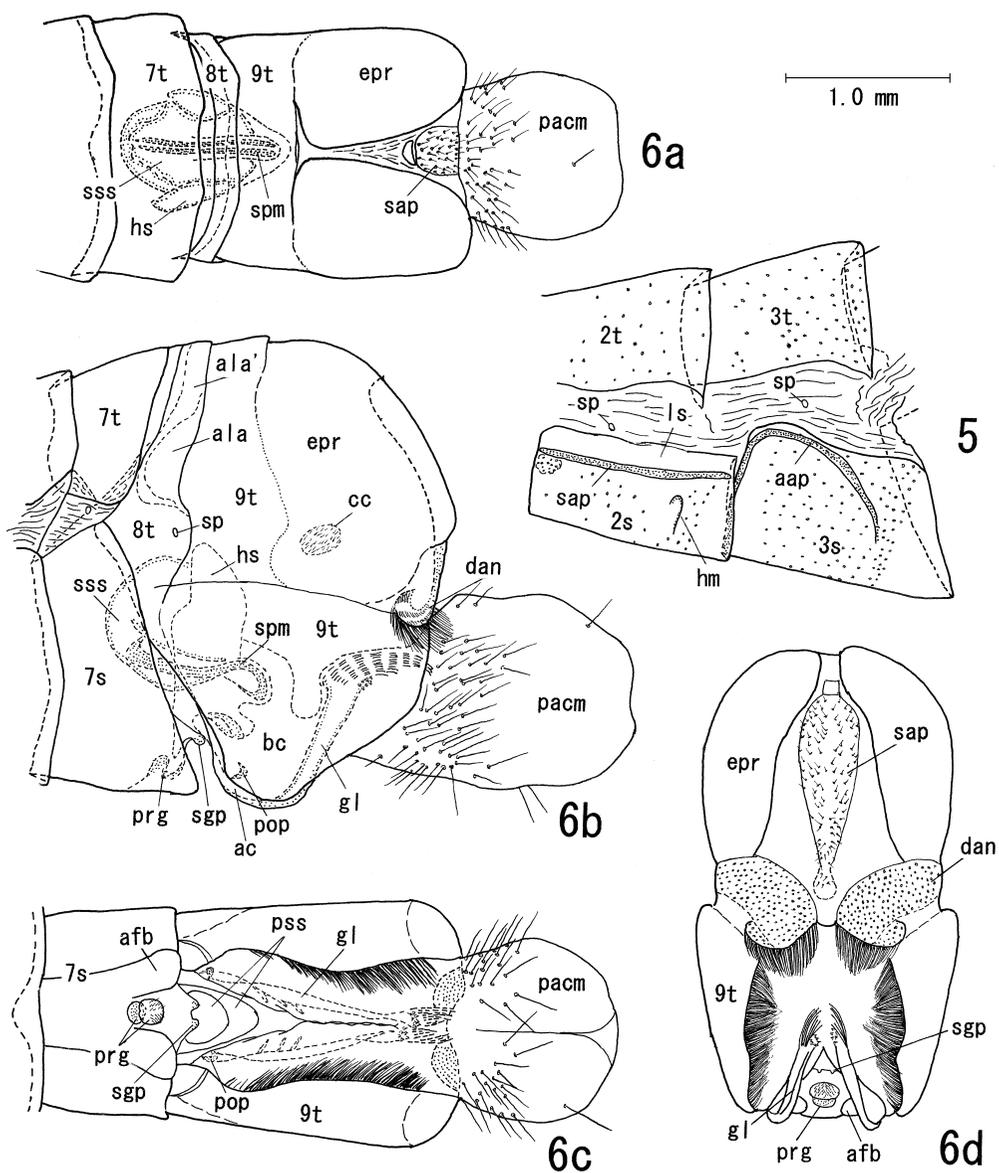
Fig. 4. *Balmes formosa* (Kuwayama, 1927), right wings, (a) forewing venation, (b) hindwing venation, (c) median part in costal margin of forewing (ag, additional gradate series of crossveins; cov, costal gradate series of crossveins, only both ends of the series lettering; Cu, cubitus; Cu1 and Cu2, branches of Cu; g1, discal gradate series of crossveins; g2, internal gradate series of crossveins; M, media; M1 and M2, branches of M; matr, macrotrichia; mitr, microtrichia; mvl, marginal veinlet; n, nigma; R, radius; Rs, radial sector; Sc, subcosta; S1–S16, S1–S9, branches of radial sectors in forewing and hindwing respectively, only both ends of the branches lettering; tri, trichosor; tv, terminal gradate series of crossveins; wm, wing margin; 1A, 1st analis; 2A, 2nd analis; 3A, 3rd analis).

descent or lustrous; veins faintly whitish on most parts but faintly brownish in some lights, pale brown on basal areas; venation as shown in Figs. 4a and b; macrotrichia present on longitudinal veins, marginal veinlets and trichosors, very rarely found on crossveins, not occurring on wing margins between trichosors and veinlets (Fig. 4c). Forewings: Marked and spotted with pale brown to blackish-brown, as in Fig. 1; vena triplicata markings mostly reducing or disappearing except portion between nearly one-half and two-thirds from base, consisting of spot at basal one-third, one-half, two-thirds and distal end respectively, those of basal one-third and distal end indistinct or disappearing; intraradial markings mainly consisting of ribbon-shaped internal marking lying on internal gradate series and discal spot located along outside of discal gradate series, and not observed or disappearing near base; mediocubital markings faint, indistinct or disappearing near base, dividing or subdividing into several irregular fragments distad; marginal markings very dim except three spots on posterior margin, barely observed by looking at wings through light, clouded with pale gray, nearly rounded subtriangular. Nygmata present inside basal crossvein between Rs and M. Number of branches of Rs and main crossveins as follows, branches of Rs: 16, cov: 37, Sc-R: 21 and 26, R-Rs: 17 and 18, g1-g2: 11 and 14, M2-Cu1: 9 and 11, Cu1-Cu2: 8 and 9. Discal gradate series (g1) distinctly curved distad; internal gradate series (g2) somewhat curved basad; costal gradate series (cov) almost complete, without one or two proximal crossveins; terminal gradate series (tv) complete; additional gradate series (ag) present from Cu2 to 2A on basal one-fifth to two-fifths of posterior area, consisting of eight crossveins. Hindwings: without any markings, spots and clouds; number of branches of Rs and main crossveins as follows, branches of Rs: 9 and 11, Sc-R: 10 and 12, R-Rs: 14 and 16; discal gradate series somewhat curved distad; internal gradate series not curved; costal gradate series incomplete, with several distal crossveins; terminal gradate series almost complete; additional gra-

date series lacking. Thoracic setae usually translucent, whitish but somewhat brownish in some lights; length moderate to long on most parts, very long on anterior area of pronotum (Fig. 2), short on tibiae, very short or microscopic on tarsi; macrotrichia of wings short to long, mainly moderate.

Abdomen pale brown, dimly lustrous on tergites and sternites, obscurely mottled with brown on 2nd to 8th tergites, enlarged toward large distal apex, wholly covered with rich setae (Fig. 2), intensively wrinkled on lateral membranous regions; 2nd sternite with a pair of lateral smooths, sublateral apodemes and additional hooked marks; 3rd sternite with a pair of arched apodemes extending along anterior margin through antero-lateral angle then postero-ventrad (Fig. 5). Abdominal setae usually translucent, whitish but somewhat brownish in some lights, tinged with blackish-brown on ventro-posterior projections of 7th sternite; length moderate to long on most parts, very short along ventral margin of 9th tergite.

Terminalia and genitalia: Terminalia as shown in Fig. 6. Seventh abdominal segment somewhat narrower than preceding segments; 7th tergite transversely wide, about three-quarters length of 6th tergite on dorsal margin in lateral view, becoming narrower from dorsal margin toward lateral margin; 7th sternite transversely distinctly wide, becoming narrower from ventral margin toward lateral margin, somewhat projecting at ventro-posterior apex in lateral view, smooth on basal half of ventral side, finger-shapedly bifurcate postero-medially in ventral view. Eighth tergite very narrow, somewhat broadening laterally, extending and tapering ventrad far beyond lateral median stria, almost united with 9th tergite near ventral apex. Ninth tergite somewhat narrow on dorsal half, enlarged on ventral half, with prominent antecosta, infolding along ventral margins and fringed with many setae inwardly, and more or less united with ectoproct: transverse boundary between dorsal half of 9th tergite and ectoproct hardly traceable as suture except dorso-medial to -submedian areas, but faintly traceable as



Figs. 5–6. *Balmes formosa* (Kuwayama, 1927).—5, Second to 3rd abdominal segments, setae omitted, setal sockets illustrated, lateral view (aap, arched apodeme; hm, hooked mark; ls, lateral smooth; sap, sublateral apodeme; sp, spiracle; 2s and 3s, 2nd and 3rd sternites; 2t and 3t, 2nd and 3rd tergites); 6, terminalia, most of setae omitted, (a) dorsal view, (b) lateral view, (c) ventral view, (d) posterior view, posterior abdominal chamber membrane omitted (ac, antecosta; afb, apex of finger-shaped bifurcation; ala, inner layer; ala', intervenient layer; bc, bursa copulatrix; cc, cercal callus; dan, distal angle; epr, ectoproct; gl, gonapophysis lateralis; hs, horn-shaped sac; pacm, posterior abdominal chamber membrane; pop, postgenitale; prg, praegenitale; pss, post-subgenitale sclerite; sap, subanale; sgp, subgenitale; sp, spiracle; spm, spermatheca; sss, sclerite surrounding spermatheca; 7s, 7th abdominal sternite; 7t–9t, 7th to 9th abdominal tergites).

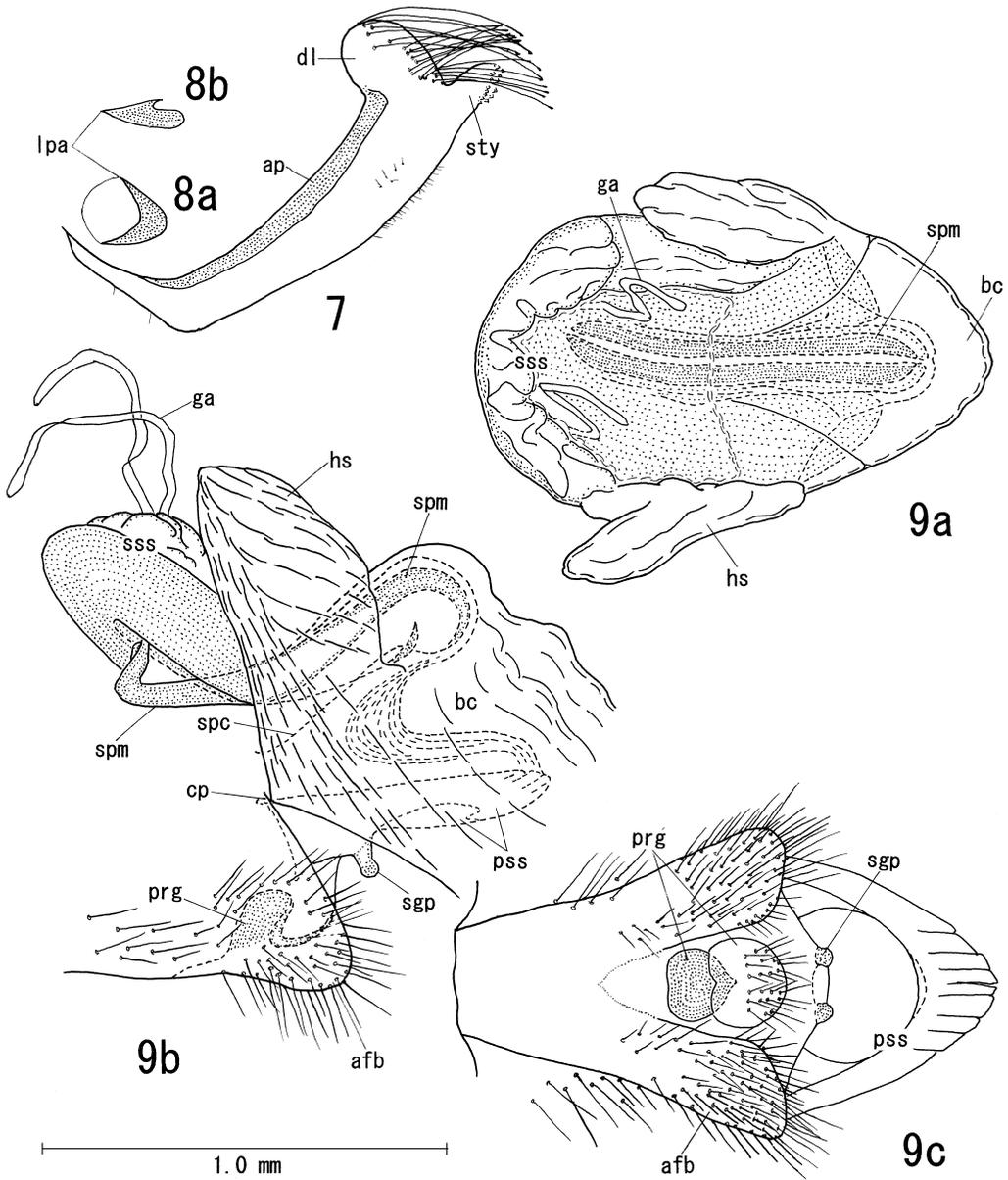
fine and smooth belt; longitudinal boundary between ventral half of 9th tergite and ectoproct apparently edged with stria or fold, which is prolonged anteriorly and reaches to the halfway of the 8th tergite. Ectoproct narrowly separated mid-dorsally, more and more widely separated downward, membranously joined to each other; a pair of distal lower angles involute in about 180° arc, fringed with many setae; lateral sides somewhat depressed above near the angles; cercal callus on either side indistinct, with about 35 trichobothria. Subanale large and long, narrowing downward, reaching near distal lower angles of ectoproct, with many microscopic setae. Gonapophyses laterales as shown in Fig. 7, thin plate-like, relatively narrow, tapering basad; apodeme running in contact with dorsal margin; lateral longitudinal row of stiff setae absent; dorsal lobe with apically expanded and hooked setae, which consist of two different lengths, generally short basally and long apically; stylus with microscopic spines, without aggregation of setae near insertion. Genitalia as shown in Figs. 8–9. Praegenitale situated between finger-shaped bifurcation of 7th sternite in ventral view, nearly wavy in lateral view, consisting of basal brown cavity and apical setiferous disk. Subgenitale membranously joined postero-upwardly to praegenitale, small, indistinct basally, brown on a pair of apical protuberances. Postgenitalia nearly crescent in front view, thin, not flat, cubic, curved mediad, somewhat thumb-shaped in lateral view (Fig. 8). Spermatheca paired in dorsal view, nearly sigmoid in lateral view; spermathecal canal directly extending antero-ventrad and somewhat curved dorsad at apex. Bursa copulatrix very large, provided with sclerite surrounding spermatheca, a pair of asymmetrical horn-shaped sacs and post-subgenitale sclerite; a pair of weak glandulae accessoriae occurring from dorso-anterior area of sclerite surrounding spermatheca. Posterior abdominal chamber membrane thin, with many microscopic setae on proximal one-third in everted condition (Figs. 6a–c).

Primary type. Holotype: ♀ (as ♂ in the original description) (Fig. 1b). Formosa: Taichiu-dis-

trict: Rengechi, near Horisha [Taiwan: Nantou County: Lienhoachi, near Pu-li]. [HU]. [The specimen was not examined, but the photographs of the holotype were available.]

Specimens examined. 2♀. Paratype: 1♀ (as ♂ in the original description) (Fig. 1c). Formosa: Tainan-District: Kagi [Taiwan: Chiai]. Data on five labels of main body of specimen: ⟨KAGI TAIWAN 8–1921 S. Hirayama⟩, ⟨*Psychopsis (Orientichopsis) formosa* KWYM. 1927 (PARATYPE) det. S. KUWAYAMA⟩, ⟨*Balmes formosa* (KUWAYAMA) det. SATORU KUWAYAMA 1960⟩, ⟨det. T. R. NEW 1986 ABDOMEN IN VIAL (♀)⟩, ⟨*Psychopsis formosa* Kuwayama, 1927♀ Paratype det JDOswald 1994⟩. Data on two labels of abdomen in vial: ⟨PARATYPE♀ ABDOMEN det. T. R. NEW 1986 *PSYCHOPSIS FORMOSA* Kuwayama⟩, ⟨*Psychopsis formosa* Kuwayama, 1927♀ Paratype det JDOswald 1994⟩. [HU]. The main body of the specimen is hardly available to examine except the upper surfaces of the wings: because it is mounted on a paper, the head and the lower parts of the thorax and abdomen are concealed, and the upper parts of the thorax and abdomen are in a bad condition owing to adhesion of mold, etc. It also is partly damaged or transformed in the thorax, the forewings and the 1st to 3rd abdominal segments, and is supposed to have faded or discolored; the setae are lost in many parts. In the vial the posterior part of the 3rd abdominal tergite and the 4th to terminal abdominal segments remain in the condition prepared and stained, but the following parts are taken apart from terminalia: right ectoproct, subgenitale, postgenitale, spermatheca, parts of bursa copulatrix (viz. sclerite surrounding spermatheca and upper halves of horn-shaped sacs) and right gonapophysis lateralis; other parts of the bursa copulatrix and the posterior abdominal chamber membrane are lost or not found.

1♀, Japan: Kyushu: Tsushima Islands: Izuhara (Fig. 1a). Data on four labels: ⟨Izuhara Tsushima Is. 28 March 1959 K. Fujimoto⟩, ⟨*Balmes formosa* (Kuwayama) W. NAKAHARA⟩, ⟨Nakahara Collection⟩, ⟨NSMT-I-Nr No. 4367⟩. [NMNS].



Figs. 7-9. *Balmes formosa* (Kuwayama, 1927).—7, Left gonapophysis lateralis, lateral view (ap, apodeme; dl, dorsal lobe; sty, stylus.); 8, left postgenitale, (a) front view, (b) lateral view (lpa, lateral pointed apex); 9, genitalia, (a) dorsal view, (b) lateral view, ventro-posterior part of 7th abdominal sternite also illustrated, (c) ventral view, ventral side of 7th sternite also illustrated (afb, apex of finger-shaped bifurcation; bc, bursa copulatrix; cp, connecting point of 7th sternite and bursa copulatrix; ga, glandula accessoria; hs, horn-shaped sac; prg, praegenitale; pss, post-subgenitale sclerite; sgp, subgenitale; spc, spermathecal canal; spm, spermatheca; sss, sclerite surrounding spermatheca).

The specimen before this examination was somewhat damaged or transformed in the antennae, thorax and 1st abdominal segment, and was sup-

posed to have faded or discolored, especially in the ground color; the setae were more or less lost.

Biological notes. Izuhara (34°4'50"–34°17'28"N, 129°9'57"–129°19'41"E), Tsushima Islands, the locality of the Japanese specimen is the most northern of known localities of extant psychopsid species in the world. *Balmes formosa* has been only recorded from Taiwan (2 females by Kuwayama, 1927) and Fujian (2 females by Wang and Bao, 2006) of China; the male has not been known up to the present. They were collected in August in Taiwan, May in Fujian and March in Tsushima Isls. Kuwayama (1927) mentioned that this species was attracted by light at night. The specimen from Tsushima Isls. also may have been presumably collected by light-trap at night, as moth scales are observed to attach to it. Environments of their localities were not reported and the biology of the species has not been known at all.

Distribution. Japan (Kyushu: Tsushima Islands) (new record); China (Fujian); Taiwan.

Etymology. Oswald (1995) estimated that the specific epithet, *formosa*, is derived from Latin *formosus* (beautiful). But Kuwayama (1927) gave the species the Japanese name of "Taiwan-kinubakagerou" in the Japanese summary of his original description. The Japanese word Taiwan-kinubakagerou is composed of "Taiwan" (=Formosa) and "kinubakagerou" (=silky lace-wing). Therefore, it is evident that "*formosa*" was named after a proper name as same as Taiwan and should be treated as a noun in apposition.

Comments on morphology. Some characters recognized in the present study have not been known or adequately treated in the psychopsid taxonomy. In the following lines, comments on those characters and their morphology are briefly mentioned.

1. The dorsal half of the 8th tergite is lined with two thin antecostal layers, viz. small inner layer (Fig. 6b: ala) and large intervenient layer (Fig. 6b: ala') which lines most of the dorsal half, covers the small inner layer and ends at lower point of it. The inner layer (ala) was treated as anterolateral apodeme issuing from the 9th tergite by Oswald (1993), but the intervenient layer (ala') has hitherto not been recognized.

2. The sclerite surrounding spermatheca (sss) is densely furnished with many microscopic spines on the bottom, of which the upper surface is covered with soft membranous matter on the anterior half; the marginal area anterior to the horn-shaped sacs is strongly dilated and wrinkled (Figs. 9a, b). The spermatheca is almost entirely enclosed in the sclerite surrounding spermatheca (sss) except the canal.

3. The horn-shaped sacs (hs) are somewhat stoutly membranous, the anterior bases of the sacs originating at a connecting point of the posterior margin of the 7th sternite and the bursa copulatrix, and protrude dorsad beyond the lateral margin of the sclerite surrounding spermatheca (sss) (Fig. 9b).

4. The post-subgenitale sclerite (pss) is just behind the subgenitale, consists of an inner roundish concavity and an outer subparabolic plane in the ventral view (Fig. 9c) and is weakly sclerotized. The subparabolic plane becomes gradually membranous basad and is longitudinally striated or slit distally.

5. New (1989a) figured the postgenitalia in contact with the gonapophyses laterales (e.g., Figs. 30, 220). In my examination, however, the postgenitalia are located at a little interval from the bases of the gonapophyses laterales and connected with the membrane near the entrance of the bursa copulatrix at the two lateral pointed apices (Fig. 8a).

Remarks. Oswald (1995) and Wang and Bao (2006) mentioned that *Balmes formosa* is distinctly discriminated from other *Balmes* species as follows: 1) forewing costal gradate series: present, almost complete (absent in other species; one or two adventitious crossveins occasionally present), 2) forewing intraradial area with three gradate series: internal, discal and terminal gradate series (two gradate series in other species: internal and discal gradate series; terminal gradate series lacking). In addition, I recognize the following character states for this species: 1) large, forewing length: ca. 21 mm (small, forewing length: 10.8–15.7 mm in other species), 2) possession of ribbon-shaped internal

marking and discal spot which is much smaller than the internal marking (in *chikuni* Wang and Bao, 2006 internal marking not ribbon-shaped, consisting of two small roundish markings and distal spot distinctly larger than internal marking; in *birmanus* (McLachlan, 1891), *terissinus* Navás, 1910 and *notabilis* Navás, 1912 such internal marking and discal spot absent).

The internal marking faintly expands to surroundings, especially anteriorly and joins vena triplica markings. It is also variable and subtle in the shape, and was expressed in another way by authors, i.e. W-shaped in Kuwayama (1927), like a map in Wang and Bao (2006).

The forewing markings and spots of the specimen from Tsushima Islands are rather paler and smaller than those from Taiwan and Fujian. Tsushima Isls. is nearly 1,400 km distant from Taiwan and Fujian. The population of Tsushima Isls. may involve subtle geographical difference from those of Taiwan and Fujian.

Acknowledgments

I express my hearty thanks to Dr. M. Owada (National Museum of Nature and Science) for giving an opportunity to study this interesting material. I am also grateful to Dr. K. Yoshizawa (Hokkaido University) for the loan of the paratype. I wish to thank Mr. S. Sekimoto (Yokohama Plant Protection Station, Yokohama, Japan) for offering photographs of the type specimens and copies of literature, and Mr. I. Tabata (Kitakyushu, Japan) for the gift of copies of literature.

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