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The genus *Anisocentropus* McLachlan (Trichoptera, Calamoceratidae) in Japan

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Abstract

We reviewed the Japanese species of *Anisocentropus* McLachlan (Trichoptera, Calamoceratidae) and confirmed 3 species, *Anisocentropus* (*Anisocentropus*) *kawamurai* (Iwata, 1927), *A.* (*A.*) *pallidus* (Martynov, 1935) and *A.* (*A.*) *magnificus* Ulmer, 1907. The last species is recorded from Japan for the first time. For clear comparisons, adult and immature stages of the three species are described based on associations established by rearing larvae. The male, female and pupa of *A.* (*A.*) *kawamurai*, female and pupa of *A.* (*A.*) *pallidus* and female and immature stages of *A.* (*A.*) *magnificus* are newly described. *Anisocentropus* (*A.*) *minutus* (Martynov, 1930), known from southeastern Asia, is synonymized with *A.* (*A.*) *kawamurai* (Iwata, 1927).

Key words: male, female, pupa, larva, variation, new record, new synonym, Asia

Introduction

Anisocentropus McLachlan is a diverse genus of Calamoceratidae and is distributed in the Oriental (about 50 species), Australasian (about 25), Afrotropical (5), Neotropical (3), Nearctic (1) and East Palearctic (2) regions (Morse 2010; Oláh & Johanson 2010; Malicky 2011; Oláh & Malicky 2011).

In Japan, three taxonomic problems remained: (1) only the larval stage of *A. kawamurai* (Iwata 1927) was described, *i. e*., (i) Kawamura (1918) very briefly described a larva of '*Phryganea* sp.' with figures of lateral aspect of larva and ventral aspect of its case from Kizaki-ko, Nagano, Honshu, (ii) Iwata (1927a) named the larva of '*Phryganea* sp.' as '*Kizakia kawamurai* n. sp.' (Molannidae)' with brief description and reference to Kawamura (1918), (iii) Ulmer (1951) synonymized '*Kizakia*' under *Anisocentropus*; (2) males of '*A. kawamurai*' from Hokkaido (Oláh & Johanson 2010) were identified without an accurate basis for the association; and (3) unidentified *Anisocentropus* larvae with peculiar characters have been obtained on the Nansei Islands, a southernmost region of Japan (Tanida 1997, 2003).

To solve these taxonomic problems, we first redescribe and resurrect *A. kawamurai* (Iwata 1927). We could not find the larval type specimens of this species in the Iwata Collection at The Kyoto University Museum. However, since Kawamura's (1918) figures clearly indicate characteristic color patterns on the head and thoracic legs of the larvae, we obtained larval specimens which match Iwata's description of *A. kawamurai* from collections throughout Japan. We used these specimens to provide a redescription of the *A. kawamurai* larva. We also provide descriptions of adults obtained by rearing the larvae at 5 localities including the type locality.

Second, we describe or redescribe adults and immature stages of 2 other species discovered in the course of studies on *A. kawamurai* in Japan; one from Hokkaido and Honshu, and another from the Nansei Islands.

Third, we compare *A. kawamurai* with *A. minutus* (Martynov, 1930), known from southeastern Asia, and propose a new synonym. We also summarize and briefly discuss the distribution and biology of these 3 species.

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Material and methods

Association of adults and immature stages was established by rearing larvae to adults. Male and female genitalia were figured after treatment in dilute KOH. Morphological terms mainly follow Neboiss (1980) and Oláh and Johanson (2010) for adults, Wiggins and Currie (2008) for pupae, and Wiggins (1996) for larvae. Subgenus is derived from Oláh and Johanson (2010). Unless otherwise indicated in parentheses, specimens are preserved in 70–80% ethyl alcohol and deposited in the collection of the first author. The collecting methods, collectors and depositories are abbreviated as follows: light trap (L), Malaise trap (M), pan trap with light (P), sweep net (S), A. Ohkawa (AO), K. Inazu (KI), K. Tojo (KT), N. Kuhara (NK), N. Shimura (NS), R.B. Kuranishi (RBK), T. Ito (TI), T. Nozaki (TN), Y. Hayashi (YH).

Species description

Anisocentropus (*Anisocentropus*) *kawamurai* (Iwata 1927)

(Figs. 1–5, 8, 9)

Phryganea sp. Kawamura 1918, 302, fig. 400, larva, case, Japan (Honshu, Nagano). Mentioned by Iwata, 1927a.

Kizakia kawamurai Iwata 1927a, 241–242, table 10, larva, case, Japan (Honshu, Nagano) (Molannidae); Iwata, 1927b, 211, 217, larva, Japan (Honshu, Nagano).

Anisocentropus kawamurai: Ulmer 1951, 345.

Ganonema minuta Martynov 1930, 85–86, figs. 3032, China (Hainan). **New synonym**.

Anisocentropus minutus: Malicky 1994, 69–70, fig. 4, male wings, Thailand, Myanmar; Yang *et al*. 2005, 450, China (Anhui, Jiangxi, Guangxi, Guizhou); Malicky 2010, 330, male, Thailand, Vietnam.

Anisocentropus kawamurai: Inazu & Ishida 2011, 210, female, larva, case, Japan (Honshu).

Anisocentropus sp.: Maruyama & Takai 2000, 122–123, 125, photo. 239, fig. 236, larva, case, Japan (Honshu); Nozaki 2005, 112, adult, larva, case, Japan (Honshu); Hayashi *et al*. 2009, 41–47, abundance and case material selection of larvae, Japan (Kyushu).

Adult (Figs. 1, 2, 8A). Preserved specimens brown, abdomen orange in fresh specimens (within a few weeks after death); length 7.0–8.0 mm in male and 7.5–10.0 mm in female. Head (Fig. 1A) with large anteromesal setal wart, 2 pairs of small dorsal and dorsolateral warts, and pair of large posterolateral warts dorsally. Pronotum (Fig. 1A) with pair of large submesal warts and pair of small lateral warts. Mesoscutum (Fig. 1A) with longitudinal setal lines; mesoscutellum (Fig. 1A) with pair of small round warts. Maxillary palpi each 6-segmented, 3.0–4.0 mm long in total, all segments cylindrical and densely covered with short and long hairs. Labial palpi each 3-segmented, 1.0–1.5 mm long in total, all segments cylindrical and densely covered with short hairs. Antennae brown, 14–17 mm long, about 1.5 times as long as forewings; each with scape (Fig. 1A) short and round, pedicel (Fig. 1A) much shorter than scape.

Forewings (Figs. 1B, 2A, 8A) brown with some light spots in some male specimens, covered with fine brown hairs, fine hairs darker at posterior area in fresh specimens; male forewing length 8.5–11.5 mm, female 9.5–12.5 mm; rounded apically; apical forks 1, 2, 3, 4 and 5 present; discoidal, median and thyridial cells present; cross vein R1–R2 present in some specimens. Hind wings (Figs. 1B, 2A, 8A) grayish black; male hindwing length 6.0–8.0 mm, female 6.5–8.0 mm; round with broad costal area; apical forks 1, 2, 3 and 5 present; cells open; basal setal brush present in males. Spur formula 2, 4, 3.

Male genitalia (Fig. 1). Tergite and sternite of segment IX (Fig. 1C) fused laterally, lateral margins produced posteriorly into triangular lateral lobe. Median process of segment IX (Figs. 1C–F) somewhat compressed laterally, slender in dorsal view, thick with round or subacute apices in lateral view, with few very short setae. Roof-like plates of segment X (Figs. 1C, D, E, G) compressed dorsolaterally, subquadrate with apicomesal notch, apicolateral corners heavily sclerotized, more or less acute and directed ventrolaterad, with few short setae. Preanal appendages (Figs. 1C, D) compressed laterally, long oval in lateral view, rod-like in dorsal view, with many short and long setae laterally. Phallus (Figs. 1C, H) thick and short, subacute apically in lateral view, with U-shaped phallotremal sclerite. Inferior appendages (Figs. 1C, I) branchless, slender, gradually tapered distally with subacute apices, covered with many short and long setae.

Female genitalia (Fig. 2). Segment VIII (Figs. 2B, C) with subquadrate tergite and sternite, sternite with deep mesal cleft and many setae. Segment IX (Figs. 2B, C) somewhat depressed, tergite and sternite touching ventrolaterally; sternite semicircular with distinct middle cleft, and striated with gently curved streaks; tergite with small roundish or subtriangular protuberances near posterolateral apex and acute posteroventral end in ventral view (arrow in Fig. 2C). Segment X (Figs. 2B, C) fused with segment IX, covered with many setae. Vaginal sclerite (Figs. 2D, E) hexagonal with narrow proximal end in ventral view.

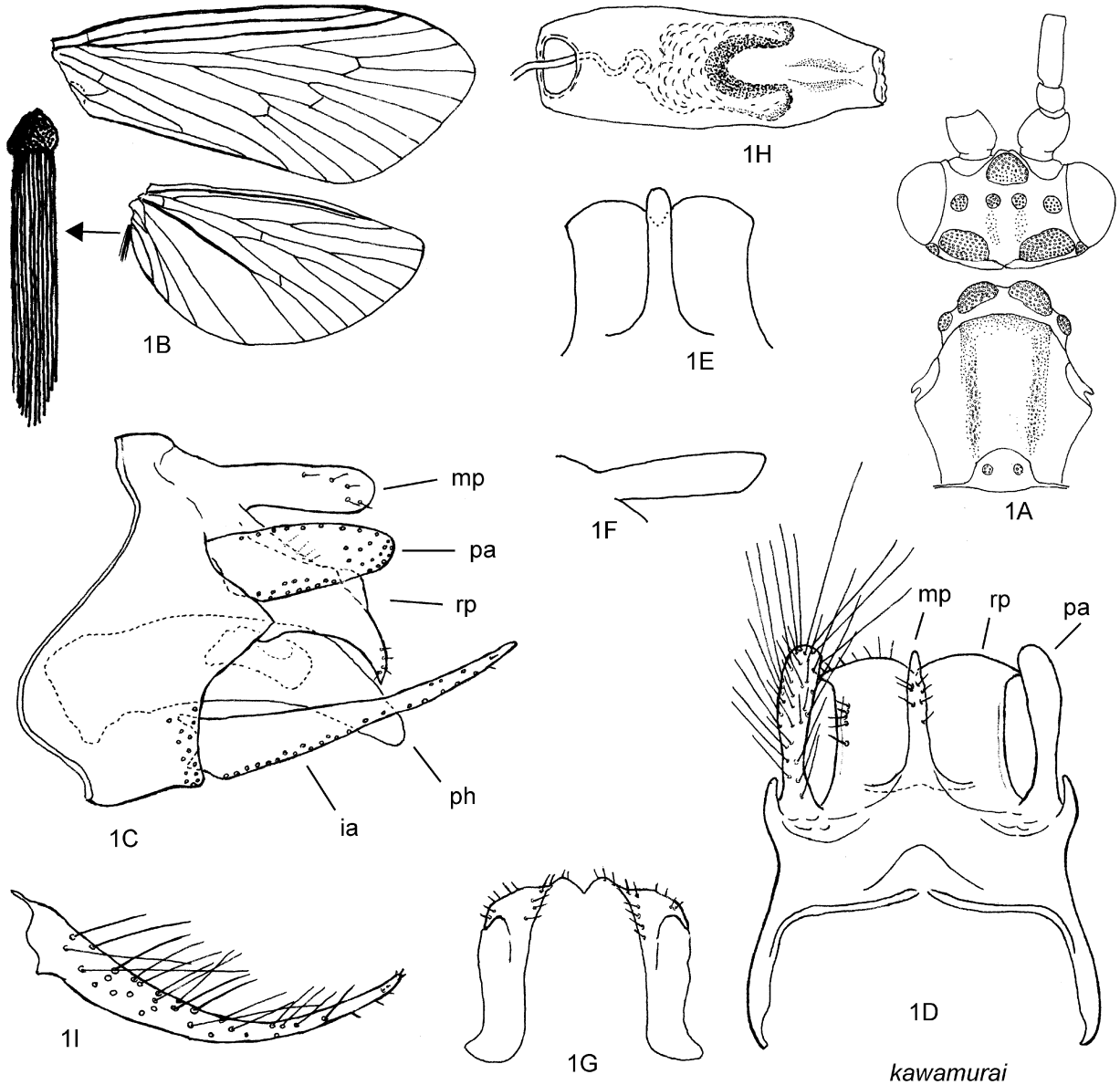

FIGURE 1. ***Anisocentropus* (*A.*) *kawamurai*** male. A, head and thorax, dorsal; B, right wings, dorsal; C, genitalia, left lateral; D, same, dorsal; E, median process and roof-like plate, variation, dorsal; F, median process, variation, left lateral; G, segment X, ventral; H, phallus, ventral; I, right inferior appendage, ventral. Abbreviations: ia, inferior appendage; mp, median process; pa, preanal appendage; ph, phallus; rp, roof-like plates.

Pupa (Fig. 2). Length up to 12 mm, strongly depressed. Mandibles (Fig. 2G) thin, long, about 5 times as long as basal width, gently curved mesad. Labrum (Fig. 2G) semimembranous, subtriangular, with several short setae at anterolateral margins and pair of short and pair of long setae near basolateral edges. Antennae (Figs. 2F, G) long, about 18 mm, each of ventrolateral and dorsal scape tufts composed of 4–6 long setae. Fore- and hindwing pads (Fig. 2F) reaching abdominal segments IV and V, respectively. Dense swimming setae (Fig. 2F) present on mesotarsus. Abdominal segment I (Fig. 2J) with spined ridges dorsoposteriorly. Paired anterior hook plates (Figs. 2F, H)

on dorsum of segments III–VII, each plate with 4–5 hooks; paired posterior hook plates (Figs. 2F, I) on dorsum of segment V, each with 6–7 hooks. Tracheal gills (Fig. 2F) 2–3- (mostly 3-) branched and arranged as in Table 1. Lateral fringe (Figs. 2F, K) extending on each side across segment II through segment VII and turning ventrad on segment VIII. Anal processes (Figs. 2K, L) slender, directed posterolaterad, subacute apically.

TABLE 1. Arrangement and number of branches of gills of *Anisocentropus* (*A.*) *kawamurai* pupae.

Segment	I	II	III	IV	V	VI	VII	VIII
Dorsal		3	3	3	3	3	3	
Lateral		3	3	3	3	3	2	2
Ventral		3	3	3	3	3	3	3

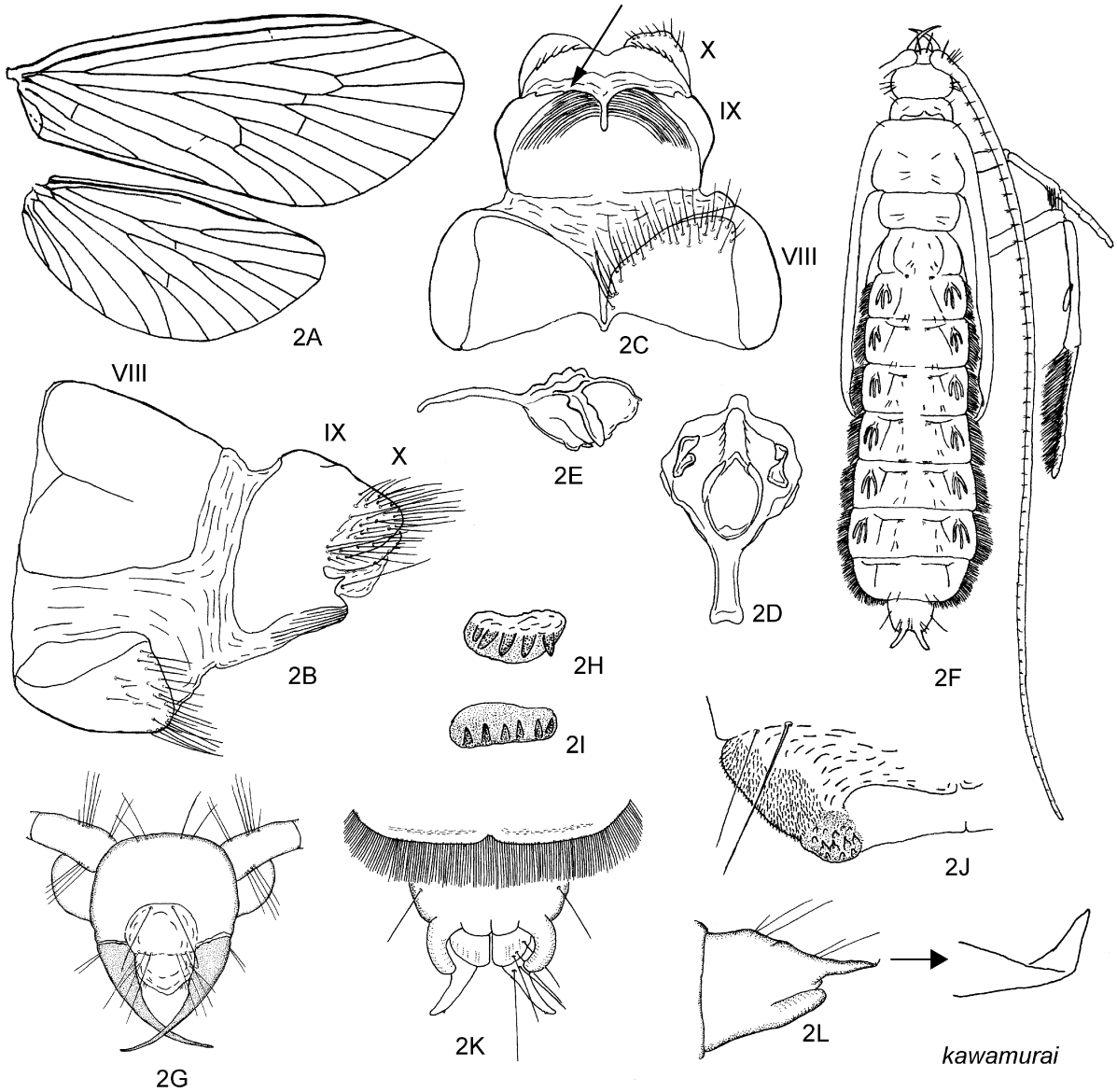

FIGURE 2. ***Anisocentropus* (*A.*) *kawamurai*** female and pupa. Female (A–E): A, right wings, dorsal; B, genitalia, left lateral; C, same, ventral (for explanation of arrow, see text); D, vaginal sclerite, ventral; E, same, left lateral. Pupa (F–L): F, dorsal; G, head, frontal; H, left anterior hook plate of segment V; I, left posterior hook plate of segment V; J, left spined ridge of segment I; K, anal processes, ventral; L, same, left lateral. Abbreviations: VIII to X, abdominal segments VIII to X.

Final instar larva (Figs. 3, 4). Length up to 15 mm. Thorax and abdomen strongly depressed. Head (Figs. 3A–C) slightly oblong, narrower anteriorly, head width 1.00–1.15 mm at cheeks; brown with light brown areas, varying

slightly individually, typical pattern of pale areas as follows: 3 pairs of small dots arranged longitudinally on anterior frontoclypeal apotome (often indistinct); large, round area at posterior of frontoclypeal apotome; large, U or V-shaped pattern along posterior of frontoclypeal suture and coronal suture; and several pairs of round or oblong areas at cheeks. Seta no. 14 longest among 18 primary setae, 9/10ths as long as head width; seta 9 second longest, 4/5ths as long as head width, setae 8 and 11 very short, other setae of various intermediate lengths; anterior ventral apotome small, triangular; posterior ventral apotome absent; cardo small, ellipsoidal. Antennae (Figs. 3A, C, D) short, situated about halfway between anterior edge of head capsule and eye spot. Mandibles (Fig. 3E) stout, with acute apices; few blunt teeth at anterior 1/3rd of dorsomesal and ventromesal edges; numerous long, jagged setae on dorsomesal edges. Labrum (Fig. 3F) with 18–24 stout setae across dorsum and numerous short, slender setae at anterior and anterolateral margins.

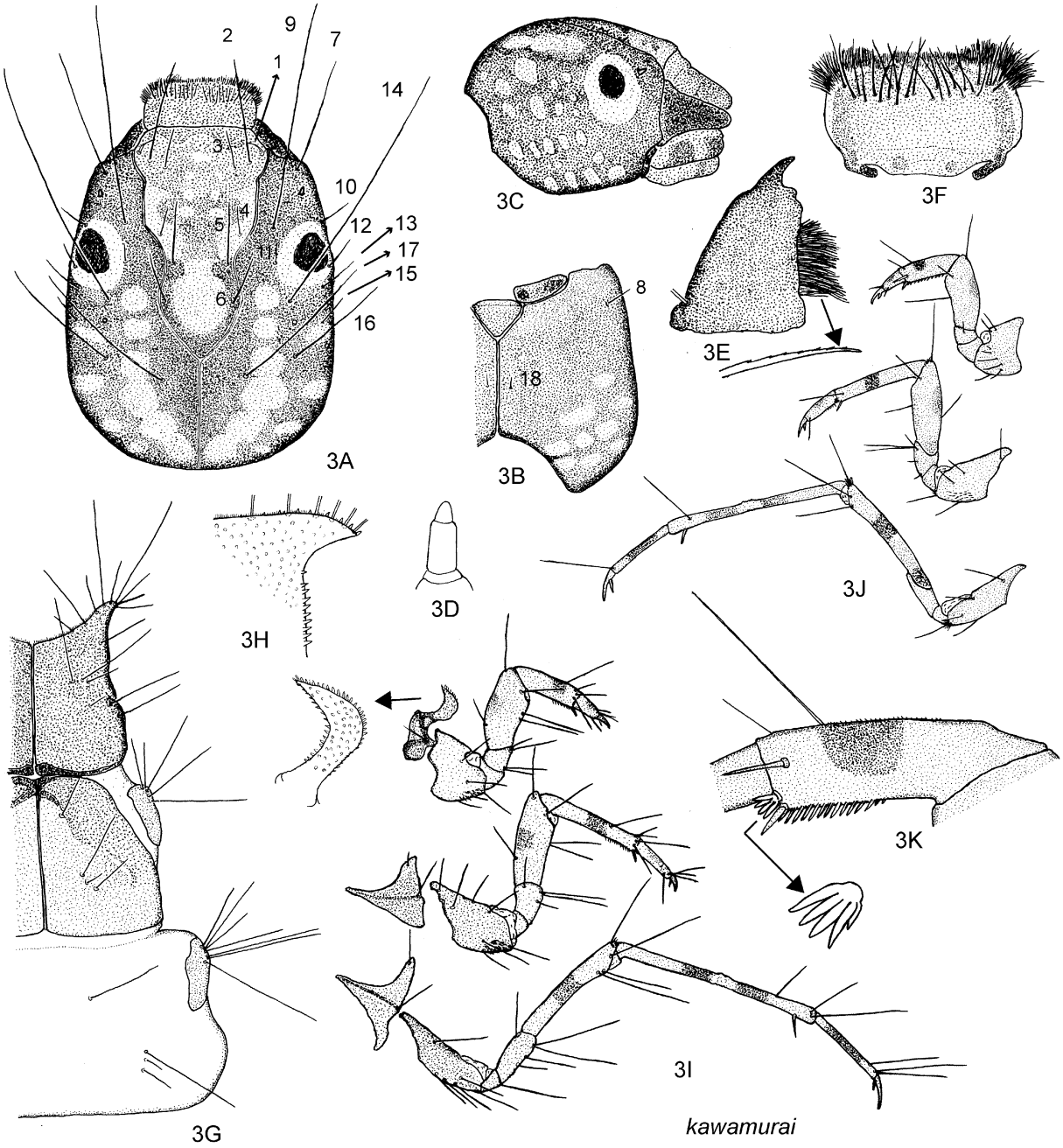

FIGURE 3. ***Anisocentropus* (*A.*) *kawamurai*** larva. A, head, dorsal, primary setae numbered; B, same, ventral; C, same, right lateral (setae not illustrated); D, antenna, dorsal; E, left mandible, dorsal; F, labrum, dorsal; G, thorax, right half, dorsal; H, anterolateral edge of pronotum, ventral; I, right pleura and thoracic legs, dorsal; J, right thoracic legs, ventral; K, right foretibia, ventral.

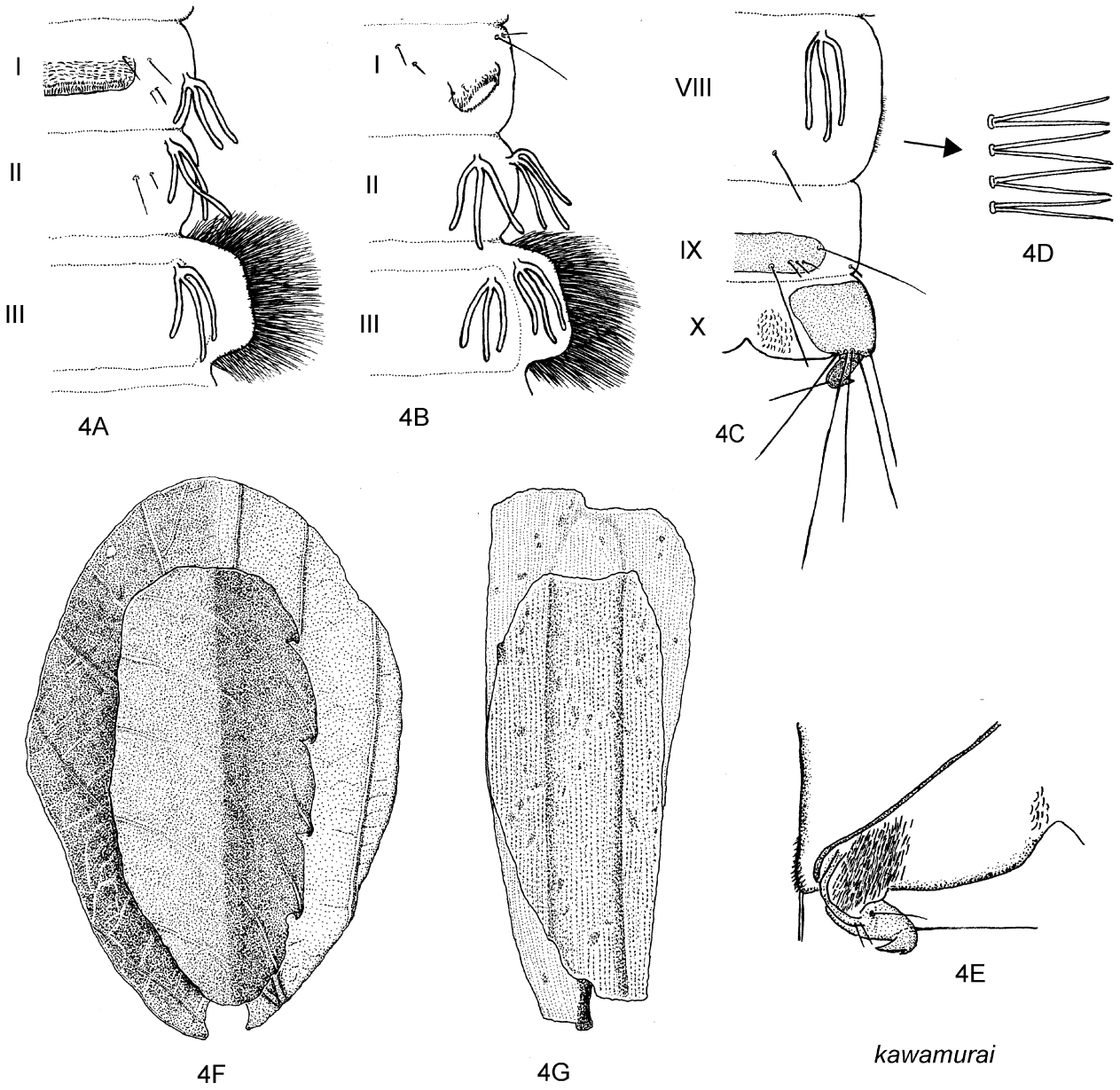

FIGURE 4. ***Anisocentropus* (*A.*) *kawamurai*** larva and case. Larva (A–E): A, right side of abdominal segments I–III, dorsal; B, left side of same, ventral; C, right side of abdominal segments VIII–X, dorsal; D, forked lamellae; E, right anal leg, ventral. Case (F, G): F, ovate case, ventral; G, rectangular case, ventral. Abbreviations: I to X, abdominal segments I to X.

Pronotum (Fig. 3G) brown with dark brown posterior edges; extended anterolaterally to subacute apices; number of setae 0, 5–6, 11–12 at setal area (*sa*) 1, *sa* 2 and *sa* 3, respectively; about 10 short spines in row at anterior 1/3rd of lateral margin and several very short spines near anterolateral margins (Fig. 3H); numerous round spines scattered on mesal surface near anterolateral corners (Fig. 3H). Mesonotum (Fig. 3G) covered with large trapezoidal and small ellipsoidal sclerites (*sa* 3), light brown with brown anterolateral area, number of setae 1, 3, 6–8 at *sa* 1, *sa* 2 and *sa* 3, respectively. Metanotum (Fig. 3G) membranous with small ellipsoidal sclerites (*sa* 3) at anterolateral corners, number of setae 1, 3, 7 at *sa* 1, *sa* 2 and *sa* 3, respectively. Foretrochantin (Fig. 3I) hooked anteriorly, mid- and hind pleura (Fig. 3H) triangular. Forelegs (Figs. 3I, J) shortest, each light brown with dark areas on anterior surfaces of femur, tibia and tarsus, dark areas on femur and tarsus sometimes indistinct; ventral surface of coxa with numerous fine, round spinules on anterior half and with fine, comb-like spines near posterior margin; tibia (Fig. 3K) with small spines along 2/3rds of posterior margin and with 2–5 (mostly 4–5) branched, fan-like spines at

apicoposterior edges. Middle legs (Figs. 3I, J) each light brown with dark areas on anterior surfaces of femur, tibia and tarsus, dark areas on femur and tarsus sometimes indistinct; coxa with numerous fine, comb-like spines near posterior margin; tibia with 4–5 branched, fan-like spines at apicoposterior angles. Hind legs (Figs. 3I, J) about 2.5 times as long as forelegs, each with tibia secondarily subdivided; light brown with dark band-like areas at middle of femur, basal and apical halves of tibia and tarsus; dark areas on tarsus sometimes indistinct; short dark area also present on ventral surface of femur base (Fig. 3J); numerous very fine comb-like setae scattered along ventral surface of femur.

Abdominal segments I and II (Figs. 4A–C) narrower than segments III–VIII; dorsal hump (Fig. 4A) low, with wide rectangular dorsal plate; lateral humps (Fig. 4B) displaced ventrally with large sucker-like, setal arrangement. Two- or 3- (mostly 3-) branched tracheal gills (Figs. 4 A–C) arranged as in Table 2. Lateral fringes (Figs. 4A, B) composed of long, dense setae on segments III–VII, these setae 1/4th as long as segment width. Short, forked lamellae (Figs. 4C, D) on lateral margins of posterior half of segment VIII. Dorsal sclerite of segment IX (Fig. 4C) broadly rectangular, weakly sclerotized, with pairs of 2 long and 3 short setae. Anal prolegs (Figs. 4C, E) each with large, subquadrate lateral sclerite; basal tuft of 5 stout, dark setae, and numerous very slender setae near ventrolateral edge; anal claw (Fig. 4E) with fine accessory hook.

TABLE 2. Arrangement and number of branches of gills of *Anisocentropus* (*A.*) *kawamurai* larvae.

Segment	I	II	III	IV	V	VI	VII	VIII
Dorsal	3	3	3	3	3	3	3	2–3
Lateral		3	3	3	3	3	2	2
Ventral		3	3	3	3	3	3	3

Case (Figs. 4F, G). Larval case made of 2 ovate (Fig. 4F) to rectangular (Fig. 4G) pieces of leaves. Larger piece forming dorsal shield over smaller ventral piece. Usually posterior end of dorsal piece with mesal, semicircular or U-shaped excision. Length and width up to 30 mm and 20 mm, respectively.

Specimens examined. **JAPAN. Hokkaido**: Bibai-shi, Koshunai, Hokkaido Forestry Research Institute, small stream, 1.viii.2011, Y. Nagasaka (larvae), reared and emerged (or simply preserved) during viii–ix.2011 by TI, 1 male, 4 females, 2 larvae; Sapporo-shi, Hitsujigaoka, National Agricultural Research Center, small stream, 29.vi–6.vii.2010, K. Konishi, M, 1 male; Eniwa-shi, Ichankoppe-zawa, 300 m above sea level, 11–28.viii.2010, TI, L, 1 female; Eniwa-shi, Izari-gawa, Suisei-bashi, 2.viii.2010, TI, L, 1 female; Eniwa-shi, Izari-gawa, Eniwa-ohashi, 9–15.vii.2005, TI, L, 1 female; Chitose-shi, Rankoshi, Chitose-gawa, 25.viii.1994 (pupa), reared and emerged in viii.1994, NK (NK), 1 male. **Honshu**. **Nagano**: Kizaki-ko (type locality of *A. kawamurai*), 15.iv.2011 (larvae), KT and RBK, reared and emerged (or preserved) in v–vi.2011 by TI, 3 males, 1 female, 5 pupae, 7 larvae (2 males pinned, others in alcohol); Nakatsuna-ko, 27.ix.1990, NK (NK), 2 males, 1 female; ibid., 28.viii.2008, N. Katsuma, L, 1 female; ibid., 15.iv.2011 (larvae), KT and RBK, reared and emerged (or preserved) in v–vi.2011 by TI, 7 males, 1 female, 6 pupae, 10 larvae (5 males pinned, others in alcohol). **Ibaraki**: Shirosato-cho, Fujii-gawa, Damushita, 21.viii.2010, N. Katsuma, L, 1 male. **Chiba**: Kimitsu-shi, Satsugo, Obitsu-gawa, 31.x.1986, TN (TN), 3 larvae. **Aichi**: Seto-shi, Yoshino-cho, Kaisho-no-mori, pond, 4.iv.2011, TN (TN), 3 larvae. **Shiga**: Otsu-shi, Sakamoto-cho, Harihata-gawa, 18.vi.2003, TN (TN), 1 larva. **Osaka**: Kaizuka-shi, Kotsumi, Akiyama-gawa, 17.iv.2011, T. Fujitani, 1 larva. **Hyogo**: Asago-shi, Wadayama-cho, Ishibe-jinja, 25.ix.2008, KI, 1 female; ibid., 20.v.2009, KI, 1 female; ibid., 21.vi.2010, KI, 1 larva; Haga-cho, Hara, Hachijo-gawa, Fudo-no-taki, 8.viii.2001, AO, 1 larva; Yamasaki-cho, Ibo-gawa, Michi-no-eki, 8.viii.2001, AO, 1 female. **Shimane**: Ota-shi, Sanbe, Ukinuno-no-ike, 5.viii.2001, AO, 1 pupa, 1 larva. **Shikoku**. **Tokushima**: Miyoshi-shi, Awayama, 15.ix.2006, NK (NK), P, 1 female. **Ehime**: Uchiko-machi, Odamiyama, Namakusa-dani, 10.v.1999, E. Yamamoto, 5 larvae. **Kochi**: Shimanto-shi, Enomura, 26.iv.2003, M. Takai (TN), 1 male, 1 female; Tosa-shimizu-shi, Ashizuri, Tsuro, 16.x.2004, M. Takai (TN), 2 males, 1 female. **Kyushu**. **Nagasaki**, **Tsushima**: Tsushima-shi, Hikage, 19.ix.2000, H. Moriya, 2 males, 3 females; Tsushima-shi, Sago-gawa, Oiwa-bashi, 3.ix.1987, TI, 2 larvae; Tsushima-shi, Niigawa, Nakasato-bashi, 4.ix.1987, TI, 2 larvae. **Miyazaki**: Aya-cho, Kawanaka, Aya-minami-gawa, tributary, 16.vi.2007, YH, 1 larva; ibid., 28.vii–29.viii.2008, YH, 13 larvae; ibid., 28.iii.2009, YH, 3 pupal exuviae; ibid., 20.iv.2009 (larvae), reared and emerged on 7–16.v.2009, YH, 3 males, 7 females. **Okinawa**. **Yonaguni-jima**: Dunan-dagi, 9.iv.2008, NS, 1 larva; Akazaki, 10.iv.2011, NS, 1 larva; ibid., 10.iv.2011 (larvae), reared and emerged on 1–15.v.2011, NS (NS), 1 male, 3 females.

TAIWAN. Taoyuan, Gauyaw, 380 m, 25.iv.1996, L. J. Wang, 1 male.

THAILAND. Kao Soi Doo National Park, 400 m, 23.iv.1996, H. Malicky and P. Chantaramongkol, 1 male.

Remarks. The larva of this species was briefly described by Iwata (1927a) as follows (translated from Japanese): "The larva has a dark head with many small light areas, anterolaterally extended pronotum, long tibia of hind leg with two dark band-like areas, 3-branched gills on dorsum of abdominal segment I and ventral, dorsal and lateral rows on segments II–VIII, and flat case of two leaf pieces." Iwata (1927a) had examined Kawamura's (1918) *Phryganea* sp. specimens and included Kawamura's (1918) figure (fig. 400) which was described from Kizaki-ko, Nagano, Honshu, Japan. Iwata (1927a) also synomymized Kawamura's (1918) *Phryganea* sp. The first author (Tomiko Ito) searched for the Iwata type specimen in the Iwata Collection at the Kyoto University Museum on March 8, 2011 and found a vial labeled "no. In 252 1-2, *Kizakia kawamurai* Iwata, Shinshu, Kizaki-ko, 18.VIII.1917, Iwata?" However, the enclosed larva and the case were not in accord with the Kawamura (1918) figure and Iwata (1927a)'s description; the larva found in the vial had longitudinal, V-shaped dark areas on the head, round anterolateral corners of the pronotum, short hind tibiae and a flat case of sand grains. The specimen labeled as *Kizakia kawamurai* Iwata was not chosen by Masatoshi Iwata in the 1920's but extracted from the Iwata Collection by Narita *et al*. (2001) in 1992–1994 probably based on the collecting locality and the date. Therefore, we conclude that Narita *et al*. (2001) incorrectly chose the specimen and labeled it *Kizakia kawamurai*. Throughout this work, we could not find any specimens that agree with the description by Kawamura (1918) and Iwata (1927a) in the Iwata Collection. We do not know of a separate Kawamura Collection and suspect it has been subsumed into the Iwata Collection. Thus, the type specimen studied by Kawamura (1918) and Iwata (1927a) has probably been lost.

However, the larva figured by Kawamura (1918, fig. 400) has a dark head with small light areas and dark band-like areas on the basal and distal halves of the hind tibia, which are diagnostic characters for larvae of *A* . (*A.*) *kawamurai* as discussed below. Since larvae with the characteristic patterns were collected from many localities including the type locality, we have redescribed the larval stage of *A* . (*A.*) *kawamurai* based on them. The adults of *A* . (*A.*) *kawamurai* reared from the larvae that show characteristics described in the figure of Kawamura (1918) and the description of Iwata (1927a) are described here for the first time, although Inazu and Ishida (2011) showed photographs of females which were collected together with the larvae at the same site.

The male of this species is quite similar to that of *A.* (*A.*) *pallidus* (Martynov 1935), known from continental parts of the Russian Far East, in having roof-like plates of segment X; long oval preanal appendages; a thick, short phallus and slender branchless inferior appendages. However, *A.* (*A.*) *kawamurai* is clearly distinguished from the latter as follows: In *A.* (*A.*) *kawamurai* the median process of segment IX is thick in lateral view in the male (Figs. 1C, F); the posterolateral apices of tergite IX are acute in the female (Fig. 2C, arrow); and in the larva, the head is brown with light markings (Figs. 3 A–C) and the basal and distal halves of the hind tibiae have dark band-like areas (Figs. 3I, J). In *A.* (*A.*) *pallidus*, on the other hand, the male median process of segment IX is slender in lateral view (Fig. 6B); the female posterolateral ends of tergite IX are truncate (Fig. 6I, arrow); and the larva has a pale brown head with small dark dots (Figs. 6L, M) and dark band-like areas on the distal halves of hind tibiae are absent (Fig. 6N).

Ganonema minutus Martynov 1930, originally described from southeastern China and also recorded in Vietnam, Thailand and Myanmar (Malicky 2010, Yang *et al*. 2005), is synonymized here with *A.* (*A.*) *kawamurai* based on examination of specimens, including the holotype of *Ganonema minutus* Martynov 1930 (Fig. 5; China, Hainan, June, 1904, deposited in British Museum of Natural History, London; illustrated by H. Malicky). The male genitalia of the holotype of *G. minutus* (Fig. 5) are almost identical to those of Japanese specimens of *A.* (*A.*) *kawamurai* in having a thick median process of segment IX; roof-like plates of segment X with acute apices; a thick short phallus and slender branchless inferior appendages in lateral view (Fig. 1). While roof-like plates of segment X in dorsal view are somewhat different between the holotype of *G. minutus* and other Japanese and Asian specimens, the plates are slightly variable within the species (compare Figs. 1D, E with Malicky 2010, p. 330, fig. 5A).

Several authors have described *Anisocentropus* larvae under the name of *A. immunis* or *A.* sp. in Japan. The larvae described by Maruyama and Takai (2000) and Nozaki (2005) under the name of *A.* sp. are certainly those of *A.* (*A*). *kawamurai*, because their head (dark with many light areas) and thoracic legs (with dark areas on distal and basal halves of hind tibiae) are distinctly coincided with diagnostic characters of this species discussed above.

However, identification is impossible at species taxonomic level in other references. The species name of the larva of so-called "*A. immunis*" described from Honshu by Tsuda (1943) is unclear because (1) he collected the

specimens from some ponds including Midoro-ga-ike, Kyoto, where *A.(A.) pallidus* lives (see the list of *A. (A.) pallidus* localities below), (2) his description of the head ("many small dark dots are present on the brown head"; translation from Japanese) suggests that it would be the larva of *A.(A.) pallidus*, but (3) his figures of the head (dark head with many light areas) and hind tibia (with somewhat indistinct dark areas on distal and basal halves) suggest it would be *A.(A.) kawamurai*. Therefore, we presume that Tsuda (1943) may have mixed the larval characters of the 2 species. The larvae of *A. immunis* described by Tsuda (1959) and Tsuda and Akagi (1962) also could not be identified to species since they used the same figures firstly provided by Tsuda (1943).

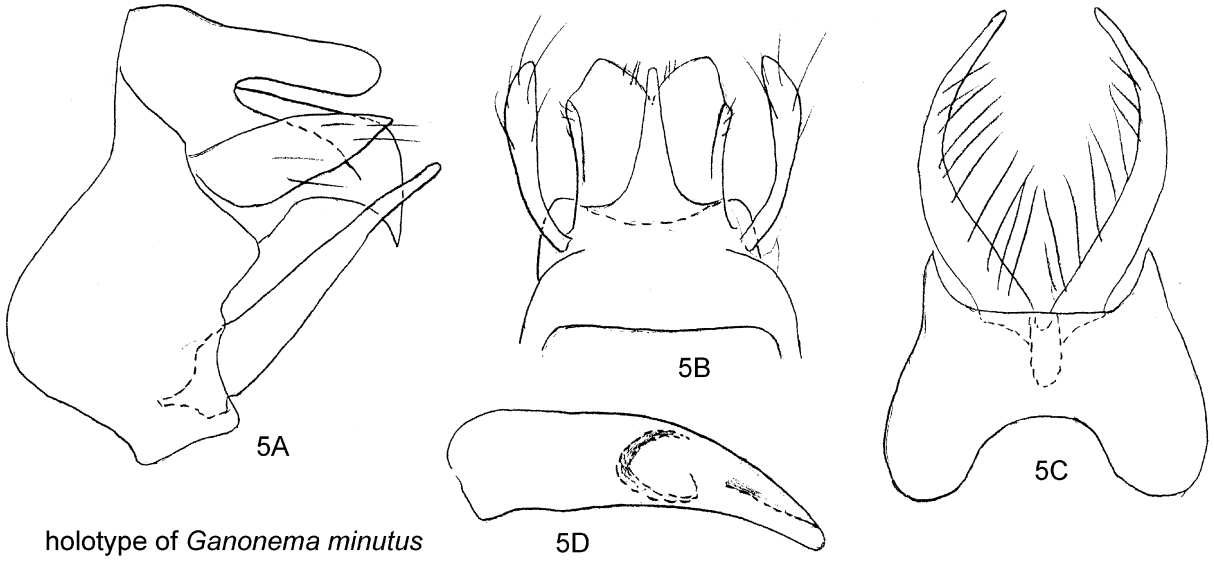

FIGURE 5. ***Anisocentropus* (*A.*) *kawamurai***. Holotype of *Ganonema minutus* Martynov 1930 (illustrated by H. Malicky). A, male genitalia, left lateral; B, same, dorsal; C, same, ventral; D, phallus, left lateral.

Tanida (1985) and Tanida (2005) described the larva with the sane dorsal aspect of the anterior part of the larva (head, thorax and abdominal segment I), without thoracic legs, under the name of "*A. immunis*" and "*A.* sp.", respectively. Specific identification of this larva is difficult due to the ambiguous color pattern of the head (the pattern of the frontoclypeal apotome is similar to that of *A.* (*A*). *kawamurai* but the patterns of other parts are like those of *A.* (*A*).*pallidus*). The adult, pupa and larva of "*A.* sp." photographed by Tanida *et al*. (1991) also could not be identified to species because no diagnostic characters are shown.

Distribution (Fig. 9). Japan (Hokkaido, Honshu, Shikoku, Kyushu, Tsushima, Yonaguni-jima), Taiwan, southeastern China (Hainan, Anhui, Jiangxi, Guangxi, Guizhou), Vietnam, Thailand, Myanmar.

Japanese name. Koban-tobikera.

Anisocentropus (*Anisocentropus*) *pallidus* (Martynov 1935)

(Figs. 6, 8, 9)

Ganonema pallidum Martynov 1935, 214–217, figs. 8–11, male, Russian Far East (Amur).

Anisocentropus pallidus: Lepneva 1971, 501–506, figs. 656–661, larva, case, Russian Far East (Primorye); Arefina & Levanidova 1997, 153, figs. 9–11, male, Russian Far East (Khabarovsk, Primorye).

Anisocentropus immunis: Ulmer 1907, 53–54, figs. 80–82, Japan (unknown locality). Misidentification.

Anisocentropus (*Anisocentropus*) *kawamurai*: Oláh & Johanson 2010, 16–18, figs. 17–21, male, Japan (Hokkaido). Misidentification.

Anisocentropus sp. 1: Kuhara *et al*. 2000, 249–250, Japan (Hokkaido).

Anisocentropus sp.: Ito *et al*. 2010, 65, 77, 85, Japan (Hokkaido).

Adult (Figs. 6, 8B). Brown, abdomen orange in fresh specimens, length 6.0–10.0 mm in male and about 8 mm in female. Warts on head and thorax, maxillary palpi, labial palpi and antennae as in *A.* (*A.*) *kawamurai*.

Forewings (Figs. 6A, 8B) brown covered with fine brown hairs, each with fine hairs darker at posterior area in fresh specimens; 9.0–11.5 mm long in male and 9.5–12.5 mm long in female. Hindwings (Figs. 6A, 8B) brown in preserved specimens, grayish black in fresh specimens, 6.0–8.0 mm long in male and 6.5–8.0 mm long in female; other characters as in *A.* (*A.*) *kawamurai*.

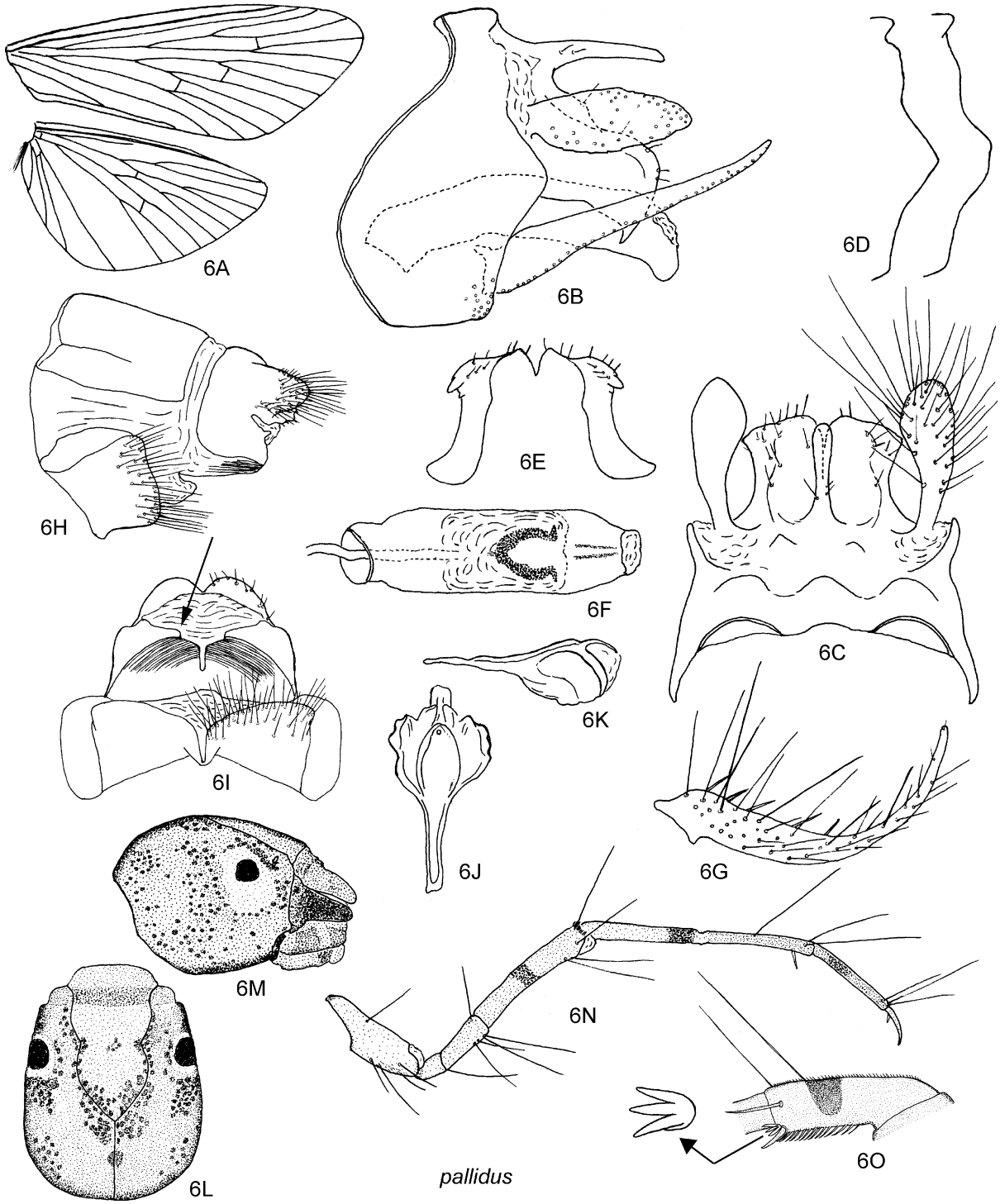

FIGURE 6. ***Anisocentropus* (*A.*) *pallidus*** male, female and larva. Male (A–G): A, right wings, dorsal; B, genitalia, left lateral; C, same, dorsal; D, 2 variations of posterior margin of segment IX, left lateral; E, segment X, ventral; F, phallus, ventral; G, right inferior appendage, ventral. Female (H–K): H, genitalia, left lateral; I, same, ventral (for explanation of arrow, see text); J, vaginal sclerite, ventral; K, same, left lateral. Larva (L–O): L, head, dorsal (setae not illustrated); M, same, right lateral (setae not illustrated); N, right hind leg, dorsal; O, right hind tibia, ventral.

Male genitalia (Fig. 6). Tergite and sternite of segment IX (Fig. 6B) fused laterally; lateral margins produced posteriorly into somewhat triangular lateral lobe on each side; lateral lobe acute or subquadrate in some specimens (Fig. 6D). Median process of segment IX slender in dorsal and lateral views, with few very short setae. Roof-like plates of segment X compressed somewhat dorsolaterally with mesal notch and few short setae; posterolateral margins acute, heavily sclerotized and directed slightly ventrad (Fig. 6E). Preanal appendages (Figs. 6B, C) compressed laterally, long oval, with subacute apices in lateral view, rod-like in dorsal view, with many short and long setae laterally. Phallus (Figs. 6B, F) thick and short, with U-shaped phallotremal sclerite. Inferior appendages (Figs. 6B, G) branchless, slender, gradually tapered distally with subacute apices, covered with many short and long setae.

Female genitalia (Fig. 6). Segment VIII (Figs. 6H, I) with subquadrate tergite and sternite, sternite with deep mesal cleft and many setae. Segment IX (Figs. 6H, I) somewhat depressed; tergite and sternite touching each other ventrolaterally; sternite semicircular with distinct medial slit and many gently curved striations; tergite with small, roundish or subtriangular protuberance along each posterolateral margin, posteroventral margins truncate in ventral view (Fig. 6I, arrow). Segment X (Figs. 6H, I) fused with segment IX, covered with many setae. Vaginal sclerite (Figs. 6K, J) sub-hexagonal with narrow proximal end in ventral view.

Pupa. Length up to 12 mm. Number of hooks of each anterior hook plate 2–4 (mostly 4), and that of each posterior hook plate 5–6. Other characters as in *A.* (*A.*) *kawamurai.*

Final instar larva (Fig. 6). Length up to 17 mm. Head (Figs. 6L, M) slightly oblong, width 1.05–1.15 mm at cheeks; pale brown with small dark dots primarily along sutures and behind eye spots (Figs. 6L, M). Hind legs (Fig. 6N) light brown with dark bands on each femur, basal half of tibia, and sometimes on tarsus, but not on apical half of tibia. Other characters as in *A.* (*A.*) *kawamurai*.

Case. Similar to *A.* (*A.*) *kawamurai*.

Specimens examined. **JAPAN**. **Hokkaido**: Sarufutsu-mura, Kamuito-numa, 8.vii.2005, M. Nakatani, 2 males; ibid., 31.vii.2007, TI, S, 1 male; Chitose-shi, Bibi-gawa, Chitose-ko, 29.iii.1992, TI, 1 larva; ibid., 26.vii.2007, TI, S, 8 males, 2 females; 20.ix.2010, TI, 20 larvae; ibid., 8.vi–27.vii.2011, TI, S, 9 males, 11 females; ibid., 12.v–15.vi.2011 (larvae), reared and emerged (or preserved) in vi–vii.2011, TI, 10 males, 21 females, 1 pupa (5 males pinned, others in alcohol). Tomakomai-shi, Bibi-gawa, Uenae-bashi, 15.x.1977, T. Hattori, 2 larvae; ibid., 22.vii.2001, TI and AO, L, 1 female; ibid., 3.viii.2007, TI, 1 male, 1 female; Tomakomai-shi, Hakucho-ko, 19.vi.1988, TI, 4 pupae, 4 larvae; ibid., 19.vi.1999 (pupae), reared and emerged in vi.1999, TI, 2 males, 1 female; Atsuma-cho, Ueno, Matsuno-numa, 28.vii.2006, NK (NK), P, 3 males; ibid., 15.ix.2006, NK (NK), P, 1 female; Nanae-cho, Onuma, Tsukimi-bashi and Konuma-hokugan, 23.vi.2003, TI *et al*., S and L, 3 males. **Honshu**. **Miyagi**: Onoda-cho, Arasawa-shitsugen, 6.x.2001, TN (TN), 1 larva. **Kyoto**: Midoroga-ike, 30.iv.1980 (larvae), reared and emerged in v.1980, TI, 2 males, 1 female. **Okayama**: Saeki-cho, Taga, pond, 9.iv.1997, TN (TN), 1 larva; Saeki-cho, Taga, Nature Conservation Center, Heisei-ike, 9.iv.1997, AO, 1 larva. **Hiroshima**: Kozan-cho, Otani-gawa, Hattabara Dam, 23.v.2000, S. Nakamura (TN), 1 male, 1 female.

Remarks. This species is very similar to *A.* (*A.*) *kawamurai*, but is clearly distinguished from the latter as in the remarks for *A.* (*A.*) *kawamurai*. Males illustrated by Ulmer (1907), under the name of *A. immunis* McLachlan 1863, from an unknown Japanese locality, and by Oláh and Johanson (2010, figs. 17–21) under the name of *A.* (*A.*) *kawamurai* from Hokkaido, Japan, are undoubtedly *A.* (*A.*) *pallidus* based on the slender lateral aspect of the median process of segment IX. The unknown female and pupa of this species are described here.

Distribution (Fig. 9). Japan (Hokkaido, Honshu), Russian Far East (Khabarovsk, Primorye).

Japanese name. Usuiro-koban-tobikera (newly given here).

Anisocentropus (*Anisocentropus*) *magnificus* Ulmer 1907

(Figs. 7–9)

Anisocentropus magnificus Ulmer 1907, 54–56, figs. 83–85, pl. 2, male, Philippines; Oláh & Johanson 2010, 29–30, figs. 53–57, male, as *A.* (*A.*) *magnificus*, Philippines.

? *Anisocentropus* sp.: Tanida 1997, 449, Yaeyama Islands; Tanida 2003, 373, Iriomote-jima.

Adult (Figs. 7, 8C). Preserved specimens brown, abdomen bright orange in fresh specimens. Body length 6.0–7.0 mm in male and 6.5–10.0 mm in female. Head with large anteromesal wart and pair of large posterolateral warts

dorsally; pair of small dorsal and dorsolateral warts indistinct, with only scattered setae in few specimens. Maxillary palpi each 6-segmented, 3.0–4.0 mm long in total, all segments cylindrical and densely covered with long, black hairs. Labial palpi each 3-segmented, about 1 mm in total, all segments cylindrical and densely covered with short, light brown hairs. Antennae brown with black joints, about 15 mm long; scape short and round, pedicel much shorter than scape. Other characters as in *A.* (*A.*) *kawamurai*.

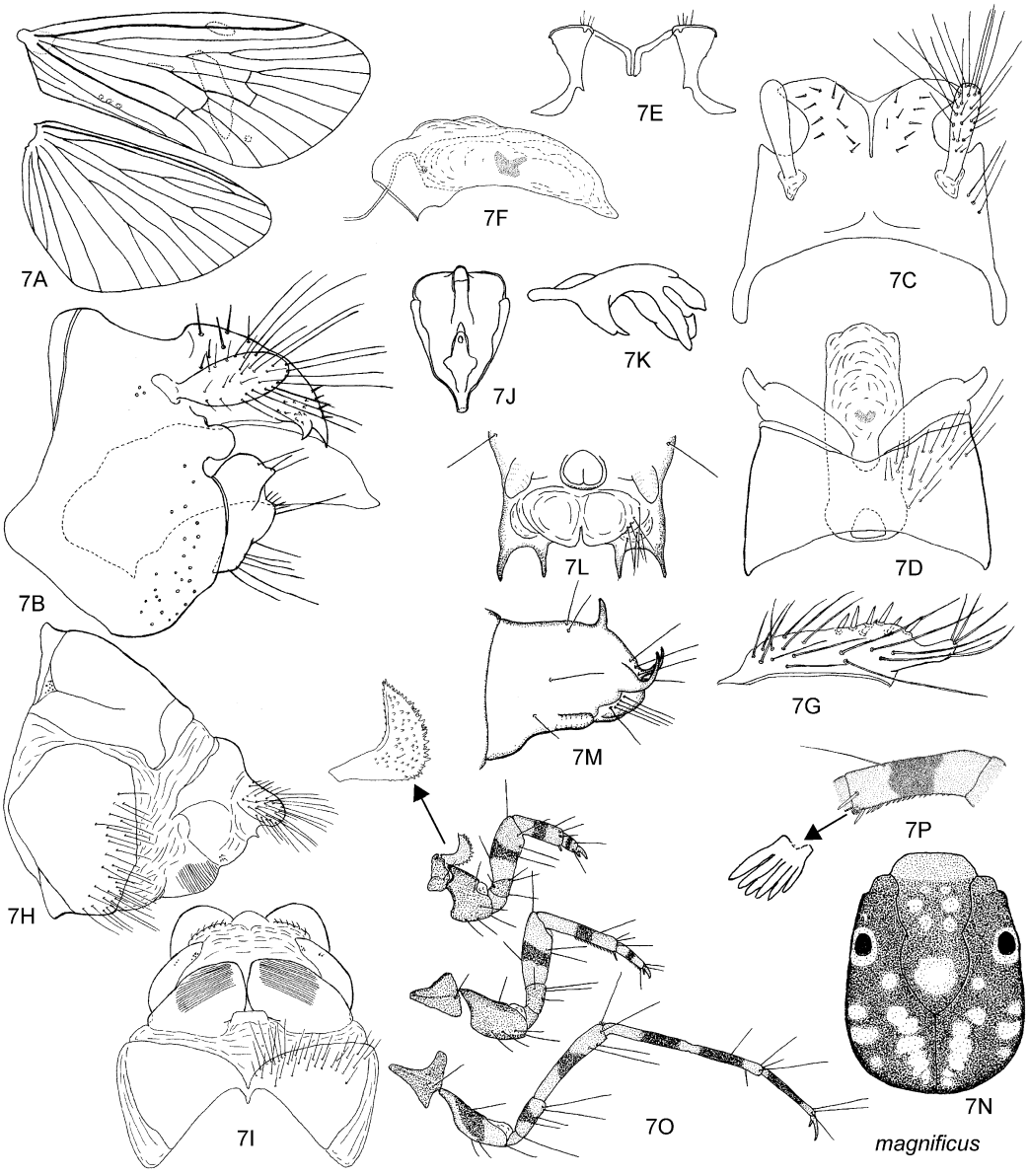

FIGURE 7. ***Anisocentropus* (*A.*) *magnificus*** male, female, pupa and larva. Male (A–G): A, right wings, dorsal; B, genitalia, left lateral; C, same, dorsal; D, same, ventral; E, segment X, ventral; F, phallus, left lateral; G, right inferior appendage, ventral. Female (H–K): H, genitalia, left lateral; I, same, ventral; J, vaginal sclerite, ventral; K, same, left lateral. Pupa (L, M): L, posterior parts, ventral; M, same, left lateral. Larva (N–P): N, head, dorsal (setae not illustrated); O, right pleura and thoracic legs, dorsal; P, right hind tibia, ventral.

Forewings (Figs. 7A, 8C) each with colorful pattern, brown (bright brown in fresh specimens) with large, white, ellipsoidal area in middle, gray blue (blue in fresh specimens) arched band along posterior edge, and blue, round or ellipsoidal areas scattered over remaining membrane; in alcohol, specimens uniformly brown with large, white ellipsoidal areas and few small white dots; 8.0–9.0 mm long in male and 9.5–10.0 mm long in female; apical forks 1, 2, 3, 4 and 5 present; discoidal, median and thyridial cells present in most specimens but discoidal cell

sometimes open. Hindwings (Figs. 7A, 8C) black in fresh specimens, brown in preserved specimens; each 6.0–6.5 mm long in male and 6.5–7.0 mm long in female; round with broad costal area, apical forks 1, 2, 3 and 5 present; cells open.

Male genitalia (Fig. 7). Tergite and sternite of segment IX (Fig. 7B) fused laterally, dorsal edge largely concave in lateral view, lateral margin produced posteriorly into circular lobe. Segment X (Figs. 7B, C, E) consisting of roof-like plates; compressed laterodorsally, subquadrate with mesal notch, posterolateral margins expanded laterally in dorsal view, directed slightly ventrad and divided apically in lateral view, with few, short setae on apical part of dorsal surface. Preanal appendages (Figs. 7B, C) compressed laterally, oval in lateral view, club-like in dorsal view, with many short and long setae laterally. Phallus (Figs. 7D, F) thick and short, with small U-shaped phallotremal sclerite. Inferior appendages (Figs. 7B, D, G) thick and short, hump-like in lateral view, thick and parallel-sided at basal 2/3rds and abruptly tapered at apical 1/3rd with subacute apices in ventral view, covered with many short and long setae, several thick short spine-like setae present mid-length on mesal margin.

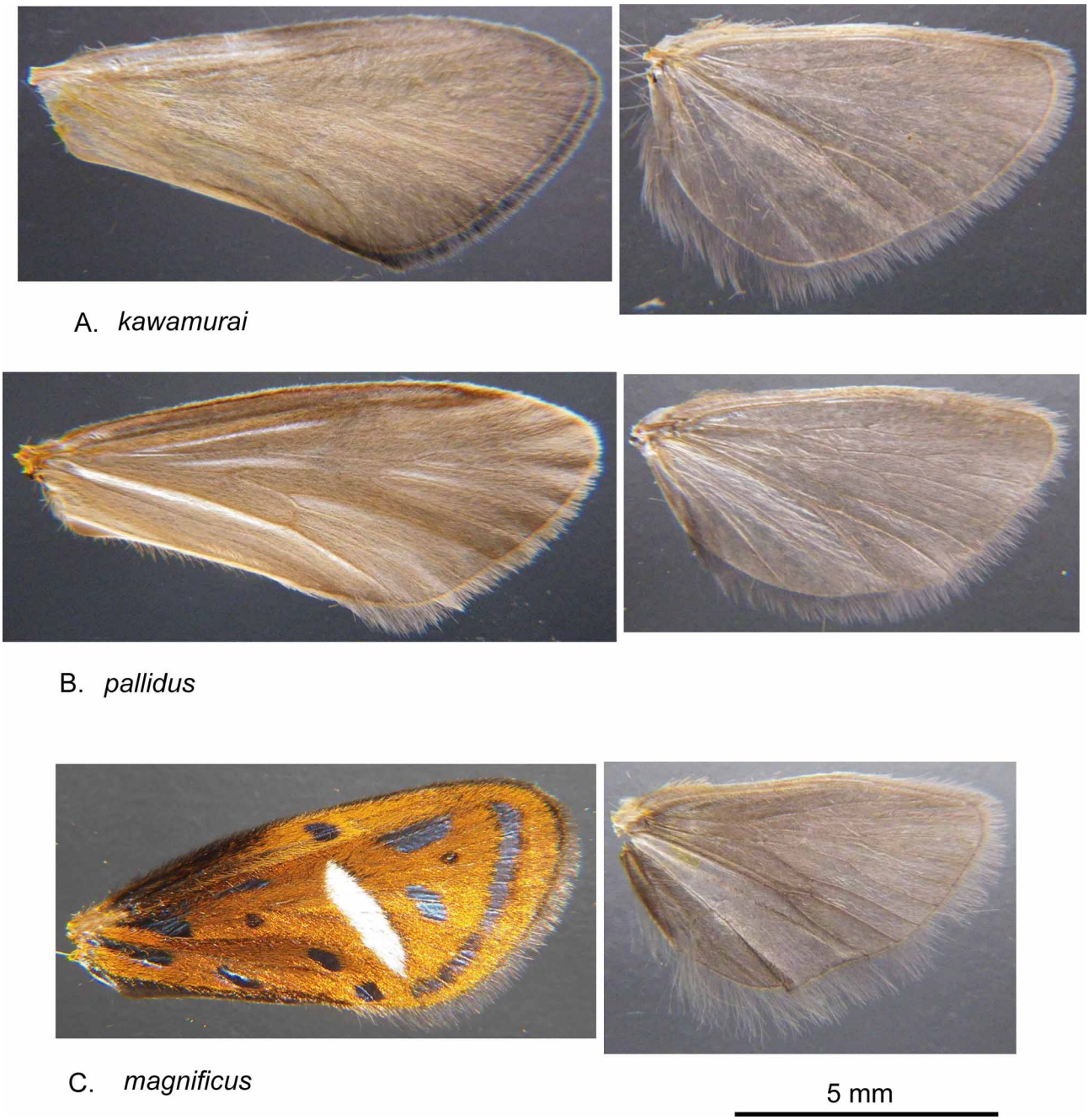

FIGURE 8. Right wings of the 3 species, dorsal. A, *Anisocentropus* (*A.*) *kawamurai* (type locality, Nagano, Kizaki-ko, 2011); B, *Anisocentropus* (*A.*) *pallidus* (Hokkaido, Chitose-ko, 2011); C, *A Anisocentropus* (*A.*) *magnificus* (Ishigaki-jima, 2011).

Female genitalia (Fig. 7). Segment VIII (Figs. 7H, I) with subquadrate tergite and sternite, sternite with deep mesal cleft and many setae, with trapezoidal projection posteromesally in ventral view. Segment IX (Figs. 7H, I) somewhat depressed; sternite divided mesally, each half with many oblique striations; tergite with round apicodorsal margin in lateral view. Segment X (Figs. 7H, I) fused with segment IX, covered with many setae, with mesal mound in ventral view and small, short, triangular protuberance ventrally in lateral view. Vaginal sclerite (Figs. 7J, K) subtriangular with proximal end narrow in ventral view, long lateral projection directed ventrocaudad in lateral view.

Pupa (Fig. 7). Length up to 12 mm. Paired anterior hook plates each with 3–6 (mostly 6) hooks, paired posterior hook plates each with 10–11 hooks. Abdominal gills arranged as in Table 3. Segment IX with pair of short, subacute tubercles (Figs. 7L, M) near posteroventral corners in male, pair of horn-like processes (Fig. 7L) dorsomesally at posterior margin and 4 pairs of strong setae dorsally. Anal processes (Figs. 7L, M) slender, strongly tapered and curved dorsad posteriorly. Other characters as in *A.* (*A.*) *kawamurai*.

TABLE 3. Arrangement and number of branches of gills of *Anisocentropus* (*A.*) *magnificus* pupae.

Segment	I	II	III	IV	V	VI	VII	VIII
Dorsal		3	3	3	3	3	3	
Lateral		3	2–3	2–3	2–3	2–3	1–2	
Ventral		3	3	3	3	3	3	

Final instar larva (Fig. 7). Length up to 14 mm. Head (Fig. 7N) slightly oblong, width about 0.9 mm at cheeks; dark brown with many light, roundish areas, large pale area on posterior frontoclypeal apotome; 3 pairs of small, light areas arranged as closed parentheses (nearly circle) at anterior frontoclypeal apotome in many specimens but large ones in few specimens, 3–4 pairs of small, pale areas on cheeks, and 6–7 pairs of small pale areas behind frontoclypeal suture and beside coronal suture. In each fore- and middle leg (Figs. 7O, P), coxa and trochanter dark brown, femur, tibia and tarsus also brown but each with darker band; tibia with small spines along 2/3rds of posterior margin and 5–6 branched, fan-like spines at apicodistal edges; fan-like spines very small (Fig. 7P). In hind leg (Fig. 7O), all segments, including each of subdivisions of femur, brown with dark bands. Abdominal gills arranged as in Table 4. Other characters as in *A.* (*A.*) *kawamurai*.

TABLE 4. Arrangement and number of branches of gills of *Anisocentropus* (*A.*) *magnificus* larvae.

Segment	I	II	III	IV	V	VI	VII	VIII
Dorsal	3	3	3	3	3	3	3	3
Lateral		3	2–3	2–3	2–3	2–3	1–2	1–2
Ventral		3	3	3	3	3	3	1–2

Case. Similar to *A.* (*A.*) *kawamurai*.

Specimens examined. **JAPAN. Okinawa**. **Ishigaki-jima**: small tributary, Nagura-gawa, 9 m, Hakusui, 13–21.x.1999, K. Konishi, M, 3 males, 5 females; ibid., 11.iv.2005, TI, 1 larva; ibid., 11–13.iv.2011, TI, 1 male, 15 larvae; ibid., 13.iv.2011 (pupae), reared and emerged on 15–17.iv.2011, TI, 2 males; ibid., 13.iv.2011 (larvae), emerged on 18.iv–9.v.2011, TI, 9 males, 3 females (4 males, 2 females pinned; others in alcohol); ibid., 13.iv.2011, reared and preserved on 9.v.2011, TI, 9 pupae, 5 larvae. **Iriomote-jima**: Aira-gawa, 3.v.1997, KT, 1 larva; ibid., 3.v.2006, KT, 1 larva; Otomi, Daiichi-do, 13.xii.1999, NK (NK), 1 male; Aira-gawa, Aira-bashi, 29.iv.2002 (larvae), reared and emerged on 14.vi.2002, T. Fujitani (K. Tanida), 1 male, 1 female.

Remarks. Larvae of *Anisocentropus* sp. recorded from Iriomote-jima by Tanida (1997, 2003) probably belong to this species because of the collecting locality, though voucher specimens are missing (Kazumi Tanida, personal communication). Males of this species are distinguished by the concave dorsal edge and circular lateral lobe of segment IX (Fig. 7B); the divided posteroventral edge of the roof-like plates of segment X (Fig. 7B); and thick short inferior appendages with slender apical parts (Figs. 7B, D). The forewings of males and females are very colorful in pinned specimens of Ishigaki-jima, in the southern part of the Nansei Islands (Fig. 8C), but they are almost entirely brown with white large patterns in alcohol specimens. The color patterns of pinned specimens from Ishi-

gaki-jima are somewhat different from the original description (Ulmer 1907, pl. 2, fig. 11), in which large dark brown patterns are present at basal half in addition to the features described above. The color patterns of the forewings may vary locally. Female, pupa and larva are newly described. This species, common in the Philippines, is reported from Japan for the first time here.

Distribution (Fig. 9). Japan (Ishigaki-jima, Iriomote-jima), Philippines. New to Japan.

Japanese name. Nishiki-koban-tobikera (newly given here).

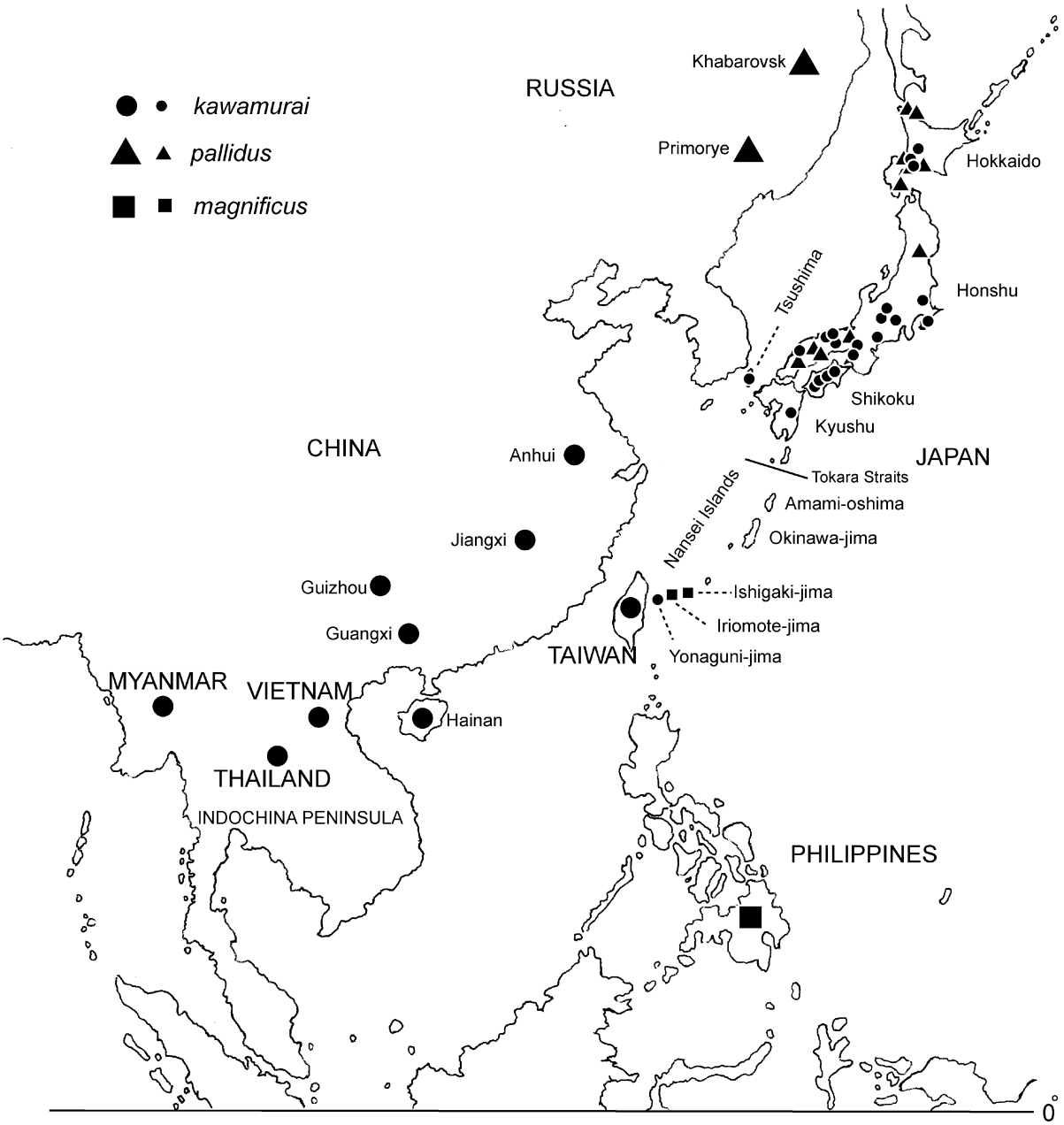

FIGURE 9. Distribution of the 3 species. Plots in Russia, China, and Indochina Peninsula are mainly from Arefina & Levanidova (1997), Yang *et al*. (2005, as *A. minutus*) and Malicky (2010, as *A. minutus*), respectively.

Distribution and biology

Geographical distribution of the 3 species is shown in Fig. 9. *Anisocentropus* (*A.*) *kawamurai* is widely distributed in East Asia, from the Indochina Peninsula to Hokkaido, Japan. *Anisocentropus* (*A.*) *pallidus* has been found in

more northern areas, *i.e*., Honshu, Hokkaido and continental parts of the Russian Far East. In Honshu and Hokkaido, the distribution of the 2 species overlap but have only rarely been collected together at the same site.

In the southern part of the Nansei Islands, *A.* (*A.*) *kawamurai* is distributed on Yonaguni-jima and *A.* (*A.*) *magnificus* on Ishigaki-jima to Iriomote-jima. The 2 species have not been found together from the same island. Several caddisfly species are common on both Nansei Islands and Taiwan (Kuranishi 1997, Ito 2005, Ito *et al*. 2010, Shimura 2010). However, in the genus *Anisocentropus*, one species is distributed in Taiwan to Yonaguni-jima and the other from the Philippines to Iriomote-jima and Ishigaki-jima. This distribution pattern has been detected for the first time. No species of *Anisocentropus* have been found in the northern part of the Nansei Islands, from Tokara Strait to Okinawa-jima. Further studies are needed in the area.

Anisocentropus (*A.*) *kawamurai* occurs in lakes, ponds, reservoirs and stagnant stream waters, while *A.* (*A.*) *pallidus* occurs in lakes, ponds and marshes (including streams in marshes) but never in mountain streams. Both species occur in lakes and ponds, but their habitat preferences seem to differ, with larvae of *A.* (*A.*) *kawamurai* preferring lakes and ponds with relatively large inflow/outflow, but *A.* (*A.*) *pallidus* prefering lakes and ponds located in marshes. Larvae of *A.* (*A.*) *magnificus* are found abundantly in small streams (1–2 m wide, 5 cm deep) in subtropical forests. Larvae of all 3 species inhabit accumulations of submerged leaves.

Hayashi *et al*. (2009) studied larval cases of *A.* (*A.*) *kawamurai* in mountain streams in Kyushu and showed that stiff leaves of proper sizes found in litter packs, regardless of tree species, are used for disc processing, though the processing avoids main leaf veins. Fifth instar larvae of *A.* (*A.*) *kawamurai* fix their cases on stable substrate several centimeters below the water surface to pupate.

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