Bull. Natl. Mus. Nat. Sci., Ser. A, 44(2), pp. 69–85, May 22, 2018

Kuwayamachrysa, a New Genus of Lacewings (Insecta, Neuroptera, Chrysopidae, Chrysopinae, Chrysopini) with Markedly Divergent Adult and Larval Features

Shigehiko Tsukaguchi[1] and Toshihiro Tago[2]

[1] 10–10–203 Kanbara, Nishinomiya, Hyogo 662–0021, Japan
E-mail: 6ih443@bma.biglobe.ne.jp
[2] 1–29–13–101 Motogou, Kawaguchi, Saitama 332–0011, Japan
E-mail: tago-ke@za2.so-net.ne.jp

(Received 22 March 2018; accepted 28 March 2018)

Abstract The authors describe *Kuwayamachrysa* gen. nov. from northeastern Asia–Japan, Korea and Russian Far East. This new genus is characterized by a number of extraordinary features in the male and female genitalia, and also in the pattern of larval setation. In the male genitalia, there is a uniquely asymmetrical and intersecting gonapsis; in the female genitalia, a bursa-vela connector, vaginal frame and laminate link are present; and in the first instar, secondary setae occur on both thoracic and abdominal segments. The type species of the monotypic genus is *Chrysopa kichijoi* Kuwayama, 1936. It is redescribed with emphasis on the adult abdominal hypodermal coloration, female terminalia, and larval morphology (first and third instars), all of which were previously unknown. Several features of the new genus are compared with those of other genera: (i) the morphology of the gonapsis in relation to the dorsal membrane of the 9th sternite (ii) the morphology of newly described features (bursa-vela connector, vaginal frame and laminate link), and (iii) the first and third instar patterns of setation.
Key words: Chrysopini, genitalia, Japan, *kichijoi*, Korea, *Kuwayamachrysa*, larval setation, new combination, new genus, Russian Far East.

Introduction

Kuwayama in 1936 originally described *Chrysopa kichijoi* from a male specimen collected from Sapporo, Hokkaido, Japan. In 1985 Tsukaguchi transferred the species to the genus *Apertochrysa* based on Tjeder (1966), and in 1995 he redescribed the type specimen. In 2017, on the basis of molecular evidence, Mochizuki *et al.* proposed that "*Apertochrysa*" *kichijoi* was not related to other *Apertochrysa* species but formed a clade with *Eremochrysa*, *Suarius* and *Chrysomesa*. Although the species has not been found during the long period since the type specimen was collected in 1933, recently we have been able to obtain additional specimens from northern to central regions of Honshu in Japan and from Korea. As a result of these new specimens, we discovered specialized character states in the male genitalia, the female genitalia, and the setation of the first instar.

In the present paper we propose and describe the new genus, *Kuwayamachrysa*, redescribe the type species *Chrysopa kichijoi* including the previously unknown female and larva, and discuss the morphology of the genitalia and the pattern of the larval setation.

Materials and Methods

Materials.

The adults were collected from Japan and Korea and were sufficiently mature for the examination of the genitalia. The larval specimens

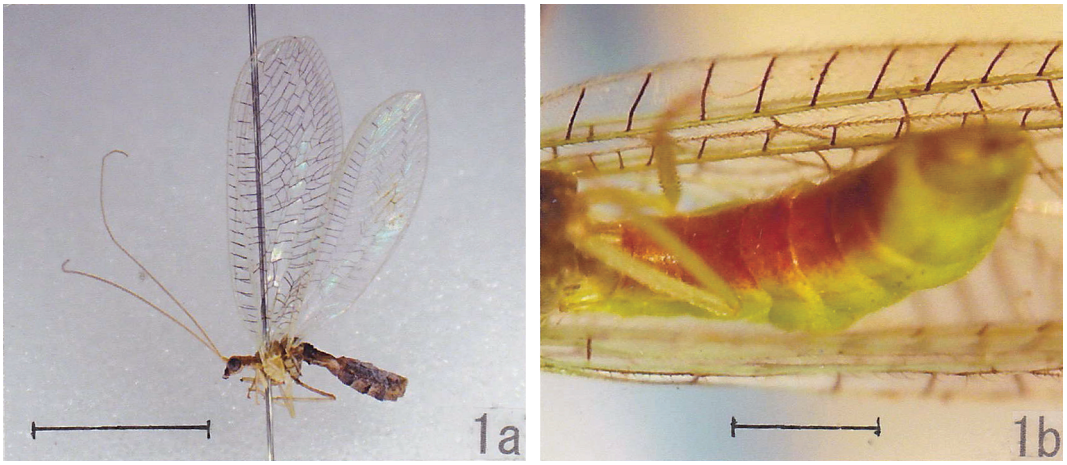


Fig. 1. *Kuwayamachrysa kichijoi* (Kuwayama, 1936), comb. nov., adult, female, (a) lateral view, scale line: 7 mm, (b) do., abdomen, ventral view, scale line: 2 mm.

were laboratory-reared offspring from a female collected in Japan; the full-grown specimens of each instar were used for study. The voucher specimens (adult: 8 ♂, 6 ♀; larva: 9 exs.) are deposited in the National Museum of Nature and Science (NMNS; the abbreviation of the collection: NSMT), Tsukuba, Ibaraki, Japan. Additional laboratory-reared adult specimens (2 ♂, 1 ♀) are deposited in the National Institute for Agro-environmental Sciences (NIAES), Tsukuba, Ibaraki, Japan.

Methods.

①The observation of the specimens was made using an OLYMPUS binocular stereoscopic microscope (10 to × 100 magnification). External characters of the adults were examined in the dried condition or in the 70% ethanol preserved condition. For the examination of terminalia and genitalia the abdomen was removed from the body, treated with 10% KOH solution, fully washed in water and stained in a solution of 70% ethanol and Chlorozol Black. The terminalia and genitalia were dissected, described and figured in glycerin.

②The larvae were incised on the ventral side of the abdomen, treated with 10% KOH solution, fully washed in water, stained in a solution of 70% ethanol and Chlorozol Black. They were examined and illustrated in the 70% ethanol or glycerin preserved condition under magnifications × 25 to × 100.

③The measurements of the external characters are as follows: Adult, body length: distance from anterior margin of head to posterior margin of 9th tergite + ectoproct; head width (Fig. 2, hw): maximal transverse distance between outer margins of both eyes in frontal view; eye diameter (Fig. 3, ed): horizontal diameter vertically viewing frontal aspect of head; eye protrusion (Fig. 2, ep): maximal transverse distance between outer and inner margins of eye in frontal view; antennal length (incremental measurement with summuation of increments): distance from base to apex in lateral view; wing length: distance from base to apex in dorsal view. Larva, body length: distance from apex of jaw to terminal end of abdomen; head width: maximal transverse distance between outer margins of both eyes in dorsal view.

④The coloration was described from the specimens and photographs, but the specimens fade and become discolored with age and preservation.

The numbers of abdominal dorsal setae and setal rows on the larvae are shown approximately in the figures because the setae are often in complicated and entangled states.

⑤The adult terminology mainly follows

Tjeder (1966), Adams and Penny (1987) and Tsukaguchi (1995). The nomenclature for the wing-venation mainly follows Tillyard (1916). The following terms are coined for convenience of the description and comment on four characters of the genitalia: in the male, bugle-shaped basal laminae, in the female, bursa-vela connector, vaginal frame and laminate link. See below for more detail. In the larva the nomenclature used for the larval cranial setae is that of Rousset (1966), and other terminology mainly follows Tsukaguchi (1978, 1979, 1995) but some symbols are changed from previous usage in the figures. Complicated larval setation is arranged and the following four setal group regions are used: anterior region, median region, posterior region and spiracular region.

Kuwayamachrysa gen. nov.

[New Japanese name: kuwayama-kusakagerou zoku]

Gender. feminine.

Etymology. The generic name is derived from the late Dr. Kuwayama (described *Chrysopa kichijoi* as a new species) plus *chrysa* (referring to Chrysopid genus).

Type species. *Chrysopa kichijoi* Kuwayama, 1936.

Diagnosis.

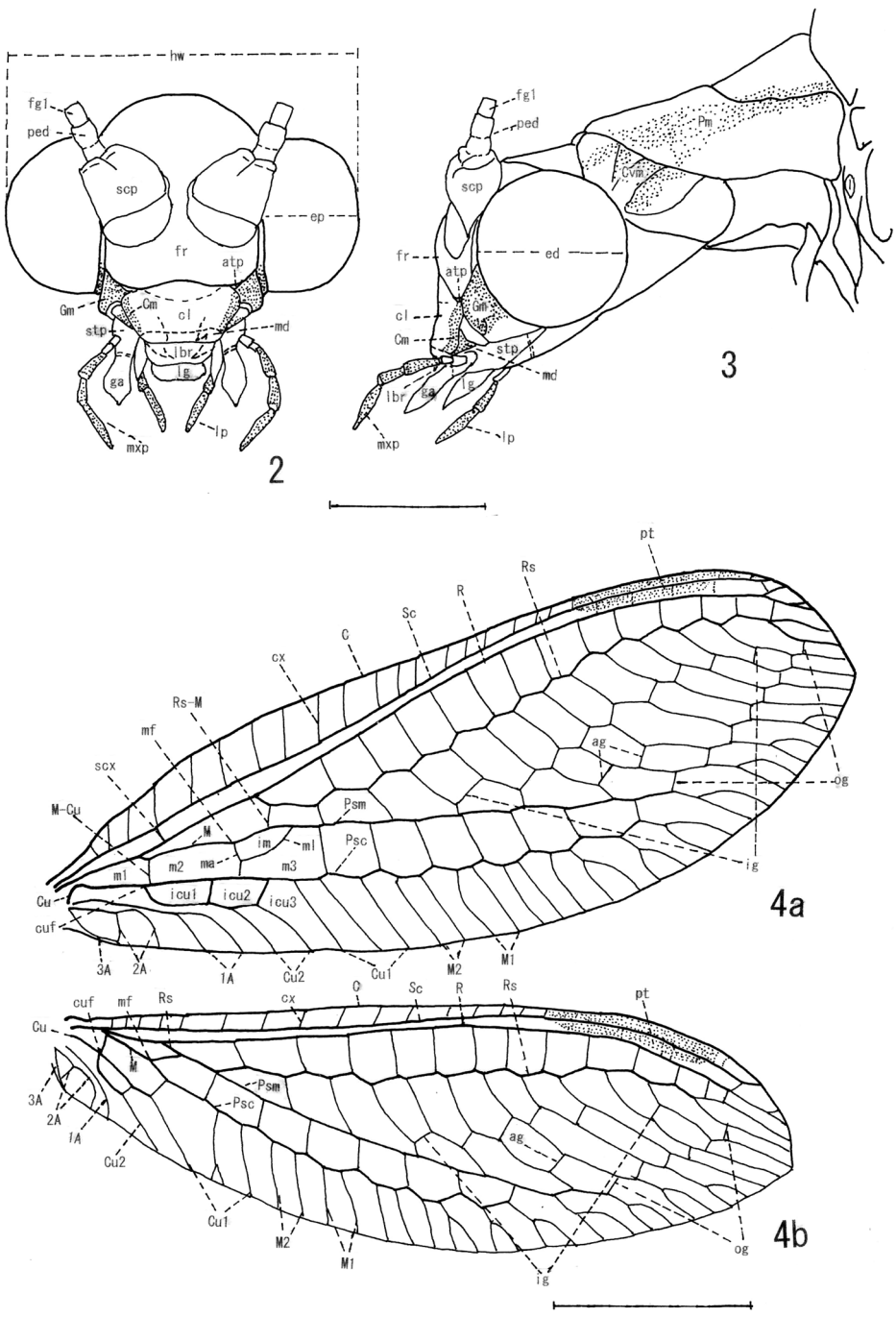
This new genus is distinguishable from other Japanese genera in the tribe Chrysopini by the following unique character states: In the male, the gonapsis consists of a pair of the extraordinarily asymmetrical and intersecting median pieces; in other genera the gonapsis is (i) absent, or (ii) with a single, unpaired median piece, or (iii) paired, but without extraordinarily asymmetrical and intersecting median pieces. In the female, the genitalia bears the oval bursa-vela connector derived from the bursal duct, the vaginal frame consisting of the dorsal extension of the subgenitale and a pair of the longitudinal flat laminate links in the bursa copulatrix; in other genera such genital elements not found. In the first instar, the dorsal sides of the 1st to 6th abdominal segments have three to four transverse rows consisting of primary setae and many secondary setae; in other genera these contain only primary setae of generally seven pairs on the 1st segment and six pairs on each of the 2nd to 6th segments. In the third instar, the debris carrier with humped abdomen, the 1st abdominal segment has three or four transverse setal rows on the median region and the 6th abdominal segment has a complete set of backward and forward curved setal rows on the anterior and posterior regions; in other Chrysopini genera with debris carrying larvae the 1st segment of the third instar has one or two rows and the 6th segment is without such sets of setal rows.

Description.

Adult (Figs. 1–6). Small in size. Length of forewing ca. 11.5–13.7 mm.

Head marked on clypeal lateral side and gena, unmarked on other regions; with rather short face; anterior tentorial pit located slightly above lower point of eye (Figs. 2, 3); eye protrusion somewhat larger than half the distance between eyes. Antenna slightly longer than forewing. Mandibles broad, asymmetrical, with tooth on inner margin of left one. Palpi marked. Prothorax marked on latero-dorsal area. Legs with claws strongly curved, squarely dilated at bases. Wings narrow to moderate in width, with rather subacute apices, unmarked; both cells of inner gradates rather broad; tip of cell im distinctly beyond Rs-M crossvein; gradates mainly consisting of two series; inner gradate of fore wing not joining pseudomedia; hind wing with Sc and R separated (Fig. 4). Abdomen simple, without stridulatory, file-like structure on lateral side of 2nd segment.

Terminalia and genitalia, ♂ (Fig. 5): Terminalia broad. Eighth tergite somewhat shorter than 7th tergite. Tergite 9 + ectoproct simple, not separated on mid-dorsal axis, nearly round on dorsal apex, without any projection, not extending ventrad beyond lateral margin of sternite 8 + 9, with antero-lateral margin leaning back and without cleft, with elongated anterior lower angle nearly reaching to anterior margin of 8th segment; apodeme reaching and surrounding callus cerci.


hw
fgl
ped
scp
ep
fr
atp
Gm
Cm
cl
stp
md
lbr
lg
ga
lp
mxp
2
Pm
CVm
ed
3
pt
Rs
R
Sc
C
cx
Rs-M
mf
scx
M-Cu
M
im
ml
Psc
Psm
ma
m1
m2
m3
icu1
icu2
icu3
Cu
cuf
3A
2A
1A
Cu2
Cu1
M2
M1
ag
og
ig
4a
4b

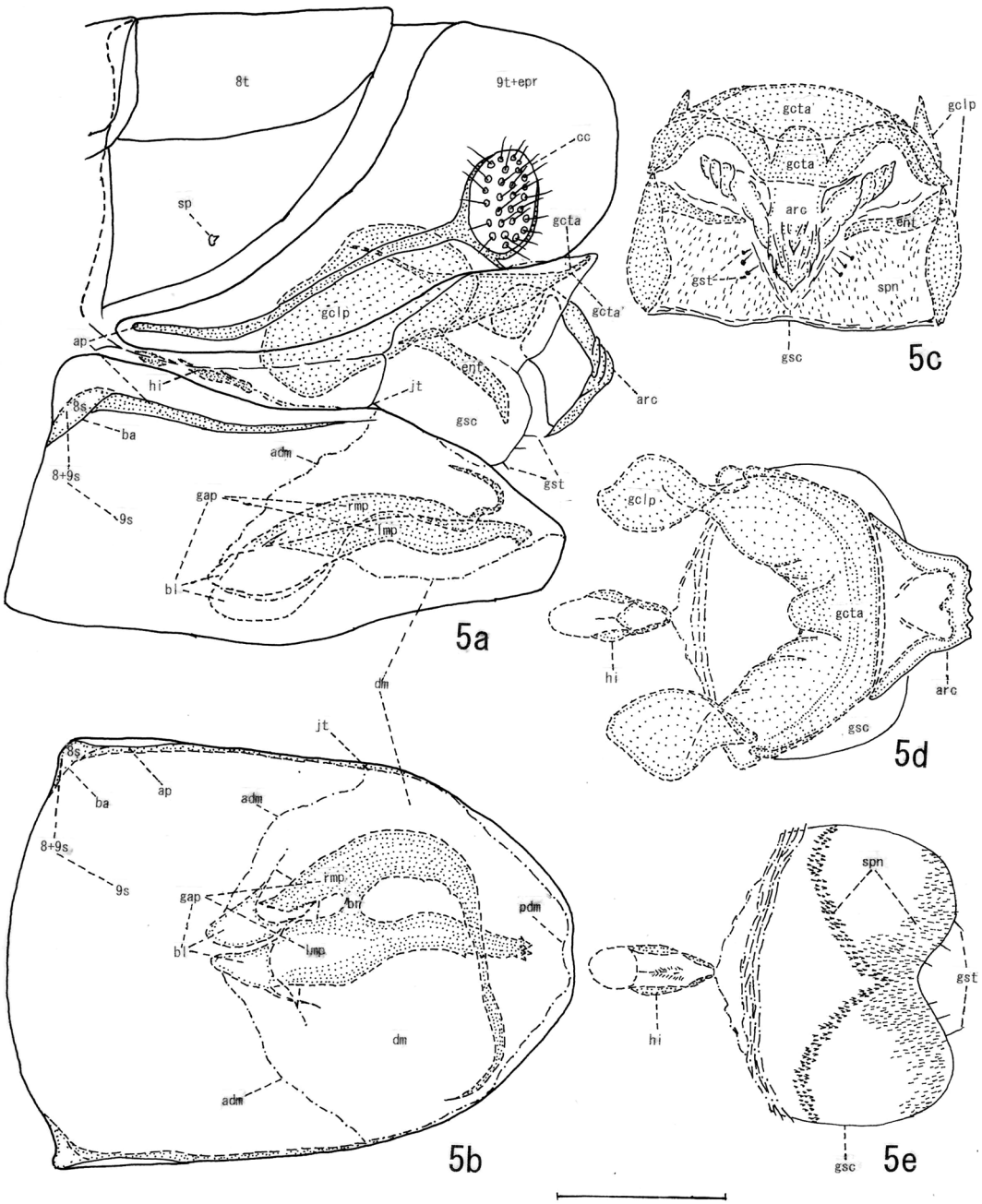
Sternite 8 + 9 united, but composed of very large 9th sternite (almost occupying sternite 8 + 9) and very small 8th sternite (reduced to antero-lateral corner of sternite 8 + 9) (Figs. 5a, b), simple, not constricted on postero-lateral margin, broadly round on posterior margin in ventral view, not extending backward beyond terminal end of tergite 9 + ectoproct; apodeme somewhat indistinct, slender. Genitalia relatively large; gonarcus robust, broad in transverse arch and lateral plates, with transverse arch consisting of subdorsal and ventral extensions from lateral plates, undivided and completely unified medially, double on upper half (of subdorsal extension + ventral extension), single on lower half (of subdorsal extension) (Figs. 5a, c, d) and without mediuncus and additional projection; arcessus broad and trianguloid in posterior view, almost rectangularly bending ventrad in lateral view; a pair of entoprocessus simple, slender, without additional projection, firmly connected with inner surface of gonarcus at cavity under the ventral extension (Figs. 5a, c), entirely separating from each other; gonosaccus consisting of rather robust membrane, with gonosetae and spinellae; gonapsis consisting a pair of extraordinarily asymmetrical and intersecting median pieces and a pair of the bugle-shaped basal laminae, located above dorsal membrane occurring from posterior margin of 9th sternite, oriented backward (Figs. 5a, b); tignum, pseudopenis and gonocristae absent.

♀ (Fig. 6): Seventh sternite simple, not incised on posterior margin. Subgenitale well developed, more or less well sclerotized at base, with heart-shaped apical lobe, bearing neck between base and apical lobe. Spermatheca with basal reservoir of moderate thickness, with somewhat small ventral incision; duct slightly long, strongly twisted. Additional apparatus of bursa-vela connector, vaginal frame, and a paired, longitudinal laminate link present.

Larva (Fig. 7). Debris carrier form with humped abdomen. Cranium marked; a pair of frontal markings almost entirely united to each other, connected with clypeal marking, forming frontoclypeal marking; postfrontal marking united with submedian part of epicranial marking, extending far beyond S11. Antenna longer than jaw. Legs moderate in length; claws smoothly curved, simple, squarely dilated at bases. Metathorax ridgeline-like along transverse setal row between latero-dorsal sclerites. Abdomen suddenly swelling along first transverse setal row of 1st segment in lateral view, well swollen on dorsal side of 1st to 6th segments. Cranial seta S12 present; 1st to 6th segments of abdominal dorsal side with one or two sets of transverse rows consisting of backward and forward curved hooked setae.

First instar (Figs. 7a, b): Meso- and metathoraces with one transverse row consisting of three pairs of setae between latero-dorsal sclerites. First to 6th segments of abdominal dorsal side with transverse rows of many hooked setae on median and posterior regions as follows: median regions with irregular three rows of backward curved hooked setae on 1st segment, with irregu-

Figs. 2–4. *Kuwayamachrysa kichijoi* (Kuwayama, 1936), comb. nov., adult (setae, macrotrichia and microtrichia omitted), 2. head, frontal view, and 3. head and prothorax, lateral view, scale line: 0.6 mm (atp, anterior tentorial pit; cl, clypeus; Cm, clypeal marking; Cvm, cervical marking; ed, eye diameter; ep, eye protrusion; fg1, 1st subsegment of flagellum; fr, frons; ga, galea; Gm, genal marking; hw, head width; lbr, labrum; lg, ligula; lp, labial palpus; md, mandible; mxp, maxillary palpus; ped, pedicel; Pm, prothoracic marking; scp, scape; stp, stipes); 4. right wings, (a) forewing and (b) hindwing, scale line: 3 mm (1A–3A, 1st–3rd anal veins; ag, additional gradates; C, costa; Cu, cubitus; Cu1 and Cu2, upper and lower branches of cubitus; cuf, cubital fork; cx, costal veinlets; icu1-icu3, intra-cubital cells 1–3; ig, inner gradates; im, intra-median cells; M, media; M1 and M2, upper and lower branches of media; ma, median arculus; M–Cu, medio-cubital crossvein; mf, median fork; ml, median loop; m1–m3, 1st–3rd median cell; og, outer gradates; Psc, pseudocubitus; Psm, pseudomedia; pt, pterostigma; R, radius; Rs, radial sector; Rs–M, crossvein between radial sector and media; Sc, subcosta; scx, subcostal crossveins).


8t
9t+epr
cc
sp
gcta
gclp
gcta
ap
hi
jt
ent
arc
8s
ba
gsc
adm
8+9s
gst
gap
rmp
9s
lmp
bl
5a
gcta
gclp
gcta
arc
ent
gst
spn
gsc
5c
gclp
gcta
hi
arc
gsc
5d
dm
jt
8s
ba
ap
adm
8+9s
9s
rmp
gap
bm
pdm
bl
lmp
dm
adm
5b
spn
gst
hi
gsc
5e

lar two rows of those on 2nd segment and with one row of those on 3rd to 6th segments; posterior regions with one set of transverse rows of backward and forward curved hooked setae on 1st to 6th segments.

Third instar (Figs. 7c, d): Prothoracic lateral tubercle nearly clavate and about twice as long as broad, protruding forward; meso- and metathoracic ones short, nearly cylindrical and as long as wide, protruding outward; abdominal ones weakly developed and small, protruding slightly outward. Thorax with one submedian seta on each submedian tubercle (= chalaza); metathorax with one transverse row consisting of about seven to eight pairs of hooked setae behind suture between latero-dorsal sclerites. Abdomen with several transverse rows of numerous hooked setae throughout dorsal sides of 1st to 6th segments respectively as follows: anterior regions with one set of transverse rows of backward and forward curved hooked setae on 2nd to 6th segments; median regions with irregular three to four rows of backward curved hooked setae on 1st segment, with irregular two or three rows of those on 2nd to 5th segments and with two rows of those on 6th segment; posterior regions with one set of transverse rows of backward and forward curved hooked setae on 1st to 6th segments.

Morphology of genitalia and pattern of larval setation.

1. *Gonapsis in male genitalia* (Figs. 5 a, b; 8).

The gonapsis is recognized from 16 genera in Chrysopini by our investigation of below references: *Anomalochrysa* McLachlan, 1883; *Atlantochrsa* Hölzel, 1970; *Ceraeochrysa* Adams, 1982; *Chrysemosa* Brooks and Barnard, 1990; *Chrysopidia* Navás, 1910; *Chrysopodes* Navás, 1913; *Cunctochrysa* Hölzel, 1970; *Elemochrysa* Banks, 1903; *Glenochrysa* Esben-Petersen, 1920; *Mallada* Navás, 1925; *Kymachrysa* Tauber and Garland, 2014; *Meleoma* Fitch, 1855; *Parachrysopiella* Brooks and Barnard, 1990; *Peyerimhoffina* Lacroix 1920; *Pseudomallada* Tsukaguchi, 1995; *Rexa* Navás, 1920 [see Brooks and Barnard (1990), Mochizuki *et al.* (2017), Tsukaguchi (1995), Tauber (2003), Tauber and Garland (2014)]. But, its location and morphology have not adequately considered. Below, the structure is reconsidered based on four genera bearing the gonapsis in Japanese Chrysopidae.

The gonapsis may be regarded as a sclerite located under or above the dorsal membrane, forward extended from the posterior margin of the 9th sternite, and originating from the anterior part of the dorsal membrane. The relationship between the gonapsis and dorsal membrane varies among the genera. When the gonapsis is located under the dorsal membrane, it is oriented forward but when it is located above the dorsal membrane, it is oriented backward. In some genera the gonapsis generally consists of a single or paired median pieces (central piece in Tjeder, 1966) and a pair of lateral pieces. Furthermore the anterior margin of the dorsal membrane extends laterad along the lateral pieces and joins a junction on the postero-lateral margins of the 9th sternite (Figs. 5, 8: jt: junction on anterior

Fig. 5. *Kuwayamachrysa kichijoi* (Kuwayama, 1936), comb. nov., male terminalia and genitalia, scale line:0.5 mm, (a) terminalia and genitalia, lateral view, (b) sternite 8 + 9 and gonapsis, dorsal view, (c) gonarcus, arcessus, entoprocessus and gonosaccus, posterior view, (d) gonarcus, arcessus, gonosaccus and hypandrium internum, dorsal view, (e) gonosaccus, spinellae and hypandrium internum, ventral view (arc, arcessus; ap, apodeme; ba, boundary of 8th and 9th sternites; cc, callus cerci; dm, dorsal membrane of 9th sternite (adm, anterior margin of dorsal membrane; pdm, posterior margin of dorsal membrane); ent, entoprocessus; gap, gonapsis (bl, bugle-shaped basal laminae; br, bridge; lmp, left median piece; rmp, right median piece); gclp, lateral plate of gonarcus; gcta, transverse arc of gonarcus (in more detail gcta: transverse arc from subdorsal extension from lateral plates; gcta': transverse arc from ventral extension from lateral plates); gsc, gonosaccus; gst, gonosetae; hi, hypandrium internum; jt, junction in anterior margin of dorsal membrane and lateral margin of 9th sternite; sp, spiracle; spn, spinellae; 8s, 8th sternite; 9s, 9th sternite; 8 + 9s, sternite 8 + 9 = fused 8th and 9th sternites; 8t, 8th tergite; 9t + epr, tergite 9 + ectoproct = fused 9th tergite and ectoproct).

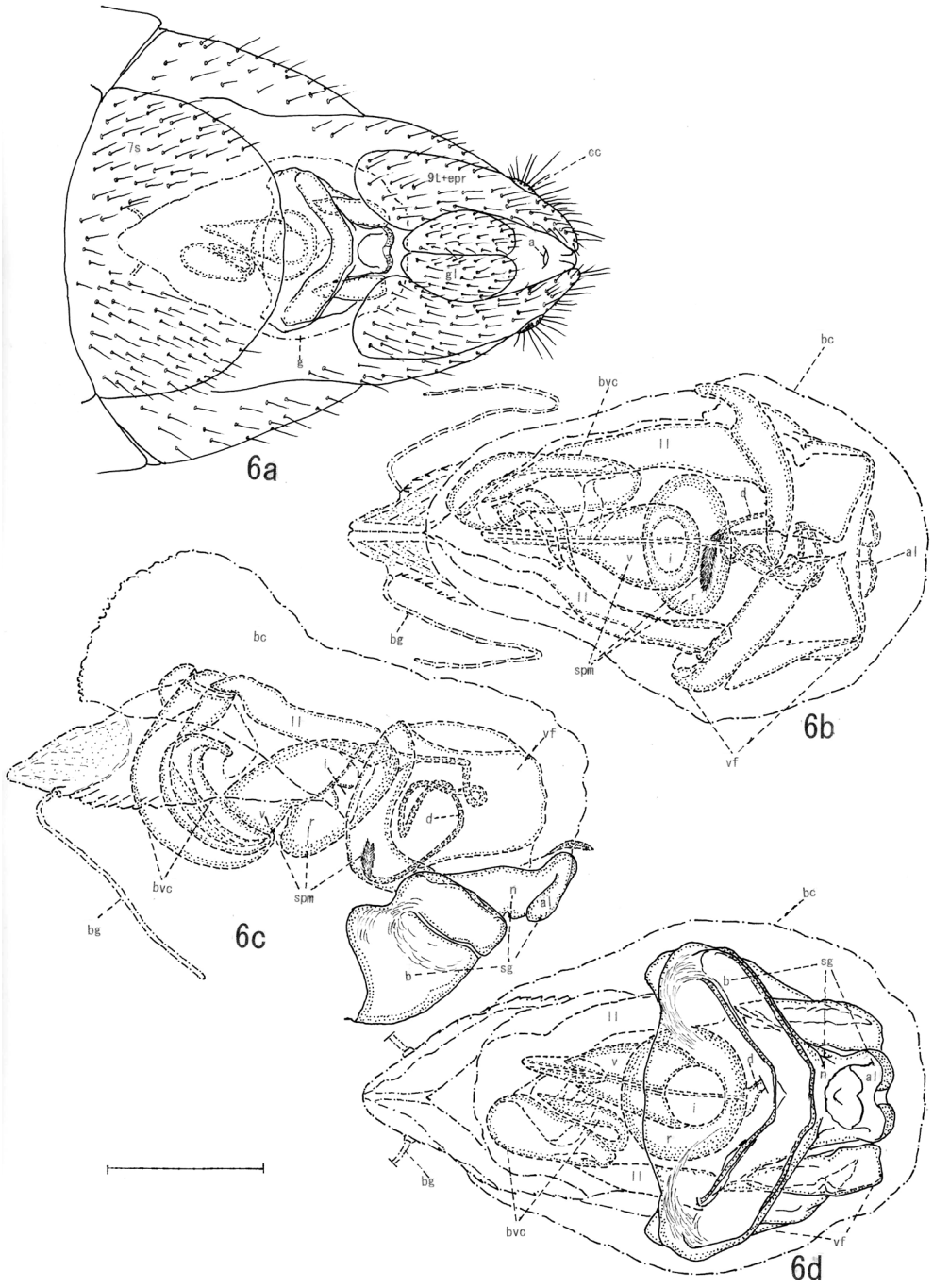


Fig. 6. *Kuwayamachrysa kichijoi* (Kuwayama, 1936), comb. nov., female terminalia and genitalia, scale line, a: 1.0 mm, b–d: 0.5 mm, (a) terminalia, ventral view, (b) genitalia, dorsal view, (c) do., lateral view, (d) do., ventral view (a, anus; bc, bursa copulatrix; bg, bursal gland; bvc, bursa-vela connector; cc, callus cerci; g, genitalia; gl, gonapophyses lateralaes; ll, laminate links; sg, subgenitale (al, apical lobe; b, base; n, neck); spm, spermatheca (d, spermathecal duct; i, ventral impression; r, reservoir = chamber in Tsukaguchi, 1995; v, vela); vf, vaginal frame; 7s, 7th sternite; 9t + epr, tergite 9 + ectoproct = fused 9th tergite and ectoproct).

margin of dorsal membrane and lateral margin of 9th sternite). The structure, the relation to the dorsal membrane and the orientation of the gonapsis in the Japanese four genera are as follows:

Pseudomallada Tsukaguchi, 1995 (Fig. 8a): gonapsis consisting of paired lateral pieces and single median piece, located under dorsal membrane, oriented forward, usually accompanied with gonocristae; a pair of lateral pieces unified, forming single plate, bending ventrad posteriorly and becoming median piece from here; median piece positioned ventrally to lateral pieces, single, rod-shaped, free from dorsal membrane; anterior margin of dorsal membrane extending laterad along anterior margins of lateral pieces beyond median piece. Japanese *Pseudomallada* spp.: *alcestes* (Banks, 1911), *astur* (Banks, 1937), *cognatellus* (Okamoto, 1914), *formosanus* (Matsumura, 1910), *parabolus* (Okamoto, 1919), *prasinus* (Burmeister, 1839), *ussuriensis* (Makarkin, 1985).

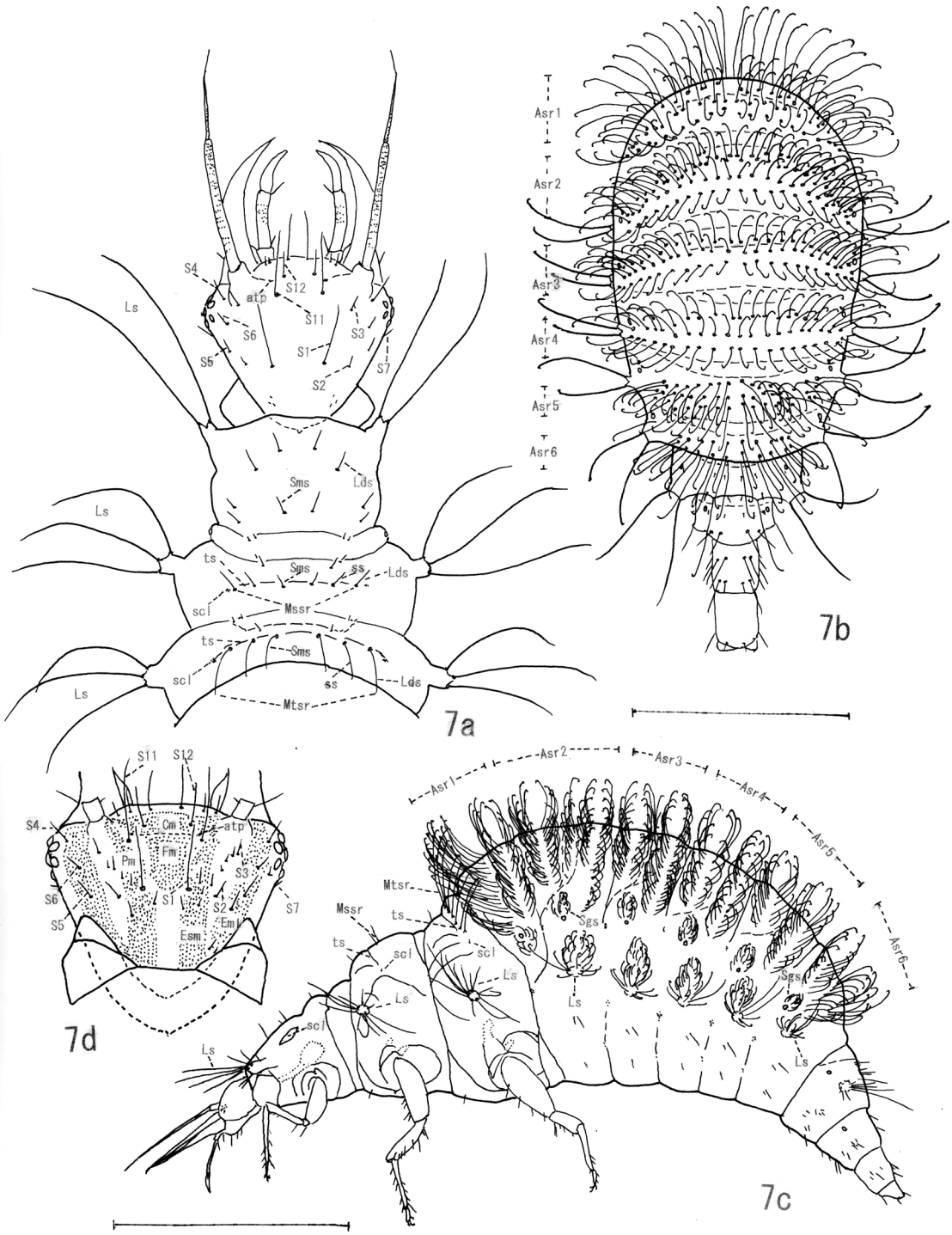
Cunctochrysa Hölzel, 1970 (Fig. 8b): gonapsis paired, consisting of paired lateral pieces and median pieces, located under dorsal membrane, oriented forward, accompanied with gonocristae; a pair of lateral pieces unified, forming single plate, bending ventrad posteriorly and becoming median pieces from here; median pieces positioned ventrally to lateral pieces, not single, consisting of rather asymmetrical pairs, bridged by faint lamina except for basal and apical parts, thin rod-shaped, free from dorsal membrane; anterior margin of dorsal membrane extending laterad along anterior margins of lateral pieces beyond median piece. Japanese *Cunctochrysa* sp.: *albolineatoides* (Tsukaguchi, 1995).

Mallada Navás, 1925 (Fig. 8c): gonapsis consisting of paired lateral pieces and single median piece, located above dorsal membrane, oriented backward, not accompanied with gonocristae; a pair of lateral pieces arm-shaped, occurring from lateral base of median piece, entirely separated by median piece; median piece positioned between paired lateral pieces, single, scalelike, connecting with dorsal membrane on ventral side between lateral pieces; anterior margin of dorsal membrane extending laterad along lateral pieces across median piece. Japanese Mallada spp.: *basalis* (Walker, 1853), *desjardinsi* (Navás, 1911), *krakatauensis* (Tsukaguchi, 1988); in *krakatauensis* the gonapsis has not been found.

Kuwayamachrysa gen. nov. (Figs. 5a, b): gonapsis paired, consisting of paired basal laminae and median pieces, located above dorsal membrane, oriented backward, not accompanied with gonocristae; a pair of basal laminae (correspondents to lateral pieces, shown below) bugle-shaped, separated from each other, joining to bases of median pieces; median pieces positioned posteriorly to basal laminae, not single, consisting of extraordinarily asymmetrical pairs, distinctly separated except for bridge, free from the dorsal membrane; anterior margin of dorsal membrane extending laterad from basal laminae (i.e. lateral pieces). Japanese *Kuwayamachrysa* sp.: *kichijoi* (Kuwayama, 1936).

Tsukaguchi in 1995 mentioned that the gonapsis of *kichijoi* consisted of a pair of the asymmetrical and crossed arms but did not mention the median and lateral pieces. According to the present examination, the structure of the gonapsis is shown as follows: The bugle-shaped basal laminae are considered as correspondents to the lateral pieces from the connection with the dorsal membrane, and the arms positioned posteriorly to the basal laminae are treated as the median pieces. Furthermore the right and left median pieces are not completely separated from each other but joined by a bridge near the bases (Fig. 5b), and firmly connected with the basal laminae. The left median piece is backward oriented, rod-shaped and slightly curved, and the right median piece is also backward oriented but excessively long, whiplike, largely curved near basal half, extending far beyond the left one and transverse on the apical half.

The gonapsis of the holotype of *K. kichijoi* comb. nov. is different in the right median piece from those of the specimens examined here. The right median piece of the holotype (Tsukaguchi, 1995: Fig. 80h, figured in ventral view) is short,


S4
S12
atp
S11
S3
S6
S1
S5
S7
S2
Ls
Sms
Lds
ts
ss
scl
Mssr
Mtsr
7a
Asr1
Asr2
Asr3
Asr4
Asr5
Asr6
7b
S11
S12
Cm
Fm
Pm
Tm
Esm
Eml
7d
Mtsr
Mssr
Sgs
7c

not sclerotized apically beyond left median piece and may be regarded as a teneral state [see discussion by Adams (1987) and Adams and Penny (1987)].

2. *Female genital apparatus: bursa-vela connector*, *vaginal frame and laminate link* (Figs. 6b–d).

Since Tjeder (1966), studies of chrysopid female genitalia have been mainly focused on the subgenitale and spermatheca, but recently the studies of New World genera have significantly advanced and included membranous structures of the colleterial gland, bursa copuratrix and bursal duct [e.g., Adams (1977, 1987); Adams and Penny (1986, 1987); Tauber (2003, 2004, 2010); Tauber and Garland (2014); Tauber *et al.* (2006, 2012, 2013)]. Now, the female genitalia of Japanese chrysopid taxa must be reexamined in more detail. *Kuwayamachrysa* gen. nov. bears the following specialized apparatus which are expected to be morphologically and taxonomically noteworthy:

The bursa-vela connector (Figs. 6b–d: bvc) is positioned between the bursa copulatrix and the vela of the spermatheca, and is externally sclerotized, as a whole approximately oval, seen from the dorsal or ventral view and semi-circular, seen from the lateral view; the upper side somewhat spirally opening to the bottom of the bursa; the lower side joining a short membranous duct from the vela. The internal structure has not been able to be observed in our examination, but is sufficiently transparent to display a convoluted duct internally. Morphologically the bursa-vela connector is a derived modification of the bursal duct - usually a membranous duct that connects the bursa copulatrix with the vela of the spermatheca (see Adams and Penny, 1987). In the Japanese Chrysopini only *Chrysoperla* Steinmann, 1964 is known to bear a distinct, long bursal duct, which is not reported in other genera. Although detail between their bursa copulatrix and vela are unknown, the bursa copulatrix is almost directly connected with the vela (see Tsukaguchii, 1995).

The vaginal frame (Figs. 6b–d: vf) is an additional modification of the subgenitale; this structure is formed by dorsal extensions from the base of the subgenitale, covered with the posterior bottom of the bursa copulatrix and opens anteriorly, and the spermathecal duct is kept in the vaginal frame.

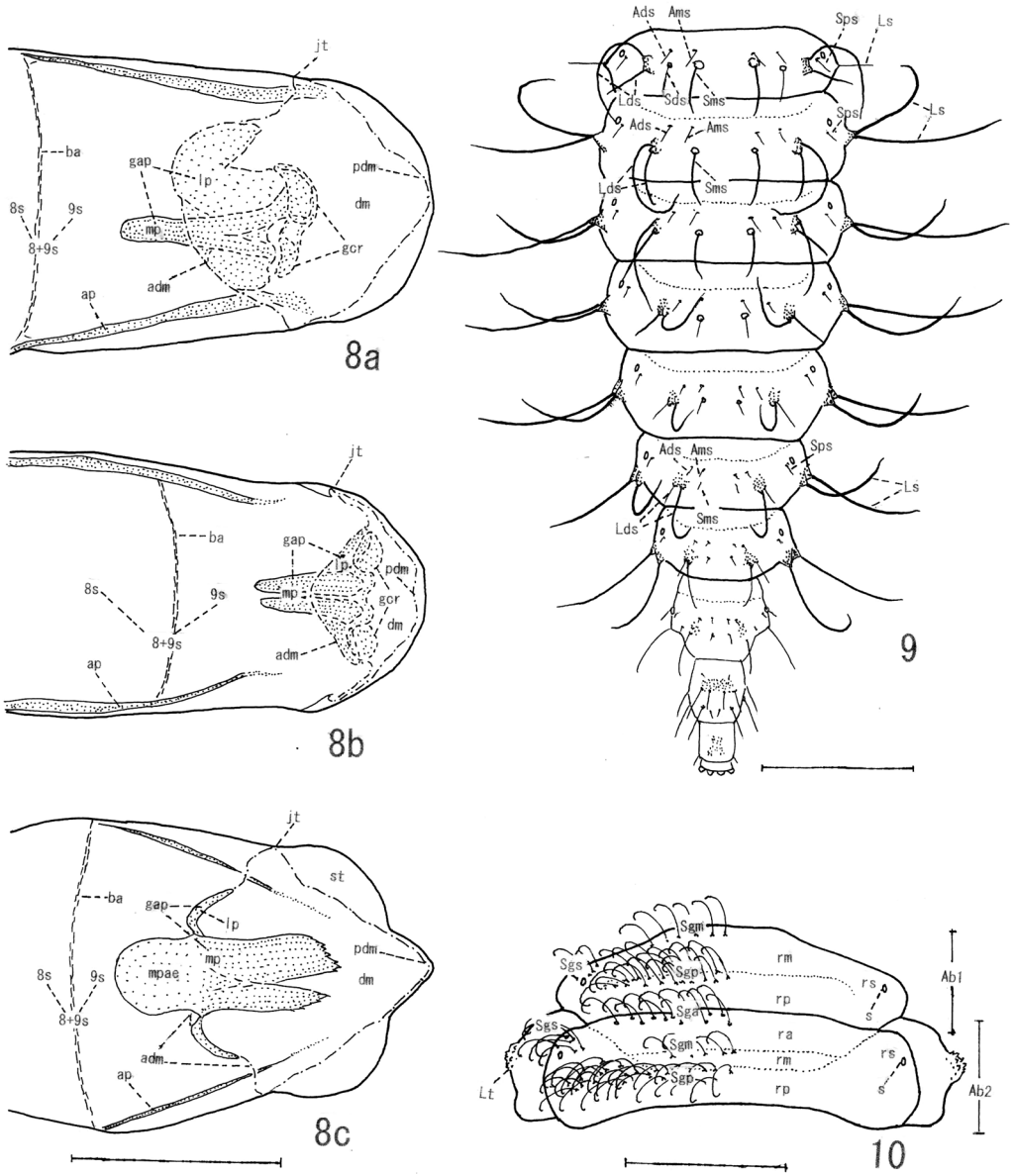
The laminate link (Figs. 6b–d: ll) is a pair of asymmetrical longitudinal laminae extending from the upper openings of the bursa-vela connector to the antero-lateral margins of the vaginal flame, not tubular but laminated, united with the bursa; the left link originating from the inner opening and the right link originating from the outer opening.

The female genitalia including the above genital elements and the subgenitale are variable probably related to the degree of sclerotization and/or maturation [see Adams (1987) and Adams and Penny (1987)]. A well sclerotized specimen was available for the figure in this study.

3. *Setae and setation in first instar larva* (Figs. 7a, b).

Tsukaguchi (1978) figured the larval setation (= chaetotaxy) of the Japanese *Chrysopa* and, following the usage of the lepidopteran taxonomy, treated the setae occurring in the first instar

Fig. 7. *Kuwayamachrysa kichijoi* (Kuwayama, 1936), comb. nov., larva, scale line, a and b: 0.2 mm, c: 2 mm, d: 0.7 mm, (a) first instar, setation of head and thorax, dorsal view, (b) do., setation of abdomen, dorsal view, (c) third instar, lateral view (atp, anterior tentorial pit; Asr-1 to Asr-6, transverse setal rows on each dorsal side of 1st to 6th abdominal segments; Lds, latero-dorsal setae; Ls, lateral setae; Mssr, mesothoracic transverse setal row between latero-dorsal sclerites; Mtsr, metathoracic transverse setal row between latero-dorsal sclerites: scl, latero-dorsal sclerite; Sgs: spiracular setal group; Sms, submedian seta; ss, secondary seta; S1–7, S11, 12, cranial primary setae 1 to 7, 11, 12; ts, transverse suture between latero-dorsal sclerites). (d) third instar, cranial markings and setation, dorsal view (Cm, clypeal marking; Eml, latero-dorsal part of epicranial marking; Ems, submedian part of epicranial marking; Fm, frontal marking; Pm, postfrontal marking; S1–7, S11, 12, cranial primary setae 1 to 7, 11, 12).



Figs. 8–10. 8. Location and direction of gonapsis, dorsal view, scale line: 0.6 mm, (a) *Pseudomallda ussuriensis* (Makarkin, 1985), (b) *Cunctochrysa albolineatoides* (Tsukaguchi, 1995), (c) *Mallada desjardinsi* (Navás, 1911) (ap, apodeme of sternite 8 + 9; ba, boundary of 8th and 9th sternites; jt, junction in anterior margin of dorsal membrane and lateral margin of 9th sternite; dm, dorsal membrane of 9th sternite (adm, anterior margin of dorsal membrane; pdm, posterior margin of dorsal membrane); gap, gonapsis (lp, lateral piece; mp, median piece; mpae, anterior extension from base of median piece); gcr, gonocristae; st, setiferous tubercle; 8s, 8th sternite; 9s, 9th sternite; 8 + 9s, sternite 8 + 9 = fused 8th and 9th sternites). Fig. 9. Primary setae on abdominal dorsal side in Chrysopini, first instar, scale line: 0.5 mm (Ams, antero-submedian seta = A1 in Tsukaguchi 1978; Ads, antero-subdorsal seta = A2 in Tsukaguchi 1978; Lds, latero-dorsal setae; Ls, lateral seta or setae; Sds, subdorsal seta; Sms, submedian seta; Sps, spiracular seta = SSp in Tauber *et al.*, 2000). Fig. 10. Setal groups on abdominal dorsal side of debris carrier larva in Japanese Chrysopini, third instar larva, 1st and 2nd segments, scale line: 1.0 mm (Ab1 and Ab2, 1st and 2nd abdominal segments; Lt, lateral tubercle; ra, anterior region; rm, median region; rp, posterior region; rs, spiracular region; s, spiracle; Sga, anterior setal group; Sgm, median setal group; Sgp, posterior setal group; Sgs, spiracular setal group).

as the primary setae. Although recently the setation on the abdominal dorsal side in the first instar has been found to be variable in *Suarius* Navás, 1914 (Díaz-Aranda and Monserrat, 1996; Monserrat and Díaz-Aranda, 2012), *Ceraeochrysa* Adams, 1982 (Tauber *et al*, 1998) and *Chrysopodes* Navás, 1913 (Tauber, 2003), it has been shown to be mostly conserved in genera of Chrysopini.

The primary setae on the abdominal dorsal side in Chrysopini is generally as shown in Fig. 9. The setal position and arrangement are not always constant but each dorsal side of the 1st to 6th abdominal segments bears the following common primary setae: a pair of Ams setae (antero-submedian setae); a pair of Ads setae (antero-subdorsal setae); a pair of Sms (submedian setae); two pairs of Lds (latero-dorsal setae); a pair of Sps (spiracular setae), and the 1st abdominal segment usually bears a pair of Sds (subdorsal setae) between submedian setae and latero-dorsal setae.

In contrast with the above common pattern of primary setae, *Kuwayamachrysa* gen. nov. bears many hooked setae on the dorsal sides of the 1st to 6th abdominal segments (Figs. 7b). Its setation is distinctly different from the basic setation of Chrysopini species and, judging from the figures of Díaz-Aranda and Monserrat (1996) and Monserrat snd Díaz-Aranda (2012), is somewhat similar to the setation of *Suarius*. The primary setae must be included among the hooked setae but are probably unable to be detected owing to being morphologically indistinguishable, that is, those hooked setae consist of the primary setae and other additional setae. Their additional setae are considered as secondary setae occurring in the first instar as also occurs in a few families of the Lepidoptera.

Similar additional setae are also observed on the thorax. On the meso- and metathoraces two pairs of the primary setae (i.e. a pair of submedian setae and a pair of latero-dorsal setae) are generally present between the latero-dorsal sclerites in the first instar larva of Chrysopini genera. In *Kuwayamachrysa* gen. nov., these primary setae are accompanied by a pair of the additional setae between the submedian setae and latero-dorsal setae; they may be also regarded as secondary setae.

4. *Setal group regions on abdominal dorsal side in debris carriers* (Fig. 10).

The typical debris carrier has a strongly humped abdomen in the second and third instars; it also lacks setiferous tubercles on the dorsal sides of the 1st to 5th or 6th segments and instead bears transverse rows of hooked setae.

The setation on the humped abdomen is apparently complicated and difficult for taxonomic treatment, but here four setal group regions are observed. The dorsal side of each of the 2nd to 6th segments is divided by the transverse suture into a small anterior region and a large main region. The 1st segment lacks the anterior region and consists of only the main region. Each main region is subdivided into median region and posterior region by the weak transverse suture, which is indistinct or may be not found. These regions are provided with groups of the setae in transverse rows, and each setal group is named as follows: anterior setal group, median setal group, posterior setal group. Another setal group on the spiracular region is observed and not divided by any boundary line but is usually isolated from above three groups and treated as the spiracular setal group.

As shown in Fig. 10, the dorsal side of the 1st segment consists of three regions (median, posterior and spiracular regions) with three setal groups (median, posterior and spiracular setal groups); each of the 2nd to 6th segments consists of four regions (anterior, median, posterior and spiracular regions) with four setal groups (anterior, median, posterior and spiracular setal groups). These setal group regions are characterized in relation to the abdominal primary setae as follows: anterior region without primary setae; median region with primary setae Ams and Ads; posterior region with primary setae Sms, Sds (present only in 1st segment) and Lds; spiracular region with primary seta Sps.

As stated above, *Kuwayamachrysa* gen. nov.

bears many secondary setae on the dorsal side of the abdomen in the first instar. Those setae are not present on the anterior region, but on the median and posterior regions. No setae are known to occur on the anterior region in any first instar.

In Japanese third instar debris carriers two kinds of the transverse setal rows occur, i.e. row of backward curved setae and row of forward curved setae. The backward curved setal rows occur in all the anterior, median and posterior groups but the forward curved setal rows are more limited; they occur in each last row of the anterior and posterior setal groups. In addition, the transverse rows of *Chrysotropia* Navás, 1914 and *Pseudomallada* consist of the only backward curved setal rows but those of *Cunctochrysa*, *Mallada*, and *Kuwayamachrysa* gen. nov. consist of sets of backward and forward curved setal rows.

Remarks.

According to the molecular analysis of Mochizuki *et al.* (2017) *Kuwayamachrysa* gen. nov. forms a phylogenetic clade with *Eremochrysa*, *Suarius* and *Chrysomesa*. Currently we have not been able to find any synapomorphic morphological character states to support the clade.

Kuwayamachrysa kichijoi

(Kuwayama, 1936), comb. nov.

[Japanese name: kichijo-kusakagerou]

Chrysopa kichijoi Kuwayama, 1936: 811, 817, Figs. 3, 4; 1962: 364.

Apertochrysa kichijoi: Tsukaguchi, 1985: 505; 1995: 63, Fig. 80. — Brooks and Barnard, 1990: 268. — Ichita, 1992: 96, 115 (Fig.). — Makarkin, 2000: 625. — Wada *et al.*, 2008: 42, Fig. 15. — Haruyama *et al.*, 2009: 41, Figs. 2, 3. — Tago, 2011: 31, Fig. 7. — Mochizuki *et al.*, 2017: 58, Fig. 3.

Redescription.

Adult (Figs. 1–6). Male: body length ca. 6.5–7.0 mm, head width ca. 1.2–1.3 mm, eye diameter ca. 0.5 mm, eye protrusion ca. 0.3 mm, antenna length ca. 12.0–12.4 mm, forewing ca. 11.5–12.0 mm, hindwing ca. 10.3–10.8 mm. Female: body length ca 7.6–9.5 mm, head width ca. 1.3–1.4 mm, eye diameter ca. 0.5–0.6 mm, eye protrusion ca. 0.3–0.4 mm, antenna length ca. 15.0 mm, forewing ca. 11.6–13.7 mm, hindwing ca. 10.5–12.5 mm.

Head yellowish-creamy, distinctly marked with black as shown in Figs. 2 and 3. Eye tinged greenish-red, with golden reflection. Antenna with scape almost as long as broad in dorsal view; scape and pedicel pale yellow, unmarked; flagellum ocherous. Mouthparts apparently almost creamy except for following: mandibles lustrous dark brown; maxillary palpus distinctly marked with black except at whitish apices of 3rd to terminal segments and partly tinged with dark brown on basal two segments; labial palpus marked with dark brown to blackish-brown on 2nd to terminal segments. Cervical region pale creamy to yellowish-creamy, marked with reddish-brown on latero-dorsal area (Fig. 3). Thorax with light greenish-yellow vitta on dorsal side, longitudinally marked with reddish-brown to dark-brown on prothoracic latero-dorsal area (Fig. 3), broadly green on meso- and metathoraces; lateral to ventral sides almost pale yellowish-green or pale whitish-blue, faintly tinged with pink on ventral median parts. Legs pale bluish-white; tarsi pale ocherous; claws lustrous brown. Wings (Fig. 4) with mainly pale green longitudinal veins; forewing mainly dark brown to blackish-brown on the following: costal veinlets except on pterostigma, basal subcostal crossvein, R–Rs crossveins, basal parts of Rs, Rs–M crossvein, branches of Rs to Psm, branches of Rs to gradates, gradates, M–Cu crossvein, most of median arculus and loop, cell im–Cu1 crossvein, Psm–Psc crossveins, Cu2 by cubital fork, Cu1–Cu2 crossveins, posterior marginal branches including those of 2A, 1A and Cu2, a few marginal branches near apex and several marginal folks near postero-lateral margin; hindwing mainly with brown to blackish-brown veins on the following parts of veins: costal veinlets except on pterostigma, R–Rs crossveins, gradates, several Psm–Psc crossveins in specimens, Psc–Cu1 crossvein and Cu1–Cu2 crossvein.

Number of gradates (ig/og) in male 4–8/6–8 (forewing) and 2–6/4–7 (hindwing) and in female 5–8/6–8 (forewing) and 4–6/6–7 (hindwing); additional gradate veins present between both gradate series in several specimens (Fig. 4: ag). Abdomen light yellowish-green, vividly marked with reddish-brown vitta on ventral side (Fig. 1b); microtholi not found. Setae not pigmented, translucent, whitish on head, thorax and abdomen, deep brown on antenna, dark brown on legs, dark brown to blackish-brown on wing veins, but in some lights those on antenna, legs and veins not pigmented, translucent or whitish; tarsi with blackish-brown spinescent setae on ventral sides.

Terminalia and genitalia, ♂ (Fig. 5): Apodeme of tergite 9 + ectoproct slender, curving gently, with downward branch under callus cerci; 9th sternite wavy in lateral view (Fig. 5a). Genitalia not pigmented, translucent to transparent except for median pieces of gonapsis; arcessus somewhat weakly sclerotized, especially near basal part, with medial pointed tooth and two pairs of lateral pointed teeth apically (Fig. 5c); gonosaccus transversely broad, with three pairs of minute gonosetae (Figs. 5c, e); spinellae consisting of numerous microscopic spines on apical half of gonosaccus and with a pair of distinct spinous arched rows extending from postero-median part toward lateral base on ventral side of gonosaccus (Fig. 5e); gonapsis very large, with median pieces brown to dark brown, provided with several teeth on apical part of light piece and a few teeth near medial part of left piece (Fig. 5b).

♀ (Fig. 6): Genitalia not pigmented, translucent to transparent except for blackish-brown spermatheca. Bursa copulatrix large, hemispherically dilated in antero-dorsal part (lateral view) (Fig. 6c), bluntly protruding apically, bearing microscopic spines on antero-dorsal surface; pair of bursal glands very slender (Figs. 6b–d).

Specimens examined. 10 ♂, 7 ♀.

Japan: Honshu- 1 ♀, Kayano-kogen, Aomori, Aomori Pref., 11. VIII. 1990 (T. Ichita), NSMT-Nr-6119; 1 ♂, Oirase-keiryu, Towada, Aomori Pref., 16. VIII. 1965 (S. Fukuda), NSMT-Nr-6120; 2 ♂, 1 ♀, laboratory-reared from a female collected at Yabukawa, Tamagawaku, Morioka, Iwate Pref., 20. VIII. 2007 (N. Haruyama), NIAES: 0000014-0000016; 1 ♂, Aza-Kuroiwayama, Hinoematamura, Minamiaizu, Fukushima Pref., 1. VIII. 2009 (N. Haruyama), NSMT-Nr-6121; 1 ♀, Irikawa (1220 m), Chichibu, Saitama Pref., 5. VII. 2008 (T. Tago), NSMT-Nr-6122; 2 ♂, 2 ♀, Irikawa (1220 m), Chichibu, Saitama Pref., 7–8. VIII. 2010 (T. Tago), NSMT-Nr-6123-6126; 1 ♀, Kofu, Yamanashi Pref., 5. VIII. 2012 (A. Mochizuki), NSMT-Nr-6127; 1 ♀, Asamasanso, Komoro, Nagano Pref., 14. VIII. 1974 (S. Okuno), NSMT-Nr-6128; 2 ♂, Kisojihara, Nagawa, Matsumoto, Nagano Pref., 24–26. VI. 1990 (Y. S. Bae), NSMT-Nr-6129-6130; 1 ♂, Todai, Hasekurogouchi, Ina, Nagano Pref., 3. VII. 1975 (F. Komai), NSMT-Nr-6131.

Korea: 1 ♂, Osaek-ri, Seo-myeon, Yangyang-gun, Gangwon-do, 5–11. VIII. 1989 (M. Tanaka), NSMT-Nr-6132

Larva (Fig. 7). General features: Small in size; cranium with five bold blackish-brown to black markings on dorsal side; thorax and abdomen almost wholly creamy, faintly tinged with yellow to grayish-yellow on dorsal side; terminal segment of abdomen distinctly blackening.

First instar (Figs. 7a, b): Length of body ca. 2.0–2.1 mm; head width ca. 0.3–0.34 mm.

Second instar: Length of body ca. 4.1–4.7 mm; head width ca. 0.5 mm.

Third instar (Figs. 7c, d): Length of body ca. 6.5 mm; head width ca. 0.7–0.74 mm. Head creamy, distinctly marked as in Fig. 7d; frontoclypeal marking bold T-shaped or inverted-triangular; postfrontal marking extending to antennal inner base; epicranial marking almost entirely separated into submedian and latero-dorsal parts except at base; genal marking running from eyes to cervical region along lateral margin, extending to latero-ventral area. Jaw brown to dark brown; cardo blackish-brown; stipes greyish-creamy, tinged with blackish-brown on posterior half. Cervical region marked with brown on latero-ventral area; lateral sclerite blackish-brown. Tho-

rax longitudinally marked with dark brown band on latero-dorsal area, the band faded or almost disappearing on meso- and metathoraces; prothoracic median sclerite indistinct and latero-dorsal sclerites dark brown on inner, outer and posterior parts, not pigmented on other parts: meso- and metathoracic latero-dorsal sclerites indistinct; pleural sclerites dark brown to blackish-brown. Legs blackish-brown on coxal basal parts, femoral apical halves, tibiae, tarsi, claws and apices of empodia. Abdomen dark brown to blackish-brown on sclerites of terminal three segments. Setae: cranium with about 12–13 secondary setae; simple setae not pigmented; hooked setae dark brown to blackish-brown, not stained with secretion apically; lateral setae fanning out from tubercles in lateral view.

Specimens examined. first instar, 3 exs.; second instar, 1 ex.; third instar, 5 exs.

Japan: Honshu- laboratory-reared larvae from a female collected at Aza-Kuroiwayama, Hinoematamudra, Minamiaizu, Fukushima Pref., 1. VIII. 2009 (N. Haruyama), NSMT-Nr-6133-6135 (first instar), 6136 (second instar), 6137–6141 (third instar).

Remarks.

K. kichijoi (Kuwayama, 1936), comb. nov. adults are distinct among the Japanese Chrysopidae species by the abdominal ventral side vividly pigmented with reddish-brown vitta in living specimens. But the vitta in dried and ethanol preserved specimens is gradually faded, almost evanescent in several years after death and entirely disappears in KOH-treated specimens. Hence it is not cuticular color but hypodermal color. Kuwayama (1936) did not refer to the color in his original description and Tsukaguchi (1995) also could not observe it probably because of the discoloration or disappearance. Therefore in old specimens it may be difficult to distinguish this species from *Pseudomallada parabolus* (Okamoto, 1919) by the vitta. The larva may be readily distinguishable from other Japanese debris carriers by the five bold blackish-brown to black markings on dorsal side of the cranium.

Biological notes.

This species is rare and occurs in mountainous regions. The adults have been found from June to August in deciduous woods, attracted by light in night and are not predaceous.

Distribution.

Japan (Hokkaido, Honshu); Korea; Far East of Russia.

Acknowledgments

We wish to express our sincere thanks to Dr. C. A. Tauber (Cornell University, Ithaca, U.S.A.) and Dr. F. Komai (Ryukyu University Museum, Fujukan) for their critical reading of the manuscript and giving helpful criticism and guidance. We also express our hearty thanks to Mr. N. Haruyama (Plant Protection Section, Tochigi Prefectural Sustainable Agriculture Extension Center), Dr. N. Hirai (Osaka Prefecture University), Mr. T. Ichita (Aomori Prefecture), Mr. K. Ikeuchi (Osaka Prefecture), the late Dr. A. Mochizuki (Shizuoka Prefecture), Mr. S. Okuno (Osaka Prefecture), Mr. M. Tanaka (Hyogo Prefecture) and Dr. S. Yoshimatsu (NIAES) for kind offer or loan of valuable adult specimens. We are particularly grateful to the late Dr. A. Mochizuki for offering larval specimens, significant information on abdominal reddish-brown vitta which he first found, and literature. Further, the first author wishes to express his sincere gratitude to the following entomological taxonomists for kind guidance and help: Dr. S. Hashimoto (Aichi Prefecture), Dr. U. Jinbo (NSMT), Dr. Y. Nasu (Wakayama Prefecture) and Dr. A. Shinohara (NSMT).

References

Adams, P. A., 1977. Taxonomy of United States *Leucochrysa* (Neuroptera: Chrysopidae), Psyche, 84(1): 92–102.

Adams, P. A., 1987. Studies in neotropical Chrysopidae (Neuroptera) 3. Notes on *Nodita amazonica* Navás and *N. oenops*, n. sp., Neuroptera international, 4(4): 287–294.

Adams, P. A. and N. D. Penny 1986. Faunal Relations of

Amazonian Chrysopidae. In Gepp, J., H. Aspöck and H. Hölzel (eds.): Recent research in neuropterology. Proceedings of the 2nd International Symposium on Neuropterology, pp. 119–124.

Adams, P. A. and N. D. Penny 1987. Neuroptera of Amazon Basin, Part 11a, Introduction and Chrysopini. Acta Amazonica, 15: 413–479.

Brooks, S. J. and P. C. Barnard 1990. The green lacewings of the world: a generic review (Neuroptera: Chrysopidae). Bulletin of the British Museum Natural History, Entomology, 59(2): 117–286.

Díaz-Aranda, L. M. and V. J. Monserrat 1996. On the larval stages of genus *Suarius* Navás, 1914 in Europe (Neuroptera: Chrysopidae), Deutsche entomologische Zeitschrift, N. F., 43(1): 89–97.

Haruyama, N., A. Mochizuki, H. Konno, H. Sakamoto and K. Yamaguchi 2009. Additional record of two rare species of Chrysopidae in Japan. GEKKAN-MUSHI, 458: 41–42. (In Japanese.)

Ichita, T. 1992. Neuroptera of Aomori Prefecture. Celastrina, 27. (In Japanese.)

Kuwayama, S. 1936. The Chrysopidae of the northern Nippon. Zoological Magazine, 84: 811–820. (In Japanese with English resume.)

Kuwayama, S. 1962. A revisional synopsis of the Neuroptera in Japan. Pacific Insects, 4(2): 325–412.

Makarkin, V. J. 2000. Order Neuroptera - lacewings: 625–627. In Ler, P. A. (chief ed.): Key to insects of Far East of Russia 4, Neuropteroidea, Mecoptera, Hymenoptera 4. 651 pp. Dal'nauka, Vladivostok. (In Russian.)

Mochizuki, A., C. S. Henry and P. Duelli 2017. *Apertochrysa* (Neuroptera: Chrysopidae): A heterogeneric phantom? Zootaxa, 4238(1): 058–072.

Monserrat, V. J. and L. M. Diaz-Aranda 2012. Larval stages of the Iberian green-lacewings (Insecta, Neuroptera, Chrysopidae), new data on larval morphology applicable to the family systematics. Graellisia, 68(1): 31–158. (In Spanish with English abstract.)

Tago, T. 2011. Insects recorded from the University of Tokyo Chichibu Forest, The University of Tokyo Chichibu Forest and its vicinity, Neuroptera (2). Yosegaki, 143: 29–35. (In Japanese.)

Tauber, C. A. 2003. Generic characteristics of *Chrysopodes* (Neuroptera: Chrysopidae) with new larval Descriptions and a review of species from the United States and Canada. Annals of the Entomological Society of America, 96(4): 472–490.

Tauber, C. A. 2004. Systematic Review of the Genus *Leucochrysa* (Neuroptera: Chrysopidae) in the United States, 97(6): 1129–1158.

Tauber, C. A. 2010. Revision of *Neosuarius*, a subgenus of *Chrysopodes* (Neuroptera: Chrysopidae), ZooKeys, 44: 1–104.

Tauber, C. A. and J. A. Garland 2014. *Kymachrysa*, a genus of Nearctic Green Lacewings (Neuroptera, Chrysopidae, Chrysopini), ZooKeys, 437: 87–108.

Tauber, C. A., G. S. Albuquerque and M. J. Tauber 2012. Three new Brazilian species of *Chrysopodes* (Neuroptera: Chrysopidae). Annals of the Entomological Society of America, 105(5): 638–663.

Tauber, C. A., T. De León, J. I. Lopez Arroyo and M. J. Tauber 1998. *Ceraeochrysa placita* (Neuroptera: Chrysopidae): Generic characteristics of larvae, larval description, and life cycle. Annals of the Entomological Society of America, 91(5): 608–618.

Tauber, C. A., T. De Leon, N. D. Penny and J. Tauber 2000. The genus *Ceraeochrysa* (Neuroptera: Chrysopidae) of America north of Mexico: Larvae, adults and comparative biology. Annals of the Entomological Society of America, 93(5): 1195–1221.

Tauber, C. A., F. Sosa and G. S. Albuquerque 2013. Two common and problematic leucochrysine species-*Leucochrysa* (*Leucochrysa*) *varia* (Schneider) and *L.* (*L.*) *pretoisa* (Banks) (Neuroptera, Chrysopidae): redescriptions and synonymies. ZooKeys, 310: 57–101.

Tauber, C. A., M. J. Tauber and G. S. Albuquerque 2006. *Berchmansus elegans* (Neuroptera: Chrysopidae): Larval and adult characteristics and new tribal affiliation. European Journal of Entomology, 103: 221–231.

Tillyard, R. J., 1916. Studies in Australian Neuroptera, 3. The wing-venation of the Chrysopidae. Proceedings of the Linnean Society of New South Wales, 41(2): 221–248.

Tjeder, B. 1966. Neuroptera-Planipennia. The lace-wings of Southern Africa, 5. Family Chrysopidae. South African Animal Life, 12: 228–535.

Tsukaguchi, S. 1978. Descriptions of the larvae of *Chrysopa* Leach (Neuroptera, Chrysopidae) of Japan. Kontyu, Tokyo, 46(1): 99–122.

Tsukaguchi, S. 1979. Taxonomic notes on *Brinckochrysa kintoki* (Okamoto) (Neuroptera, Chrysopidae). Kontyu, Tokyo, 47(3): 358–366.

Tsukaguchi, S. 1985. A check list of published species of Japanese Chrysopidae (Neuroptera). Kontyu, Tokyo, 53(3): 503–506.

Tsukaguchi, S. 1995. Chrysopidae of Japan (Insecta, Neuroptera). 223 pp. Author's publication, Hyogo.

Wada, I., T. Iwata and T. Tago 2008. Records of Neuroptera・Raphidioptera・Megaloptera collected from Saitama・Chiba・Tokyo Prefectures. Yosegaki, 132: 37–54. (In Japanese.)