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<td>Author(s)</td>
<td>Kamijo, Kazuaki; Takada, Hajimu</td>
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<tr>
<td>Citation</td>
<td>Insecta matsumurana. New series : journal of the Faculty of Agriculture Hokkaido University, series entomology, 2, 39-76</td>
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<td>Issue Date</td>
<td>1973-11</td>
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<tr>
<td>Doc URL</td>
<td><a href="http://hdl.handle.net/2115/9773">http://hdl.handle.net/2115/9773</a></td>
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STUDIES ON APHID HYPERPARASITES OF JAPAN, II
APHID HYPERPARASITES OF THE PTEROMALIDAE
OCcurring IN JAPAN (HYMENOPTERA)

By KAZUAKI KAMIJO and HAJIMU TAKADA

Abstract


Eleven aphid-hyperparasitic species of Asaphes Walker (2 spp.), Assaphinae, and Coruna Walker (2 spp.), Pachyneuron Walker (5 spp.) and Euneura Walker (2 spp.), Pteromalinae, occurring in Japan are dealt with. Keys to the genera and to the species, descriptions, illustrations, and biological notes are given on the basis of about 1,300 specimens mainly reared. Host aphid—hyperparasite / primary parasite and primary parasite / host aphid—hyperparasite lists are added. A. pubescens, C. laevis, P. sapporense and P. doraphis are new spp. and A. suspensus (Nees), C. clavata Walker and E. augurus Walker new to Japan. P. gifuense Ashmead is synonymized with P. aphidis (Bouché), P. umbratum Delucchi with P. mitsukurii Ashmead, and E. laeviuscula Graham with E. nawai (Ashmead), comb. n. (=Pachyneuron nawai). P. mitsukurii is recorded as an aphid hyperparasite for the first time. As hosts of these hyperparasites 50 species of aphids in 32 genera and 34 species of aphidiids in 12 genera are recorded, and 141 different host aphid—primary parasite—hyperparasite relationships are recognized. Asaphes- and Pachyneuron-species are widely associated with various groups of Aphidoidea and Aphidiidae. Euneura-species are hyperparasitic exclusively on aphids of Lachnidae or Pterocomma through aphidiids of Pauesia, Diaeretus or Aphidius cingulatus, while such associations are unknown for Coruna. Habits of Pachyneuron-species, some of which have wide diversity in host and mode of parasitism, are discussed. Asaphes and Pachyneuron occur widely in field- to forest-type, Coruna in field- to intermediate-type, and Euneura in forest-type habitats. In any genus each species shows definite preference of habitats.

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INTRODUCTION

This paper, in which some species belonging to the Pteromalidae are reported, is the 2nd part of serial works on the taxonomy, distribution and host range of the hyperparasites of aphids occurring in Japan.

Four genera of Pteromalidae, Asaphes, Coruna, Pachyneuron and Euneura, are known as solitary, external hyperparasites of aphids through Aphidiidae and Aphelinidae. The species of these genera oviposited upon the prepupae or pupae of the primary parasites that have spun cocoons within the mummified aphids (Hagen & van den Bosch, 1968). Some Pachyneuron may attack other groups of insects in addition to those mentioned.

Of these 4 genera Asaphes and the other genera are taxonomically quite different: the former belongs to the Asaphinae and the latter to the Pteromalinae (Graham, 1969). Pachyneuron and Euneura are extremely allied to each other as Delucchi (1955) and Graham (1969) stated. Euneura is possibly a specialized group of Pachyneuron in their certain aspects in habitat and host. Coruna seems to be not so close to Pachyneuron and Euneura, being easily distinguishable from the latter in having complete notauli. However, these 3 genera are considered to belong to a monophyletical group because their wing venations are homogeneous. In conclusion the 2 groups, Asaphes on one side and Coruna, Pachyneuron and Euneura on the other, probably have independently developed the hyperparasitic mode of life on aphids.

So far as we are aware, 4 species of these genera have been reported from Japan by Ashmead (1904), Ishii (1938), Yasumatsu et al. (1946) and Hirose (1969). In the present paper are added to the fauna 7 other species, of which 4 are new to science. The terms used in this paper follow Graham (1969) except that the dorsal segment lying behind the petiole, the true third abdominal segment, is counted as “first tergite” and that the area above the clypeus and below the median ocellus is regarded as the face. The host aphids were identified by Dr. V. F. Eastop, Dr. M. Miyazaki and Dr. H. Higuchi and the aphidiids by the junior author. All the types of the new species described herein are deposited in the collection of the Entomological Institute, Hokkaido University, Sapporo.

The present study was partly carried out at the Entomological Institute of Hokkaido University while the junior author was enrolled at that Institute. This paper constitutes Contribution No. 134 from Entomological Laboratory, Kyōto Prefectural University.

CLASSIFICATION

Key to aphid-hyperparasitic genera of Pteromalidae

1. Pronotal collar not margined; occiput margined; fore wing with marginal vein not thickened (Fig. 2, 4); antennae inserted at level of ventral edge of eyes; notaulices complete .................................................. Asaphes Walker
   - Pronotal collar sharply margined; occiput not margined; fore wing with marginal vein thickened throughout (Fig. 5, 11, 28); antennae inserted above level of ventral edge of eyes; notaulices incomplete or complete .......................... 2
2. Notaulices complete and deep throughout; marginal vein long, at least half as long as submarginal vein; first tergite narrow and elongate, extending beyond apex of second tergite (Fig. 10) ........................................... Coruna Walker
- Notaulices incomplete; marginal vein short, at most one-third as long as submarginal vein; first tergite not reaching hind margin of second tergite, except in male of Pachyneuron sapporense sp. n. ........................................... 3

3. Gaster dorsally more or less sunken or flat discally; supracoxal flange of propodeum not developed, much shorter than nucha; hind femur without keels in distal two-fifths; antennae with scape fully reaching level of median ocellus, if not (female of P. sapporense, sp. n.) then the thorax is weakly arched dorsally (Fig. 15); vertex curving over into occiput and forming a rounded ridge where the two surfaces join ..............
- Gaster strongly convex dorsally, spindle-shaped; supracoxal flange well developed, a little longer than nucha (Fig. 26); hind femur with sharp keels in distal two-fifths (Fig. 27); antennae with scape not reaching level of median ocellus; vertex, behind posterior ocelli, forming a rather sharp ridge with occipital surface ............... Euneura Walker

Genus Asaphes Walker

Asaphes Walker, 1834, Ent. Mag. 2: 151 [type-species: Asaphes vulgaris Walker].
Isocratus Förster, 1856, Hym. Stud. 2, pp. 53, 58 [new name for Asaphes Walker, supposedly preoccupied].

The species of Asaphes occur in the Palaearctic, Oriental, Nearctic, and Neotropical regions, including 6 species. They are principally hyperparasitic on aphids through various species of Aphidiidae.

In Japan 2 species have been found to occur: one is new to science and the other new to Japan.

Key to species

Females

1. Pedicel at most twice as long as wide in profile (Fig. 1); combined length of pedicel and flagellum shorter than width of head; mesoscutum with long and sparse hairs; all femora pale yellowish brown; head and thorax bright green or blue ................. suspensus (Nees)
- Pedicel slender, nearly 3 times as long as wide in profile (Fig. 3); combined length of pedicel and flagellum longer than width of head; mesoscutum with short and dense hairs; all femora metallic dark green; head and thorax very dark bluish green with a strong bronzy tinge ................. pubescens sp. n.

Males

1. Combined length of pedicel and flagellum shorter than width of head; mesoscutum with long and sparse hairs; antennae with flagellum yellowish brown; all femora pale yellowish brown; head and thorax bright bluish green or blue ................. suspensus (Nees)
- Combined length of pedicel and flagellum longer than width of head; mesoscutum with short and dense hairs; antennae with flagellum blackish brown; femora, at least hind and mid ones, metallic dark green; head and thorax very dark blue with a weak bronzy tinge ................. pubescens sp. n.
Asaphes suspensus (Nees)


The Japanese specimens examined agree well with Graham's description, except for the structure of the male antennae and the lighter legs in colour as mentioned below.

On the basis of the Japanese specimens, A. suspensus is characterized as follows.

**Female.** Length of body 1.2—1.8 mm. Head in dorsal view with temples curved and rather strongly convergent, not angulate posteriorly. Combined length of pedicel and flagellum shorter than width of head; pedicel twice as long as wide in profile; second anellus larger than the first, varying from twice as wide as long to subquadrate; funicle segments progressively increasing in width, the first segment quadrate or slightly transverse, the sixth segment 1.5—2.0 times as wide as long (Fig. 1).

Pronotum with sides distinctly narrowed anteriorly. Dorsum of thorax sparsely hairy; scutellum with about 5 hairs at each side. Fore wing with marginal vein slightly shorter than postmarginal vein and slightly longer than stigmal vein (Fig. 2); speculum absent, but hairs sparser on area along parastigma and marginal vein.

Head and thorax dark to bright green with faint bronzy reflections, bluish green, or blue; propodeum and petiole darker and less bright; gaster blackish. Scape concolorous with head; pedicel with metallic reflections; flagellum blackish brown. Coxae concolorous with thorax; the rest of legs pale yellowish brown.

**Male.** Length of body 0.7—1.4 mm. Antenna with second anellus varying from twice as wide as long to quadrate; first 3 funicle segments slightly transverse or quadrate; sixth segment distinctly transverse.

Head and thorax tending to be bright green or blue; pedicel yellowish brown, sometimes darker proximally with faint metallic reflections; flagellum yellowish brown, sometimes all funicle segments slightly infuscate.
Material and host*: 895o, Kumamoto—Aphidiid sp./Macrosiphum smilacifolae/Takahashi/Smilax china; 29, Sapporo (K. Kusigemati) & 194o, Niigata (A. Otake)—Aphidiid sp./Rhopalosiphum padi (Linne)/Triticum aestivum; 19, Yakushima—Taberocephalus sakurae (Matsumura)/Prunus sp. (cherry); 496o, Hiko-san—Aphidius sp./Acyrthosiphon muradachi (Shinji)/Parabenzoin praecox; 2910, Kyōto—Aphidius sp./Hyperomyzus lactucae (Linne)/Sonchus oleraceus; 19, Kyoto—Aphidius sp./Macrosiphum ibarae Matsumura/Rosa sp.; 10, Kagoshima—Aphidius sp./Pterocomma sp./Salix sp.; 19, Kyoto—Aphidius cingulatus Ruthe; 596o, Kyoto—Aphidius areolatus Ashmead/Periphyllus californiensis (Haliday)/Acer sp.; 193o, Sapporo—Aphidius avenae Haliday/Macrosiphum akebiae Shinji/Triticum aestivum; 1935, Sapporo—Aphidius cingulatus Ruthe/Pterocomma sp./Salix sp.; 29, Kyōto—Aphidius gifuensis Ashmead/Macrosiphum euphorbiae (Thomas)/Sonanum tuberosum; 4915, Sapporo (Raphanus sativus & Solanum tuberosum), 4912, Kyōto (Brassica oleracea, Raphanus sativus & Spinacia oleracea) & 35, Kochi (Althaea rosea)—Aphidius gifuensis Ashmead/Myzus persicae (Sulzer); 16, Kagoshima—Aphidius salicis Haliday/Cavariella araliae Takahashi/Tetrapanax papyrifera; 26, Tottori & 16, Kagoshima—Aphidius salicis Haliday/Cavariella salicicola (Matsumura)/Salix sp.; 95, Sapporo—Aphidius sicarius Mackauer/Calipterinella calliptera (Hartig)/Betula sp.; 19, Kyōto—Biondaxys centaureae (Haliday)/Macrosiphum ibarae Matsumura/Rosa sp.; 5965, Kyōto—Diaeretiella rapae (M’Intosh)/Brevicoryne brassicae (Linne)/Brassica oleracea; 36, Kyōto—Diaeretiella rapae (M’Intosh)/Lipaphis erysimi (Kaltenbach)/Raphanus sativus; 2952, Kyōto, 19, Sasebo & 33, Nobeoka—Diaeretus leucopterus (Haliday)/Eulachnus thunbergii Wilson/Pinus thunbergii; 6935, Sapporo—Dyscritulus sp./Periphyllus sp./Acer sp.; 7935, Fukuoka—Ephedrus sp./Aphis craccivora Koch/Robinia pseudo-acacia; 29, Fukuoka—Ephedrus sp./Aphis nerii Boyer/Nerium indicum; 5915, Takarazuka—Ephedrus sp./Macrosiphum akebiae Shinji/Stauntonia hexaphylla; 11970, Kyōto—Ephedrus sp./Macrosiphum ibarae Matsumura/Rosa sp.; 19, Sapporo—Ephedrus sp./Myzus sp./Prunus sp.; 19, Fukuoka—Ephedrus nacheri Quilis/Coloradoa artemisicola Takahashi/Artemisia sp.; 29, Kumamoto—Ephedrus nacheri Quilis/Hyalopterus pruni (Geoffroy)/Prunus sp.; 29, Kumamoto—Ephedrus nacheri Quilis/Hyperomyzus lactucae (Linne)/Sonchus oleraceus; 2945, Sapporo—Ephedrus persicae Froggatt/Aphidid sp./Chaenomeles japonica; 1925, Kyōto & 2945, Kumamoto—Ephedrus persicae Froggatt/Capitophorus sp./Elaeagnus umbellata; 19, Fukuoka—Ephedrus plagiator (Nees)/Acyrthosiphon muradachi (Shinji)/Parabenzoin praecox; 1935, Kyōto—Ephedrus plagiator (Nees)/Aphis spiraeola Patch/Spiraea thunbergii; 1915, Kyōto—Ephedrus plagiator (Nees)/Macrosiphum akebiae Shinji/Stauntonia hexaphylla; 1995, Nara—Ephedrus plagiator (Nees)/Melanaphis bambusae (Fullaway)/Rosaceous sp.; 4935, Kyōto—Ephedrus plagiator (Nees)/Myzus persicae (Sulzer)/Malus sp.;

* Unless otherwise stated the specimens were collected by the junior author. Primary parasite (=real host), phytophagous host and host plant are given in the mentioned order. For example, “Aphidius gifuensis Ashmead/Myzus persicae (Sulzer)/Raphanus sativus” means that the hyperparasite concerned was reared from A. gifuensis, a parasite of M. persicae on R. sativus.
13990, Miyazaki & 39, Aoshima—Ephedrus plagiator (Nees)/Toxoptera odinae (van der Goot)/Pittosporum tobira; 59, Sapporo—Ephedrus salicicola Takada/Cavariella salicicola (Matsumura)/Salix vulpina; 1933, Kure, 39, Matsuyama & 18, Fukuoka—Lysaphidus pleotrichophori Takada/Pleotrichophorus glandulosus (Kaltenbach)/Artemisia sp.; 2933, Sapporo & 1933, Kyoto—Lysiphlebus japonicus Ashmead/Aphis gossypii Glover/Solanum tuberosum; 19, Fukuoka—Lysiphlebus japonicus Ashmead/Aphis spiraecola Patch/Spiraea thunbergii; 2918, Kyoho—Paelesia abietis (Marshall)/Cinara pineti (Koch)/Pinus densiflora; 19, Kyoho—Paelesia akamatsucola Takada/Cinara pineti (Koch)/Pinus densiflora; 19, Kyoho—Paelesia momicola Watanabe & Takada/Cinara sp./Abies firma; 1933, Kyoho—Paelesia unilachni (Gahan)/Schizolachnus sp./Pinus densiflora; 18, Sapporo—Praon sp./Aphidid sp./Magnolia kobus; 19, Sapporo—Praon sp./Aphidid sp./Stephanandra incisa; 19, Sapporo—Praon sp./Acyrtosiphon ibotum (Essig & Kuwana)/Ligustrum obtusifolium; 1923, Sapporo—Praon sp./Cavariella salicicola (Matsumura)/Salix vulpina; 33, Kumamoto—Praon sp./Hyperomyzus lactucae (Linné)/Sonchus oleraceus; 19, Kyoho—Praon sp./Myzus malisuctus Matsumura/Malus sp.; 3923, Sapporo & 19, Kumamoto—Praon capitophori Takada/Capitophorus sp./Elaeagnus umbellata; 11983, Sapporo—Praon dorsale (Haliday)/Indomegoura indica (van der Goot)/Staphylea bumalda; 18, Sapporo—Praon flavinode (Haliday)/Euceraphis punctipennis (Zetterstedt)/Betula sp.; 409343, Sapporo—Praon volucre (Haliday)/Acyrtosiphon magnoliae (Essig & Kuwana)/Sambucus sieboldiana; 3933, Sapporo—Praon volucre (Haliday)/Acyrtosiphon syringae (Matsumura)/Syringa emodi & S. reticulata; 3923, Kyoho—Praon volucre (Haliday)/Macrosiphum ibareae Matsumura/Rosa sp.; 19, Sapporo—Praon volucre (Haliday)/Unisitobion sorbi (Matsumura)/Sorbaria sorbiloides (Matsumura)/S. suwae; 8953, Naganuma; 7935, Sapporo (H. Higuchi, K. Kusigemati & M. Miyazaki); 1918, Kumamoto; 3915, Kagoshima (K. Kusigemati).


Geographical distribution: Japan; Europe.

Asaphes pubescens sp. n.

Female. Length of body 1.5—2.5 mm. Head in dorsal view a little wider than thorax, twice as wide as long; temples curved and strongly convergent, and about one-third as long as eye. Antennal scrobes rather deeply excavated. Postocular line more than twice as long as ocellar line (7: 2.8). Eyes separated by 1.1 times their own length, with inner orbits parallel. Malar space about half as long as eye (8: 14). Genal sulcus weak but distinct. Head finely reticulate coriaceous, more strongly so on vertex, with upper face and anterior half of genae smooth. Scape almost reaching level of vertex; combined length of pedicel and flagellum a little longer than width of head; pedicel slender,
nearly 3 times as long as wide, a little shorter than club; first anellus twice as wide as long, second anellus quadrate, sometimes slightly longer than wide; funicle segments progressively increasing in width, the first segment being quadrate, sixth segment distinctly transverse (Fig. 3).

Thorax rather slender, 1.7 times as long as wide. Pronotum about twice as wide as long, convex, with sides hardly narrowed toward apex in posterior two-thirds and having numerous minute tubercles from which arise greyish hairs, area between tubercles smooth and shining. Mesoscutum slightly shorter than scutellum, with sculpture like that of pronotum but somewhat coriaceous, with dense and short hairs. Scutellum a little longer than wide, finely reticulate coriaceous, with several long hairs and dense, short hairs except medially; frenal furrow rather weak; frenum smooth medially and aciculate laterally. Metascutellum smooth with hairs at sides. Propodeum two-thirds as long as scutellum, moderately produced beyond bases of hind coxae, its sculpture very variable, coarsely and strongly reticulate, with smooth area antero-laterally; median carina sometimes indicated anteriorly; nucha hardly developed. Fore wing: basal cell hairy throughout; speculum entirely reduced; marginal vein a little longer than stigmal vein, which is half as long as postmarginal vein (Fig. 4).

Petiole quadrate with several longitudinal carinae; area between carinae finely reticulate or almost smooth. Gaster (not including petiole) nearly as long as thorax, 1.8 times as long as wide; first tergite occupying one-third length of gaster; second tergite as long as combined length of the third and fourth; surface of gaster smooth and shining; first tergite with a few hairs at base laterally.

Head and thorax very dark bluish green with a strong bronze tinge especially on upper face, pronotum, mid lobe of mesoscutum, and scutellum. Gaster blackish. Scape and pedicel dark green, flagellum blackish brown, usually with faint metallic reflections. Coxae and femora concolorous with thorax; distal tips of femora, tibiae, and tarsi dark brown, tibiae with metallic reflections medially. Veins of fore wings dark brown.

Male. Very similar to female but differing as follows. Pedicel less slender, nearly 2.5 times as long as wide; flagellum as long as width of head; second anellus slightly longer than wide or quadrate; first funicle segment quadrate or slightly longer than wide, sixth segment a little wider than long. Petiole longer than wide (8: 6). Gaster much shorter than thorax; first tergite as long as remainder tergites together.

Head and thorax very dark blue with a weak bronze tinge; fore and mid femora sometimes lighter. Length of body 1.0—1.7 mm.

Holotype: ♀, Sapporo, 7. vi. 1963, Praon volucre (Haliday)/Acyrthosiphon magnoliae (Essig & Kuwana)/Sambucus sieboldiana.

Material & host: 1♀, Kyōto—Aphidius areolatus Ashmead/Periphyllus californiensis (Shinji)/Acer sp.; 1♀ 1♂, Kōchi—Aphidius salicis Haliday/Cavariella salicicola (Matsumura)/Salix sp.; 1♀ 1♂, Sapporo—Dyscritulus sp./Periphyllus sp./Acer sp.; 1♂, Takamatsu—Ephedrus plagiator (Nees)/Aphis spiraecola Patch/Viburnum suspensum; 1♀, Yuni—Pauesia konoi (Watanabe)/Cinara longipennis.
(Matsumura) Abies sachalinensis; 4♀ 19♂, Takamatsu—Pauesia unilachni (Gahan)/
Schizolachnus sp./Pinus densiflora; 1♀ 6♂, Sapporo—Praon sp./Aphidid sp./
Cercidiphyllum japonicum; 9♀ 6♂, Sapporo (M. Miyazaki)—Praon dorsale (Haliday)/
Indomegoura indica (van der Goot)/Staphylea bumalda; 2♀, Sapporo—
Praon flavinode (Haliday)/Euceraphis punctipennis (Zetterstedt)/Betula sp.; 8♀
12♂, Sapporo—Praon volucre (Haliday)/Acyrthosiphon magnoliae (Essig & Kuwa-
na)/Sambucus sieboldiana; 1♀, Sapporo—Praon volucre (Haliday)/Acyrthosiphon syringae (Matsumura)/Syringa emodi; 1♀, Sapporo—Triaxys euceraphis Takada/
Euceraphis punctipennis (Zetterstedt)/Betula sp.

Locality in Japan: Hokkaidō—Yuni & Sapporo; Honshū—Kyōto; Shikoku—
Takamatsu & Kōchi.

Geographical distribution: Japan.

Genus Coruna Walker

Coryna Walker, 1846, List Hym. Ins. Brit. Mus. 1, p. 29 [invalid emendation; preoc-
cupied].
Pachycrepis Förster, 1856, Hym. Stud. 2, pp. 51, 54, 59 [new name for Coruna Walker,
supposedly preoccupied].

This genus has been represented by 2 species, C. clavata being widespread
in the Holarctic region and C. orientalis (Crawford) from the Phillipines. In
this paper a third species of the genus will be described below. The available
host records indicate that the species of this genus are exclusively hyperparasitic
on aphids through Aphidiidae. The Japanese species are distinguished as follows.

Key to species

Males and females

1. Eyes less prominent with inner orbits parallel; ocellocular line 1.5 times as long as
diameter of lateral ocellus; propodeum finely reticulate; marginal vein distinctly shorter
than postmarginal vein, 1.3 times as long as stigmal vein; stigma large (Fig. 5); ant-
ennae dark brown with scape yellowish brown; in male fourth to sixth tergites dis-
tinctly reticulate .......................................................... clavata Walker

- Eyes prominent with inner orbits divergent below (Fig. 7); ocellocular line as long as
diameter of lateral ocellus; propodeum smooth and polished; marginal vein a little
longer than postmarginal vein, twice as long as stigmal vein; stigma small (Fig. 9);
antennae wholly yellowish brown; in male fourth to sixth tergites alutaceous ....
.......................................................... laevis sp. n.

Coruna clavata Walker


Through the kindness of Dr. Bouček, we have been able to examine 2 speci-
mens of clavata identified by himself (♀, Bohemia, 20. viii. 1956; ♂, Bohemia, 20.
vii. 1955, Z. Bouček). The Japanese specimens at hand agree well with them,
 differing only in the stronger sculpture on the mesoscutum and scutellum. This

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species is new to Japan. The following redescription is based on the Japanese specimens.

**Female.** Length of body 1.6—2.2 mm. Head twice as wide as long in dorsal view. Postocellar line about 1.3 times as long as ocellocular line, which is 1.5 times as long as the diameter of the lateral ocellus. Eyes separated by about 1.2 times their own length. Scape fully reaching level of vertex; combined length of pedicel and flagellum a little longer than width of head; pedicel nearly as long as first funicle segment; funicle segments almost equal in length, distinctly longer than wide.

Thorax strongly arched dorsally. Median lobe of mesoscutum rather strongly reticulate, the side lobes more weakly so; notaulices deep throughout. Scutellum moderately reticulate, more coarsely so on frenum. Propodeum densely reticulate, usually with a weak median carina; nucha distinctly set off, smooth. Fore wing: submarginal vein twice as long as marginal vein, which is much shorter than the postmarginal vein (16: 22) and is 1.3 times as long as the stigmal vein; stigma large (Fig. 5).

Petiole about as long as wide, smooth. Gaster as long as thorax, compressed; first tergite slightly extending beyond apex of the second.

Dark green, sometimes with bronzyl reflections; gaster Bluish green in apical half. Scape brownish yellow; pedicel and flagellum dark brown. Legs pale brownish yellow with coxae concolorous with thorax.

**Male.** Similar to female but differing as follows. Eyes separated by 1.3
times their own length. Pedicel a little shorter than first funicle segment; flagellum a little longer than width of head, with longer hairs. Gaster depressed; fourth to sixth tergites coarsely reticulate. Length of body 1.0—1.5 mm.

Material & host: 3♀, Morioka (Y. Maeta)—Aphidiid sp./Acyrthosiphon pisum (Harris)/Glycine max; 1♂, Sapporo—Aphidiid sp./Acyrthosiphon syringae (Matsumura)/Syringa reticulata; 1♀, Sapporo—Aphidiid sp./Macrosiphum ibaruae Matsumura/Rosa sp.; 1♂, Sapporo—Aphidius sp./Impatiens balsamines (Kaltenbach)/Impatiens sp.; 3♀1♂, Nukabira—Aphidius lonicerae Marshall/Amphorophora amurensis (Mordvilko)/Rubus sp.; 1♂, Sapporo—Praon sp./Acyrthosiphon solani (Kaltenbach)/Impatiens sp.; 1♂, Sapporo—Praon dorsale (Haliday)/Indomegoura indica (van der Goot)/Staphylea bumalda; 6♀3♂, Sapporo—Praon volucre (Haliday)/Acyrthosiphon magnoliae (Essig & Kuwana)/Sambucus sieboldiana; 1♀, Sapporo—Praon volucre (Haliday)/Macrosiphum ibaruae Matsumura/Rosa sp.


Coruna laevis sp. n.

**Female.** Length 1.3—1.9 mm. Head much wider than thorax (34: 25), transverse, nearly twice as wide as long in dorsal view (Fig. 6). Postocellar line twice as long as ocellular line, which is as long as the diameter of the lateral ocellus. Eyes prominent, separated by their own length, with inner orbits divergent below (Fig. 7). Malar space one-third as long as eye. Anterior margin of clypeus angularly produced medially. Face and clypeus longitudinally strigose. Scape fully reaching level of vertex, as long as club and last funicle segment combined. Combined length of pedicel and flagellum nearly as long as width of head. Pedicel as long as first funicle segment; funicle segments almost equal in length, a little longer than wide (Fig. 8).

Thorax less strongly arched dorsally. Median lobe of mesoscutum moderately reticulate, the side lobes weekly and densely so; notaulices rather shallow. Scutellum longer than wide (16: 13), feebly reticulate; frenum smooth and polished. Propodeum smooth and polished, without median carina; nucha distinctly set off. Fore wing: basal cell coarsely hairy, closed below by cubital hair line; speculum moderately developed, closed below; upper surface of costal cell with a row of hairs apically; submarginal vein 1.5 times as long as marginal vein, which is a little longer than the postmarginal vein and is twice as long as the stigmal; stigma small (Fig. 9).

Petiole small and smooth. Gaster nearly as long as thorax, compressed, twice as long as wide; first tergite extending beyond apex of the second, smooth (Fig. 10); the third smooth; succeeding tergites feebly alutaceous.

Bright bluish green with gaster blackish basally. Antennae yellowish brown, with pedicel and flagellum darker above. Legs pale yellow: hind coxae on basal two-thirds concolorous with thorax, middle and fore coxae darker at base.

**Male.** Similar to female, but combined length of pedicel and flagellum a
little longer than width of head. Flagellum with hairs which are as long as the width of the funicle segments. Gaster depressed; fourth to sixth tergites alutaceous. Length of body 1.1—1.8 mm.


Material & host: 1♂, Soranuma-dake—Aphidiid sp./*Impatientinum balsamines* (Kaltenbach)/*Impatiens balsaminae* Matsumura*/Syringa sieboldiana*; 1♀, Sapporo—*Praon dorsale* (Haliday)/*Indomegoura indica* (van der Goot)/*Staphylea bumalda*; 3♀♂♂, Sapporo—*Praon flavinodes* (Haliday)/*Euceraphis punctipennis* (Zetterstedt)/*Betula sp.*; 3♀♂♂, Sapporo—*Praon venturi* (Haliday)/*Acyrthosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 1♀♂♀, Sapporo—*Praon volucre* (Haliday)/*Acyrthosiphon solani* (Kaltenbach)/*Cornus sp.*; 1♀♂♂, Sapporo—*Praon venturi* (Haliday)/*Acyrthosiphon syringae* (Matsumura)/*Syringa reticulata*; 1♀♂♀, Sapporo.

Locality in Japan: Hokkaido—Sapporo & Soranuma-dake.

Geographical distribution: Japan.

Genus *Pachyneuron* Walker


*Propachyneuronia* Girault, 1917, Psyche 24: 102 [type-species: *Encyrtus siphonophorae* Ashmead].


This genus is widely distributed throughout the world, comprising more than 40 species; most are primary or secondary parasites of syrphids, chamaemyiids, aphids, or coccids.

In the present study 5 species are known to occur in Japan, of which 2 are new to science.

**Key to species**

**Females**

1. Eyes subcircular; malar space about as long as eye (Fig. 20); temples very acutely pointed posteriorly (Fig. 22); hind margin of first tergite weakly emarginate at middle .............. *dorophis* sp. n.

- Eyes normal; malar space a little more than half length of eye; temples pointed (Fig. 12) or rounded posteriorly; hind margin of first tergite not emarginate at middle ........ 2

2. Thorax weakly arched dorsally (Fig. 15); temples rather acutely pointed posteriorly; scape hardly reaching median ocellus .............. *sapporense* sp. n.

- Thorax strongly arched dorsally; temples rounded posteriorly; scape fully reaching level of median ocellus .............. 3

3. Antennae with 3 anelli and 5 funicle segments (Fig. 18); fore wing with marginal vein
thick, about 2.7 times as long as its maximum width (Fig. 19); anterior margin of clypeus strongly produced and rounded at middle; petiole not longer than wide.

- Antennae with 2 anelli and 6 funicle segments; fore wing with marginal vein less thick, more than 4 times as long as its maximum width; median produced portion of clypeus having its anterior margin emarginate or truncate, occasionally rounded; petiole distinctly longer than wide. 4

4. Fore wing with speculum open below; gaster circular, nearly as long as wide; nucha markedly set off by a transverse impression, smooth or transversely sculptured...................... mitsukurii Ashmead

- Fore wing with speculum closed below; gaster much longer than wide; nucha finely reticulate, its front edge not distinctly defined...................... solitarium (Hartig)

Males

1. Eyes subcircular; malar space about as long as eye; temples very acutely pointed posteriorly; antennae yellow throughout................ doraphis sp. n.

- Eyes normal; malar space a little more than half length of eye; temples pointed or rounded posteriorly; antennae with scape yellowish, pedicel and flagellum much darker...................... 2

2. Thorax weakly arched dorsally; temples acutely pointed posteriorly; first tergite elongate, slightly extending beyond apex of second tergite................ sapporense sp. n.

- Thorax strongly arched dorsally; temples rounded posteriorly; first tergite not reaching hind margin of the second...................... 3

3. Fore wing with marginal vein thick, 2.3–2.7 times as long as its maximum width; anterior margin of clypeus strongly produced and rounded medially; petiole not longer than wide................ aphidis (Bouché)

- Fore wing with marginal vein less thick, more than 3.6 times as long as its maximum width; median produced portion of clypeus having its anterior margin emarginate, truncate, or weakly rounded; petiole distinctly longer than wide. 4

4. Fore wing with speculum open below; propodeal nucha markedly set off by a transverse impression, smooth or transversely sculptured................ mitsukurii Ashmead

- Fore wing with speculum closed below; nucha finely reticulate, its front edge not distinctly defined...................... solitarium (Hartig)

Pachyneuron mitsukurii Ashmead


P. mitsukurii Ashmead was described from 4 specimens, which are in the U. S. National Museum. Dr. Burks has kindly compared some of our specimens with the type and informed us that they are conspecific. This species agrees well with Delucchi's and Graham's descriptions of P. umbratum Delucchi, which we consider to be the same as P. mitsukurii. Further, P. coeruleum Delucchi may be synonymous with this species, as pointed out by Graham.

On the basis of the present specimens a redescription is given below.

Female. Length 1.5–2.4 mm. Head seen from above much wider than thorax, with temples not acutely pointed posteriorly. Median produced portion
of clypeus having its anterior margin slightly emarginate. Lamina of gena less prominent, ending in a rounded lobe. Malar space slightly longer than half length of eye (10.5: 6). Scape reaching median ocellus; combined length of pedicel and flagellum a little shorter than width of head; pedicel slightly longer than first funicle segment, which is slightly longer than wide and is sometimes quadrate; sixth funicle segment varies from slightly transverse to slightly longer than wide.

Thorax moderately arched in profile. Mesoscutum rather coarsely reticulate, especially in posterior area. Scutellum convex, about as long as wide, finely reticulate; frenum reticulate as in mesoscutum, more coarsely so in smaller specimens. Propodeum finely reticulate, usually with weak carinae anteriorly and posteriorly; median carina sometimes indicated anteriorly, forked medially; plicae indicated by basal foveae; area between basal fovea and spiracular sulcus often weakly elevated, occasionally plicae rather sharply indicated by the elevation, its surface virtually smooth or weakly reticulate; nucha distinctly set off, smooth or transversely sculptured. Fore wing with marginal vein slightly longer than stigmal vein (Fig. 11); basal cell bare, basal vein with 0—7 hairs; speculum open below.

Petiole a little longer than wide. Gaster much shorter than thorax, rounded, about as long as wide; first tergite occupying half length of gaster.

Head and thorax dark green to bluish green; antennae dark brown with scape yellowish brown, usually infuscate distally; legs yellowish brown: coxae concolorous with thorax; femora more or less infuscate, sometimes wholly pale.

Male. Length of body 1.0—1.8 mm. Scape extending beyond level of vertex; flagellum filiform, usually longer than width of head, covered with long and dense hairs; first funicle segment 1.5 times as long as pedicel, fully twice as long as wide; sixth funicle segment usually a little shorter than the first, 1.5—1.9 times as long as wide; in smaller specimens sometimes first funicle segment as long as pedicel, 1.5 times as long as wide; sixth funicle segment as long as the first, 1.5 times as long as wide. Reticulation of mesoscutum and scutellum usually coarser than that of female. Basal cell of fore wing sometimes with a few hairs; upper surface of costal cell sometimes with a few hairs apically. Gaster narrower, much longer than wide. Head and thorax bright green to blue green; antennae yellowish brown with scape paler; legs yellow with coxae metallic green.

Material & host: 3♀2♂, Sapporo—*Aphidius sicarius* Mackauer (=*Lysaphidius callipterinellae*)/*Callipterinella calliptera* (Hartig)/ Betula sp.

The following specimens have been reared from coccids, syrphid puparia, or captured by sweeping on various plants: 1♀1♂, Asahikawa (K. Kamijo)—encyrtid spp./*Physokermes jezoensis* Siraiwa (Homoptera, Coccidae)/ Abies sachalinensis; 1♀, Bibai (K. Kamijo), from syrphid sp. on *Populus* sp.; 4♀10♂, Bibai (K. Kamijo), from syrphid sp. on *Larix leptolepis*; 7♀3♂, Sapporo, from syrphid sp.; 5♀4♂, Sapporo, from syrphid sp. on *Artemisia montana*; 9♀10♂, Aomori (A. Tashima), from syrphid sp. on apple; 4♀, Morioka (Y. Maeta), from syrphid sp. on soy-bean; 7♀3♂, Morioka (T. Oku), from syrphid sp. on potato; 5♀6♂, Mori-
oka (T. Oku), from syrphid sp. on corn; 5♀6♂, Morioka (H. Sato), from syrphid sp. on Pinus strobus; 4♀4♂, Kagoshima (K. Kusigemati), from syrphid sp. on wheat; 5♀, Bibai (K. Kamijo), swept on Abies sachalinensis; 4♀3♂, Bibai (K. Kamijo), swept on Pinus densiflora; 1♀, Bibai (K. Kamijo); 1♀, Kenebetsu (T. Kumata); 5♂, Sapporo (K. Kamijo); 2♀, Sapporo (S. Takagi); 1♀, Niigata (K. Kamijo); 1♀, Kōchi (K. Ochi); 3♀1♂, Kagoshima (K. Kusigemati), swept on paddy field; 8♀18, Iki; 1♀, Tokunoshima (K. Kamijo).

Locality in Japan: Hokkaidō—Kenebetsu, Asahikawa, Bibai & Sapporo; Honshū—Aomori, Morioka & Niigata; Shikoku—Kōchi; Kyūshū—Kagoshima & Iki; Ryūkyū—Tokunoshima.

Geographical distribution: Japan; Europe.

In Japan, *P. mitsukurii* is a very common species, being a gregarious, primary parasite of syrphid pupae. It also attacks, as a solitary hyperparasite, aphids and coccids through Aphidiidae and Encyrtidae, respectively, though these host relationships seem to be rare.

*Pachyneuron sapporense* sp. n.

**Female.** Length of body 1.4—2.2 mm. Median produced portion of clypeus having its anterior margin slightly emarginate. Malar space a little longer than half length of eye. Eyes separated by 1.4—1.5 times their own length, with inner orbits subparallel. Head seen from above with temples rather acutely pointed posteriorly (Fig. 12). Lamina of genae less prominent (Fig. 13). Vertex and face moderately reticulate; clypeus radiately strigose, the striae extending some distance up genae and face. Scape hardly reaching median ocellus; pedicel slightly longer than first funicle segment; combined length of pedicel and flagellum nearly as long as width of head; funicle segments progressively and slightly increasing in width; first funicle segment quadrate or slightly longer than wide, sixth segment slightly transverse or quadrate (Fig. 14).

Thorax weakly arched dorsally (Fig. 15). Mesoscutum moderately reticulate. Scutellum a little longer than wide, finely reticulate, more finely so anteriorly; frenum reticulate as in mesoscutum. Axillae reticulate as in anterior area of scutellum. Propodeum with interplical area finely reticulate; median carina sometimes indicated anteriorly; plicae sharply indicated in anterior half of propodeum by elevation between basal fovea and spiracular sulcus, and posteriorly by carina in depression before nucha, the elevated area virtually smooth and shining; nucha sharply set off, nearly one-third as long as median length of propodeum, with surface usually smooth. Fore wing with marginal vein wider distally, slightly shorter than or as long as stigmal vein (Fig. 16); upper surface of costal cell sometimes with a few hairs distally; basal cell usually bare; basal vein with a row of hairs; speculum open below.

Petiole a little longer than wide, finely sculptured. Gaster as long as thorax, 1.6—2.0 times as long as wide; second tergite a little shorter than third tergite. Bluish black to blackish: propodeum and first tergite tending towards greenish; scape yellowish brown; pedicel and flagellum dark brown; legs yellowish brown; coxae concolorous with thorax; femora dark brown, sometimes metallic

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reflections on hind ones; tibiae sometimes infuscate.

Male. Similar to female, but temples more acutely pointed posteriorly; scape reaching median ocellus; pedicel a little shorter than first funicle segment; flagellum filiform, as long as width of head, with dense and long hairs; first funicle segment 1.5–2.0 times as long as wide; the sixth as wide as and usually a little shorter than the first. Gaster much shorter and narrower than thorax; first tergite elongate, usually slightly extending beyond apex of second tergite. Length of body 1.1–1.6 mm.

Holotype: ♀, Sapporo, 14. vi. 1967 (M. Miyazaki), *Praon flavinode* (Haliday)/*Euceraphis punctipennis* (Zetterstedt)/*Betula* sp.

Fig. 11. *Pachyneuron mitsukurii* Ashmead, female: fore wing venation.
Fig. 12–16. *Pachyneuron sapporense* sp. n., female: 12, head in dorsal view—13, head in profile—14, antenna—15, thorax in profile—16, fore wing venation.
Fig. 17. *Pachyneuron solitarium* (Hartig), female: fore wing venation.
Fig. 18 & 19. *Pachyneuron aphidis* (Bouché), female: 18, antenna—19, fore wing venation.

Material & host: 1♀1♂, Sapporo—*Aphidius cingulatus* Ruthe/*Pterocomma* sp./*Salix* sp.; 4♀, Sapporo—*Calaphidius watanabei* (Takada)/*Mansakia shirakabae* (Monzen)/*Betula* sp.; 1♀, Sapporo—*Ephedrus plagiator* (Nees)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 15♀14♂, Sapporo—*Praon dorsale* (Haliday)/*Indomegoura indica* (van der Goot)/*Staphylea bumalda*; 2♀3♂, Sapporo—*Praon flavinode* (Haliday)/*Euceraphis punctipennis* (Zetterstedt)/
Betula sp.; 3♀7♂, Sapporo—Praon volucre (Haliday)/Acrysthiosiphon magnoliae (Essig & Kuwana)/Sambucus sieboldiana; 1♀1♂, Sapporo.

Locality in Japan: Hokkaido—Sapporo.

Geographical distribution: Japan.

This species seems to be allied to P. cremifanía Delucchi, from which it may be separated by the temples which are acutely pointed posteriorly, by the longer propodeum and by the shorter gaster. It differs from P. grande Thomson in the gently arched thoracic dorsum, the less prominent lamina of the gena, and the shorter scape.

Pachyneuron solitarium (Hartig)

Pachyneuron coccorum auctt. (nechneunon coccorum Linné, 1758).
Pachyneuron nawai: Ishii, 1938, Kontyu 7: 103 [host: egg of Dendrolimus superans Butler].

This species was originally described from specimens reared from the egg of Dendrolimus pini (L.). Bouček (1965) considered that P. concolor is synonymous with solitarium, the host range of which is “surprisingly” wide. On the contrary, Graham (1969) stated that concolor is distinct from solitarium in the morphological characters and in the host range: (1) in solitarium the anterior margin of the clypeus is slightly produced, the produced part weakly emarginate or subtruncated, and the surface of clypeus only weakly convex, whereas in concolor the anterior margin of the clypeus, which is more strongly convex, has a blunt, rounded median projection; (2) the host range of solitarium is restricted to the eggs of Dendrolimus, whereas concolor is parasitic on the coccids.

We have seen many Japanese specimens reared from eggs of Dendrolimus spectabilis and an authentic specimen of solitarium (♀, Bohemia, Czechoslovakia, 1941) which was reared from D. pini and identified by Dr. Bouček. The Japanese form agrees well with the European one and Graham’s description of solitarium (1969) except for the following characters:— the upper surface of the basal cell of the fore wing has 3—10 hairs, the first funicle segment is occasionally shorter than the pedicel in the female, and the mid lobe of the mesoscutum is more coarsely reticulate.

We have also examined specimens reared from aphids and coccids mentioned below, but we can not find any morphological differences between these specimens and those reared from eggs of Dendrolimus. In most specimens reared from aphids and coccids, the anterior margin of the clypeus has the median
produced portion emarginate or truncate, but in a few smaller specimens it is rounded.

In conclusion, we agree with Bouček that concolor is a synonym of solitarium, which is hyperparasitic not only on eggs of Dendrolimus but also on aphids and coccids.

On the basis of the Japanese specimens examined a brief redescription may be given below.

Female. Length of body 1.4—2.1 mm. Median produced portion of clypeus narrow, with anterior margin slightly emarginate or truncate and its surface virtually flat; in some smaller specimens the anterior margin rounded. Head in dorsal view with temples rounded posteriorly. Scape reaching upper edge of median ocellus; first funicle segment as long as the second, a little longer than wide, the sixth segment quadrate or slightly longer than wide; sometimes first funicle segment shorter than the second, subquadrate; following 4 segments a little longer than wide, and the sixth quadrate.

Mid lobe of mesoscutum coarsely reticulate. Propodeum sloping at a less steep angle, about 45° relative to the tangential plain of the mesoscutum and scutellum, narrowed posteriorly and remarkably produced beyond bases of hind coxae; median area of propodeum longitudinally and broadly elevated and plicae indicated by elevation between basal fovea and spiracular sulcus, so that a V-shaped depression is formed between the median and lateral elevations; surface of propodeum densely reticulate and without carinae; nucha finely reticulate, with front edge not distinctly defined. Fore wing with marginal vein as long as stigmal vein (Fig. 17); basal cell with 3—11 hairs; speculum closed below. Petiole slender. Gaster about 1.5 times as long as wide.

Head and thorax bluish black, gaster dark bluish green. Scape yellowish brown or dark brown; pedicel and flagellum dark brown. Coxae concolorous with thorax; femora dark brown, hind ones usually with metallic reflections; the rest of legs yellowish brown, with tibiae sometimes infuscate.

Male. Differs from the female in the antennae and gaster. Flagellum as long as width of head, with longer hairs. First funicle segment as long as or sometimes slightly longer than the second, 1.7—1.9 times as long as wide; sixth funicle segment shorter than preceding segments, 1.2 times as long as wide. Gaster shorter and depressed. Length of body 0.8—1.9 mm.

Material & host: 1♀1♂, Kyōto—Aphidius areolatus Ashmead/Periphyllus californiensis (Shinji)/Acer sp.; 1♀1♂, Sapporo—Diaeretus leucopterus (Haliday)/Eulachnus thunbergii Wilson/Pinus thunbergii; 1♂, Kyōto—Dyscritulus sp./Periphyllus californiensis (Shinji)/Acer sp.; 1♀3♂, Yakushima—Ephedrus sp./Tuberocephalus sakurai (Matsumura)/Prunus sp. (cherry); 2♂, Kumamoto—Ephedrus nacheri Quilis/Hyalopterus pruni (Geoffroy)/Prunus sp.; 1♀, Nara—Pauesia sp./Cinara sp./Abies firma; 4♀1♂, Kōbe—Pauesia abietis (Marshall)/Cinara pineti (Koch)/Pinus densiflora; 1♀, Sapporo—Pauesia pini (Haliday)/Cinaria laricis (Walker)/Larix lepotelepis; 1♀, Kyōto—Pauesia unilachni (Gahan)/Schizolachnus sp./Pinus densiflora; 1♂, Sapporo—Praon flavinode (Haliday)/Euceraphis punctipennis (Zetterstedt)/Betula sp.; 1♀, Sōun-kyō (S. Takagi); 1♀,
Nagano (K. Kamijo); 1, Minō (K. Kamijo).

In addition, this species has also been reared from other than aphid parasites as follows:—6, Asahikawa (K. Kamijo), encyrtid spp./Physokermes jezoensis Siraiwa (Homoptera, Coccidae)/Abies sachalinensis; 49, Fukuoka (Y. Murakami), from Phenacoccus aceris Signoret (Homoptera, Pseudococcidae); 29, Fukuoka (Y. Hirose), Trichogramma dendrolimi Matsumura (Hymenoptera, Trichogrammatidae)/eggs of Dendrolimus spectabilis Butler (Lepidoptera, Lasiocampidae)/Pinus thunbergii.


Geographical distribution: Japan; Saghalien; Europe.

P. solitarium has a wide host range, hyperparasitizing aphids, coccids and eggs of Dendrolimus. According to Orlov (1962), this species parasitizes Ooencyrtus, Telenomus, and Trichogramma, which are the main egg parasites of Dendrolimus sibiricus. Hirose (1969) also reported that it is hyperparasitic on eggs of D. spectabilis through Trichogramma dendrolimi Matsumura or Telenomus dendrolimi (Matsumura). In the case of parasitizing Physokermes jezoensis, it is probable that P. solitarium develops on mature larvae or pupae of encyrtids, which are predaceous on eggs in the dead body of the adult female of P. jezoensis.

Pachyneuron aphidis (Bouché)


The Japanese specimens examined agree well with descriptions mentioned above and with a European specimen of aphidis identified by Dr. Bouček (Bohemia, 3. viii. 1956, Z. Bouček).

Pachyneuron gifuense Ashmead was described from 3 specimens reared from an unidentified aphid, which are deposited in the U. S. National Museum. Dr. Burks kindly examined the type material and informed us that gifuense is the same as aphidis.

This species is characterized as follows.

Female. Length of body 1.1—1.6 mm. Anterior margin of clypeus strongly produced and rounded at middle. Antennae with 3 anelli; third anellus nearly as long as the first and second combined; flagellum progressively increasing in width, about as long as distance between eyes; first funicle segment subquadrate, slightly shorter than the second, which is a little longer than wide; the fifth quadrate (Fig. 18).

Thorax strongly arched dorsally. Propodeum finely reticulate; its surface flat, without elevations or carinae, but occasionally a pair of short, weak carinae visible on depression before nucha; basal foveae small; median carina absent.
Fore wing with marginal vein thick, about 2.7 times as long as its maximum width (Fig. 19); basal cell bare, open below; speculum open below. Petiole not longer than wide, virtually smooth. Gaster rounded, a little longer than wide.

Head and thorax blackish; gaster shiny, blackish with a greenish or bluish tinge. Scapus blackish with faint metallic reflections; pedicel and flagellum dark brown. Coxae concolorous with thorax; femora dark brown becoming yellowish brown apically; tibiae yellowish brown, usually infuscate medially; tarsi yellowish brown.

Male. Length of body 0.7—1.2 mm. Antennae with 2 anelli; flagellum filiform, nearly as long as width of head, with longer hairs; funicle segments longer than wide, sometimes the first segment shorter than the succeeding segments and quadrate. Fore wing with marginal vein 2.3—2.7 times as long as its maximum width. In smaller specimens coxae occasionally dark brown with faint metallic reflections; femora dark brown with distal tips lighter.

Material & host: 1910, Sapporo (K. Kusigemati)—Aphidiid sp./Rhopalosiphum padi (Linné)/Poaceous sp.; 2♀, Kyōto—Aphidius gifuensis Ashmead/Myzus persicae (Sulzer)/Raphanus sativus; 3♀3♂, Tottori & 1928, Kagoshima—Aphidius salticus Haliday/Cavariella salicicola (Matsumura)/Saltix sp.; 3♀7♂, Sapporo—Aphidius sicarius Mackauer/Callipterinella calliptera (Hartig)/Betula sp.; 3♀4♂, Kyōto & 16♀15♂, Takarazuka—Diaeretiella rapae (M’Intosh)/Breviceps brasicae (Linné)/Brassica oleracea; 1918, Kyōto—Diaeretiella rapae (M’Intosh)/Lipaphis erysimi (Kaltenbach)/Raphanus sativus; 2♂, Sasebo & 1♂, Kagoshima—Diaeretus leucopterus (Haliday)/Eulachnus thunbergii Wilson/Pinus thunbergii; 1918, Fukuoka—Dyscritulus sp./Periphyllus sp./Acer sp.; 1918, Fukuoka—Ephedrus sp./Aphis craccivora Koch/Robinia pseudo-acacia; 1♀, Takarazuka—Ephedrus sp./Macrocephus akebiae Shinji/Stauntonia hexaphylla; 2♀1♂, Kyōto—Ephedrus sp./Rhopalosiphum padi (Linné)/Triticum aestivum; 76♀8, Fukuoka—Ephedrus nacheri Quilis/Aphis nerii Boyer/Nerium indicum & Robinia pseudo-acacia; 5♀2♂, Kumamoto—Ephedrus nacheri Quilis/Hyalopterus pruni (Geoffroy)/Pruus sp.; 79♀8, Sapporo—Ephedrus nacheri Quilis/Myzus persicae (Sulzer)/Pruus sp.; 1♀, Kagoshima—Ephedrus persicae Froggatt/Capitophorus elaeagni (del Guercio)/Elaeagnus umbellata; 2♀, Sapporo—Lipolexis gracilis Foerster/Rhopalosiphum padi (Linné)/Zea mays; 1918, Kure & 1♂, Matsuyama—Lysaphidus pleotrichophori Takekura/Plaeotrichophorus glandulosus (Kaltenbach)/Artemisia sp.; 1♀, Sapporo—Lysiphlebus japonicus Ashmead/Aphis gossypii Glover/Solanum tuberosum; 49♀1♂, Yasugeshō (T. Kato)—Lysiphlebus japonicus Ashmead/Toxoptera citricida (Kirkaldy)/Citrus deliciosa; 2♀, Miyazaki—Lysiphlebus japonicus Ashmead/Toxoptera odinae (van der Goot)/Pittosporum tobira; 5♀, Kōbe—Pausia abietis (Marshall)/Cinara pineti (Koch)/Pinus densiflora; 1♂, Kyōto—Pausia unilachni (Gahan)/Schizolachnus sp./Pinus densiflora; 1935, Sapporo (K. Kusigemati)—Praon sp./Acythosiphon ibotum (Essig & Kuwana)/Ligustrum obtusifolium; 2♀, Kumamoto—Praon capitophori Takekura/Capitophorus sp./Elaeagnus umbellata; 1♀, Sapporo (K. Kusigemati); 1♀1♂, Kyōto; 17♀♂, Fukuoka.

Locality in Japan: Hokkaidō—Sapporo; Honshū—Gifu (after Ashmead, 1904),
Kyoto, Takarazuka, Kobe, Tottori, Kure & Yasugeshō (Yamaguchi-ken); Shikoku—Matsuyama; Kyūshū—Fukuoka, Sasebo, Kumamoto, Miyazaki & Kagoshima.

Geographical distribution: Japan; Europe.

Pachyneuron doraphis sp. n.

Female. Length 1.5—1.9 mm. Head of characteristic shape; in frontal view cheeks long, converging straight towards mouth (Fig. 20). Malar space about as long as eye. Median produced portion of clypeus having its anterior margin broadly and slightly emarginate. Eyes small, circular, a little longer than wide, separated by 1.8 times their own length. Lamina of gena less prominent, ending in a rounded lobe (Fig. 21). Head seen from above 3 times as wide as long, with temples acutely pointed posteriorly (Fig. 22). Head densely reticulate; clypeus with striae which extend a little way up the genae and face. Scape reaching median ocellus; pedicel a little longer than first funicle segment; combined length of pedicel and flagellum much shorter than width of head; flagellum gradually and slightly increasing in width distally; first funicle segment slightly longer than wide; the sixth segment quadrat or slightly transverse (Fig. 23).

Thorax robust, 1.4 times as long as wide, rather strongly arched dorsally. Mesoscutum densely reticulate; its side lobes with antero-lateral flange well developed, so that in dorsal view the sides of the mesoscutum are subparallel (Fig. 24). Scutellum a little shorter than wide, very finely reticulate throughout; frenal furrow distinct. Axillae finely reticulate. Propodeum short, half as long as distance between inner edge of propodeal spiracles; median carina usually

59
indicated anteriorly and several irregular carinae extending from anterior and posterior margins; area between carinae finely reticulate or smooth; plicae indicated by basal foveae and posteriorly by strong carinae in depression before nucha; area between basal foveae and spiracular sulci convex, with surface weakly sculptured; spiracular sulci very shallow; nucha distinctly set off, finely reticulate. Fore wing with marginal vein slightly wider distally, a little shorter than stigmal vein (Fig. 25); basal cell usually bare; basal vein with a row of hairs; speculum broadly open below.

Petiole as long as wide. Gaster much shorter than thorax, rounded, as long as wide. First tergite occupying more than half length of gaster, with hind margin incised at middle.

Head and thorax bluish black, gaster blackish; antennae yellowish brown; legs yellowish brown; coxae concolorous with thorax; femora dark brown in basal two-thirds; tibiae infuscate basally. Fore wing with veins pale.

Male. Length of body 1.4–1.6 mm. Malar space a little shorter than eye. Scape extending beyond level of vertex; pedicel slightly longer than first funicle segment; combined length of pedicel and flagellum a little shorter than width of head; flagellum covered with dense and long hairs; first funicle segment slightly longer than wide; the sixth segment quadrate. Antennae wholly yellow.

Holotype: ♀, Yamabe, 10. vii. 1961 (K. Kamijo), (?)/Doraphis populi (Maskell)/Populus euramericana.

Material & host: 6♀2♂, Yamabe (K. Kamijo)—♀/Doraphis populi (Maskell)/Populus euramericana; 3♀, Bibai (K. Kamijo), swept on Populus euramericana.

Locality in Japan: Hokkaido—Yamabe & Bibai.

Geographical distribution: Japan.

This unique species is readily distinguished from other representatives of the genus by the shape of the head and by the mesoscutum with a well-developed flange antero-laterally. P. doraphis is reared from a coccid-type aphid, Doraphis populi, though the exact host relationship has not been determined. Judging from the general habit of Pachyneuron (see: biological notes), doraphis is possibly hyperparasitic in habit through its primary parasite (?) Encyrtidae. So far as we are aware, however, none is recorded as a primary parasite of the aphid.

Genus Euneura Walker


This genus is represented in the Palaearctic region by 2 species and in the Nearctic region by another species. Furthermore, 2 other species have been described from Madagascar. The host preferences of the Holarctic species are principally limited to lachnid aphids through Pauesia and Diaeretus.

In this paper are given the following 2 species, of which one is new to Japan.
Key to species

Males and females

1. Face with conspicuously strigose sculpture, the longitudinal striae being strong, the transverse walls of the areoles weak; basal cell of fore wing hairy, closed below by cubital hair line; mesoscutum with dense and black hairs; marginal vein hardly thicker at apex than at base (Fig. 28) .......................... augurus Walker

- Face finely reticulate; basal cell of fore wing almost bare, open below; mesoscutum with sparse and black hairs; marginal vein distinctly thicker at apex than at base (Fig. 30) .......................... navai (Ashmead)

Euneura augarus Walker


The Japanese specimens examined agree well with Delucchi’s redescription of the species and with European specimens (2♀2♂, Italia, viii, 1969, Z. Bouček), which were identified as E. augarus by Dr. Bouček.

In addition to those given in the key, augurus has the following characters.

Female. Anterior margin of clypeus deeply emarginate, sometimes shallowly so. Scape nearly reaching lower margin of median ocellus; first funicle segment slightly longer than wide, the sixth segment quadrate; occasionally first funicle segment quadrate and the sixth slightly transverse. Frenum reticulate like area in front of frenal furrow. Propodeum with median carina sometimes present but weak; supracoxal flange well developed, with outer corner strongly produced laterally, so that the anterior and posterior margins of the propodeum are subparallel (Fig. 26); its surface nearly smooth. Hind femur with sharp keels anteriorly and posteriorly in distal two-fifths (Fig. 27). Submarginal vein nearly 3 times as long as marginal vein (Fig. 28); speculum closed below.

Body dark blue with a violet tinge to dark bluish green. Scape yellowish brown; pedicel and flagellum dark brown; coxae concolorous with thorax; femora dark to blackish brown, hind ones sometimes with metallic reflections; tibiae dark brown to yellowish brown; tarsi yellowish brown or pale yellow. Length of body 1.4—2.8 mm.

Male. Very similar to female but body darker: bluish black or blackish; scape usually infuscate apically; tibiae infuscate medially. Length of body 1.1—2.0 mm.

Material & host: 8♀5♂, Nara—Pauesia sp./Cinara sp./Abies firma; 2♀, Tōya (K. Kusigemati)—Pauesia sp./Cinara sp./Larix leptolepis; 3♀, Kyōto, 13♀13♂, Hirakata & 1♀, Kōbe—Pauesia abietis (Marshall)/Cinara pinetii (Koch)/Pinus densiflora; 5♀5♂, Naganuma (Abies sachalinensis) & 2♀2♂, Kyōto (Abies firma)—Pauesia konoi (Watanabe)/Cinara sachalinensis (Matsumura); 3♀3♂, Kyōto—Pauesia momicola Watanabe & Takada/Cinara sp./Abies firma; 1♀, Nopporo & 7♀2♂, Soranuma-dake—Pauesia nopporensis Watanabe & Takada/Cinara longipennis (Matsumura)/Abies sachalinensis; 1♀1♂, Nopporo & 1♀, Sapporo—
**Puaesia pini** (Haliday)/**Cinaria laricis** (Walker)/**Larix leptolepis**; 7♂♀♀, Bibai (K. Kamijo).


Geographical distribution: Japan; Europe.

**Euneura nawai** (Ashmead), comb. n.


*Pachyneuron nawai*: Yasumatsu et al., 1946, Mushi 17: 9 [host: *Aphidius salignae* Watanabe/*Tuberolachnus saligna* Gmelin].


Syn. n.

(Nec *Pachyneuron nawai*: Ishii, 1938, p. 103; Tabata and Tamanuki, 1939, p. 8.)

This species was originally described from Japan on the basis of female specimens, which were reared from an unidentified aphid. Dr. Burks has kindly compared part of the present specimens with the type of *nawai* in the U. S. National Museum and informed us that they are completely identical. Furthermore, specimens examined agree well with the original description of *laeviscula* and a European specimen (♀, Italia, 13. ix. 1969, Z. Bouček) identified as *laeviscula* by Dr. Bouček.

On the basis of the Japanese specimens examined a brief redescription is given below.

**Female.** Length of body 1.8—2.4 mm. Antennal scape hardly reaching lower margin of anterior ocellus; pedicel as long as first funicle segment; funicle seg-

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27, right hind coxa in profile—28, fore wing venation.

ments quadrate, with last two segments sometimes slightly transverse (Fig. 29). Face finely reticulate; clypeus radiately strigose, with anterior margin shallowy emarginate. Eyes less prominent, separated by 1.5 times their own length. Mesoscutum, scutellum, and propodeum rather uniformly and finely reticulate, except for frenum being more strongly so. Mesoscutum as long as scutellum, with sparse and black hairs. Propodeum with median carina usually visible anteriorly; supracoxal flange a little longer than nucha, nearly smooth, with outer corner weakly produced. Femur with carinae similar to those of augaricus. Fore wing: submarginal vein fully 3 times as long as marginal vein, which is distinctly thicker at the apex than at the base (Fig. 30); basal cell bare, or with at most 6 hairs, usually open below; speculum open below. Gaster as long as thorax; first tergite smooth; succeeding tergites feebly alutaceous.

Dark green to dark bluish green with bronzy reflections. Scape yellowish brown; pedicel and flagellum dark brown; coxae concolorous with thorax; femora dark brown to blackish becoming lighter apically, hind ones usually with a metallic tinge; rest of legs yellowish brown, with hind and mid tibiae sometimes infuscate medially.

Male. Very similar to female but differing as follows: hairs on flagellum dense and as long as two-thirds width of flagellum; gaster shorter than thorax. Head and thorax somewhat darker; scape usually infuscate apically; tibiae infuscate medially. Length of body 1.1—2.0 mm.

Material & host: 219120, Sapporo—Aphidius cingulatus Ruthe/Pterocomma sp./Salix sp.; 27, Yamabe (K. Kamijo)—Pauesia sp./Cinara sp./Larix leptolepis; 109158, Kyōto—Pauesia abietis (Marshall)/Cinara pineti (Koch)/Pinus densiflora; 5978, Kyōto—Pauesia japonica (Ashmead)/Lachnus tropicalis (van der Goot)/Quercus sp.; 11999, Mashike (K. Kusigemati), 109158, Sapporo (S. Takagi), 19118, Nagano (N. Ueda), 5978, Hamada (A. Machida) & 119158, Kagoshima (K. Kusigemati)—Pauesia salignae (Watanabe)/Tuberolachnus salignus (Gmelin)/Salix spp.

Locality in Japan: Hokkaidō—Mashike, Yamabe & Sapporo; Honshū—Atami & Gifu (after Ashmead, 1904), Nagano, Kyōto & Hamada; Kyūshū—Fukuoka (after Yasumatsu et al., 1946) & Kagoshima.

Geographical distribution: Japan; Europe.

BIOLOGICAL NOTES

Table 1 lists the localities of the aphid hyperparasites of Pteromalidae in Japan, with other known distribution areas. Of the 11 species occurring in Japan 4 are known only from Japan, 6 are Palaearctic and 1 Holarctic as follows:— (i) Species known only from Japan: Asaphes pubescens, Coruna laevis, Pachyneuron sapporensis and P. doraphis. A. pubescens occurs in Hokkaidō, Honshū and Shikoku, while 3 other species are recorded only from Hokkaidō. None of them may be truely endemic and other areas will be included in their distribution area after further records are obtained. (ii) Palaearctic species:
Table 1. Geographical distribution of aphid hyperparasites of Pteromalidae occurring in Japan.

<table>
<thead>
<tr>
<th>Species</th>
<th>Locality</th>
<th>Other countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Japan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hokkaidō</td>
<td>Honshū</td>
</tr>
<tr>
<td>Asaphes suspensus</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. pubescens</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Coruna clavata</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>C. laevis</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Pachyneuron mitsukurii</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>P. sapporense</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>P. solitarium</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>P. aphidis</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>P. doraphis</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Euneura augurus</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>E. nawai</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Asaphes suspensus, Pachyneuron mitsukurii, P. solitarium, P. aphidis, Euneura augar’sus and E. nawai. All of these species occur almost in whole areas of Japan, the first 3 being recorded also from Korea. Furthermore, they are known to be distributed widely in Europe. (iii) Holarctic species: Coruna clavata. This species is recorded from northern Japan. The species is known also from Europe and North America but only from the northern parts of these areas.

Habitat distribution

Sekhar (1958) has found that on the grounds of the University of Massachusetts Asaphes fletcheri (Crawford) is more abundant in the shady section with shrubs than in the open sections with shrubs or grasses. Thus, the aphid

<table>
<thead>
<tr>
<th>Species</th>
<th>Field</th>
<th>Intermediate</th>
<th>Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. suspensus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. pubescens</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>C. clavata</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. lasarib</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. mitsukurii</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. sapereines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. solitarium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. aphidis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. dorabian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z. augurus</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Z. nawai</td>
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</tbody>
</table>

Fig. 31. Habitat distribution of aphid hyperparasites of Pteromalidae occurring in Japan.

hyperparasites as well as the primary parasites show definite preference for certain types of habitats though the former are more widely specialized to host species than the latter. The range of occupied habitats is various in different species. On the basis of the reared and swept material given in this study and other sources of data (Takada, unpublished) the habitats of the aphid hyperparasites treated in this paper are summarized in Fig. 31.

Two species of Asaphes form a striking contrast in habitat preference: suspensus occurs in field- to intermediate-type habitats, whereas pubescens occurs in the intermediate- to forest-type. Coruna-species occur in field- to intermediate-
type habitats. The species of *Pachyneuron* except *mitsukurii* seem to be restricted to respective types of habitats: *aphidis* in field- to intermediate-type habitats; *sapporense* in the intermediate-type; *solitarium* and perhaps also *doraphis* in the intermediate- to forest-type. *Euneura* seems to be a group which has specialized in forest-type habitats, the species of this genus occurring mostly in forest-type habitats.

On the basis of the range of their occupied habitats these hyperparasites may be divided into 5 groups as follows:— (i) Species occurring mostly in field- to intermediate-type habitats and rarely in the forest-type: *Asaphes suspensus*, *Coruna clavata* and *Pachyneuron aphidis*. (ii) Species occurring mostly in intermediate-type habitats and not in the field-type: *Coruna laevis* and *Pachyneuron sapporense*. (iii) Species occurring in intermediate- to forest-type habitats and not in the field-type: *Asaphes pubescens*, *Pachyneuron solitarium* and *P. doraphis*. (iv) Species occurring mostly in forest-type habitats, less frequently in the intermediate-type and never in the field-type: *Euneura augarus* and *E. nawai*. (v) Species occurring widely in field- to forest-type habitats: *Pachyneuron mitsukurii*.

**Parasitism and host**

*Asaphes*, *Coruna*, *Euneura* and some *Pachyneuron*, which are exclusively hyperparasitic on aphids, are external, solitary, prepupal or pupal parasites of Aphidiidae and Aphelinidae (Hagen & van den Bosch, 1968). However, certain species of *Pachyneuron* may attack other groups of insects in addition to those mentioned, with a different mode of parasitism: (i) *P. mitsukurii* is reared either from puparia of Syrphidae which live with aphids, or from coccids through encyrtid parasites. In the former case this parasite is not solitary but gregarious in habit. (ii) *P. solitarium* is also hyperparasitic on lepidopterous eggs and coccids through egg parasites and perhaps encyrtids, respectively.

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**Table 2. Capsule—real host relationship in *Pachyneuron*-species.**

<table>
<thead>
<tr>
<th>Capsule</th>
<th>Real Host</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphid mummy</td>
<td>Aphidiidae (Prepupae &amp; pupae)</td>
<td><em>mitsukurii</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>sapporense</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>solitarium</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>aphidis</em></td>
</tr>
<tr>
<td>Coccid mummy</td>
<td>Encyrtidae (Pupae)</td>
<td><em>mitsukurii</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>solitarium</em></td>
</tr>
<tr>
<td>Egg shell of Dendrolimus</td>
<td><em>Trichogramma</em>, <em>Ooencyrtus</em> &amp; <em>Telenomus</em></td>
<td><em>solitarium</em></td>
</tr>
<tr>
<td>Puparium of Syrphidae</td>
<td>Syrphidae (Pupae)</td>
<td><em>mitsukurii</em></td>
</tr>
</tbody>
</table>
Hirose (1969), who studied *Dendrolimus spectabilis* Butler and its egg parasites on the Japanese black pine, says that “*Pachyneuron* sp.” (=*solitarium*) hyperparasitized eggs of the moth through 2 gregarious egg parasites, *Trichogramma dendrolimi* (Matsumura) and *Telenomus dendrolimi* Matsumura, and that only one individual of the hyperparasite emerged from one egg irrespective of the primary parasite concerned. This fact shows that *solitarium* consumes more than a single host individual in order to reach maturity. On this basis *solitarium* in this host relationship may not be regarded as a parasite but as a predator (Doutt, 1959).

It is interesting to note that in spite of taxonomically wide variety of their recorded host (Peck, 1963; Graham, 1969) *Pachyneuron*-species have a common habit: they parasitize hymenopterous or dipterous prepupae or pupae which are obligatorily included within capsules of some kinds. The relationship between the real host and the capsule in the Japanese species is shown in Table 2.

The association of the hyperparasites with both aphids and primary parasites is summarized in Table 3. Asaphes- and *Pachyneuron*-species, except *P. doraphis* recorded only from the coccid-type aphid *Doraphis populi*, are widely associated

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
<th>“Coccid-type” Host (Lachnidae, Chaitophoridae, Callaphididae, Aphididae &amp; “Aphid-type” Thelaxidae)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphidiidae</td>
<td><em>Pusia</em>, <em>Diaeretus</em> &amp; <em>A. cingulatus</em></td>
<td>Aphidiidae Most genera except for <em>Pusia</em> &amp; <em>Diaeretus</em></td>
</tr>
<tr>
<td>Asaphes suspensus</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td><em>A. pubescens</em></td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td><em>Coruna clavata</em></td>
<td>+</td>
<td>++</td>
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<tr>
<td><em>C. laevis</em></td>
<td></td>
<td>++</td>
</tr>
<tr>
<td><em>Pachyneuron mitsukurii</em></td>
<td>(-)</td>
<td></td>
</tr>
<tr>
<td><em>P. sapporens</em></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><em>P. solitarium</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. aphidis</em></td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td><em>P. doraphis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Euneura augarai</em></td>
<td>++</td>
<td></td>
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<tr>
<td><em>E. nawai</em></td>
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</table>

Table 3. Host range of aphid hyperparasites of *Pteromalidae* occurring in Japan.
with various major groups of Aphidoidea and Aphidiidae. On the contrary, Euneura-species are consistent in their host ranges, being reared exclusively from Lachnidae and Pterocomma through Pauesia, Diaeretus and Aphidius cingulatus. Coruna, which comprises various groups of aphids and aphidiids in host range, is not known from the “Lachnidae—Pauesia-Diaeretus” association.

**HOST APHID—HYPERPARASITE/PRIMARY PARASITE LIST***

**Lachnidae**

- Cinara sp. on Abies firma
  - Euneura augarus Walker / Pauesia sp.

- Cinara sp. on Abies firma
  - Pachyneuron solitarium (Hartig) / Pauesia sp.

- Cinara sp. on Abies firma
  - Asaphes suspensus (Nees) / Pauesia monica Watanabe & Takada
  - Euneura augarus Walker / Pauesia monica Watanabe & Takada

- Cinara sp. on Larix leptolepis
  - Euneura augarus Walker / Pauesia sp.
  - Euneura nawai (Ashmead) / Pauesia sp.

- Cinara longipennis (Matsumura)
  - Asaphes pubescens sp. n. / Pauesia kono Watanabe
  - Euneura augarus Walker / Pauesia kono Watanabe & P. nopporensis Watanabe & Takada

- Cinara pineti (Koch)
  - Asaphes suspensus (Nees) / Pauesia abietis (Marshall) & P. akamatsucola Takada
  - Euneura augarus Walker / Pauesia abietis (Marshall)
  - Euneura nawai (Ashmead) / Pauesia abietis (Marshall)
  - Pachyneuron aphidis (Bouché) / Pauesia abietis (Marshall)
  - Pachyneuron solitarium (Hartig) / Pauesia abietis (Marshall)

- Cinaria laricis (Walker)
  - Euneura augarus Walker / Pauesia pini (Haliday)
  - Pachyneuron solitarium (Haliday) / Pauesia pini (Haliday)

- Enlachnus thunbergii Wilson
  - Asaphes suspensus (Nees) / Diaeretus leucopterus (Haliday)
  - Pachyneuron aphidis (Bouché) / Diaeretus leucopterus (Haliday)
  - Pachyneuron solitarium (Hartig) / Diaeretus leucopterus (Haliday)

- Lachnus tropicalis (van der Goot)
  - Euneura nawai (Ashmead) / Pauesia japonica (Ashmead)

- Schizolachnus sp. on Pinus densiflora
  - Asaphes pubescens sp. n. / Pauesia unilachni (Gahan)
  - Asaphes suspensus (Nees) / Pauesia unilachni (Gahan)
  - Pachyneuron aphidis (Bouché) / Pauesia unilachni (Gahan)
  - Pachyneuron solitarium (Hartig) / Pauesia unilachni (Gahan)

- Tuberculachnus salignus (Gmelin)
  - Euneura nawai (Ashmead) / Pauesia salignae (Watanabe)

**Chaitophoridae**

- Periphyllus sp. on Acer sp.
  - Asaphes pubescens sp. n. / Dyscritulus sp.
  - Asaphes suspensus (Nees) / Dyscritulus sp.

* Restricted to records in Japan.
Pachyneuron aphidis (Bouché)/Dyscritulus sp.
Periphyllus californiensis (Shinji)
Asaphes pubescens sp. n./Aphidius areolatus Ashmead
Asaphes suspensus (Nees)/Aphidius areolatus Ashmead
Pachyneuron solitarium (Hartig)/Aphidius areolatus Ashmead & Dyscritulus sp.

Callaphididae

Callipterinella calliptera (Hartig)
Asaphes suspensus (Nees)/Aphidius sicarius Mackauer
Pachyneuron aphidis (Bouché)/Aphidius sicarius Mackauer
Pachyneuron mitsuurii Ashmead/Aphidius sicarius Mackauer

Euceraphis punctipennis (Zetterstedt)
Asaphes pubescens sp. n./Praon flavinode (Haliday) & Trioxys euceraphis Takada
Asaphes suspensus (Nees)/Praon flavinode (Haliday)
Coruna laevis sp. n./Praon flavinode (Haliday)
Pachyneuron sapporense sp. n./Praon flavinode (Haliday)
Pachyneuron solitarium (Hartig)/Praon flavinode (Haliday)

Shivaphis celti Das
Asaphes suspensus (Nees)/Trioxys shivaphis Takada

Aphididae

Aphid sp. on Cercidiphyllum japonicum
Asaphes pubescens sp. n./Praon sp.
Aphid sp. on Chaenomeles japonica
Asaphes suspensus (Nees)/Ephedrus persicae Frooggatt
Aphid sp. on Stephanandra incisa
Asaphes suspensus (Nees)/Praon sp.
Aphid sp. on Magnolia kobus
Asaphes suspensus (Nees)/Praon sp.
Acerthosiphon ibatom (Essig & Kuwana)
Asaphes suspensus (Nees)/Praon sp.
Pachyneuron aphidis (Bouché)/Praon sp.
Acerthosiphon magnoliae (Essig & Kuwana)
Asaphes pubescens sp. n./Praon volucre (Haliday)
Asaphes suspensus (Nees)/Praon volucre (Haliday)
Coruna clavata Walker/Praon volucre (Haliday)
Coruna laevis sp. n./Praon volucre (Haliday)
Pachyneuron sapporense sp. n./Ephedrus plagiator (Nees) & Praon volucre (Haliday)

Acerthosiphon mura-dachi (Shinji)
Asaphes suspensus (Nees)/Aphidius sp. & Ephedrus plagiator (Nees)
Acerthosiphon pisum (Harris)
Coruna clavata Walker/Aphidiiid sp.
Acerthosiphon solani (Kaltenbach)
Coruna clavata Walker/Praon sp.
Coruna laevis sp. n./Praon volucre (Haliday)
Acerthosiphon syringae (Matsumura)
Asaphes pubescens sp. n./Praon volucre (Haliday)
Asaphes suspensus (Nees)/Praon volucre (Haliday)
Coruna clavata Walker/Aphidiiid sp.
Coruna laevis sp. n./Praon volucre (Haliday)

Amphorophora amurensis (Mordvilkov)
Coruna clavata Walker / Aphidius lonicerae Marshall
Aphis craccivora Koch
Asaphes suspensus (Nees) / Ephedrus sp.
Pachyneuron aphidis (Bouché) / Ephedrus sp.
Aphis gossypii Glover
Asaphes suspensus (Nees) / Lysiphlebus japonicus Ashmead
Pachyneuron aphidis (Bouché) / Lysiphlebus japonicus Ashmead
Aphis nerii Boyer
Asaphes suspensus (Nees) / Ephedrus sp.
Pachyneuron aphidis (Bouché) / Ephedrus nacheri Quilis
Aphis spiraecola Patch
Asaphes pubescens sp. n. / Ephedrus plagiator (Nees)
Asaphes suspensus (Nees) / Ephedrus plagiator (Nees) & Lysiphlebus japonicus Ashmead
Brevicoryne brassicae (Linné)
Asaphes suspensus (Nees) / Diaeretiella rapae (M’Intosh)
Pachyneuron aphidis (Bouché) / Diaeretiella rapae (M’Intosh)
Capiotphorus sp. on Elaeagnus umbellata
Asaphes suspensus (Nees) / Ephedrus persicae Froggatt & Praon capitophori Takada
Pachyneuron aphidis (Bouché) / Praon capitophori Takada
Capiotphorus elaeagni (del Guercio)
Pachyneuron aphidis (Bouché) / Ephedrus persicae Froggatt
Cavariella araliei Takahashi
Asaphes suspensus (Nees) / Aphidius salicis Haliday
Cavariella salicicola (Matsumura)
Asaphes pubescens sp. n. / Aphidius salicis Haliday
Asaphes suspensus (Nees) / Aphidius salicis Haliday, Ephedrus salicicola Takada & Praon sp.
Pachyneuron aphidis (Bouché) / Aphidius salicis Haliday
Coloradoa artemisicola Takahashi
Asaphes suspensus (Nees) / Ephedrus nacheri Quilis
Hyalopterus prunii (Geoffroy)
Asaphes suspensus (Nees) / Ephedrus nacheri Quilis
Pachyneuron aphidis (Bouché) / Ephedrus nacheri Quilis
Pachyneuron solitarium (Hartig) / Ephedrus nacheri Quilis
Hyperomyzus lactucae (Linné)
Asaphes suspensus (Nees) / Aphidius sp. , Ephedrus nacheri Quilis & Praon sp.
Impatientinum balsamines (Kaltenbach)
Coruna clavata Walker / Aphidius sp.
Coruna laevis sp. n. / Aphidiiid sp.
Indomegoura indica (van der Goot)
Asaphes pubescens sp. n. / Praon dorsale (Haliday)
Asaphes suspensus (Nees) / Praon dorsale (Haliday)
Coruna clavata Walker / Praon dorsale (Haliday)
Coruna laevis sp. n. / Praon dorsale (Haliday)
Pachyneuron sapporense sp. n. / Praon dorsale (Haliday)
Lipaphis erysimi (Kaltenbach)
Asaphes suspensus (Nees) / Diaeretiella rapae (M’Intosh)
Pachyneuron aphidis (Bouché) / Diaeretiella rapae (M’Intosh)
Macrocephoniella sanborni (Gillette)
Asaphes suspensus (Nees) / Aphidius sp.
Macrocephum akebiae Shinji

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Asaphes suspensus (Nees) / Aphidius avenae Haliday, Ephedrus sp. & E. plagiator (Nees)
Pachyneuron aphidis (Bouché) / Ephedrus sp.
Macroisiphum euphorbiae (Thomas)
Asaphes suspensus (Nees) / Aphidius gifuensis Ashmead
Macroisiphum ibarai Matsumura
Asaphes suspensus (Nees) / Binodoxys centaurea (Haliday), Ephedrus sp. & Praon volucre (Haliday)
Coruna clavata Walker / Aphidiid sp. & Praon volucre (Haliday)
Coruna laevis sp. n. / Aphidiid sp.
Macroisiphum smilacifoliae Takahashi
Asaphes suspensus (Nees) / Aphidiid sp.
Melanaphis bambusae (Fullaway)
Asaphes suspensus (Nees) / Ephedrus plagiator (Nees)
Myzus sp. on Prunus sp.
Asaphes suspensus (Nees) / Ephedrus sp.
Myzus malisuctus Matsumura
Asaphes suspensus (Nees) / Praon sp.
Myzus persicae (Sulzer)
Asaphes suspensus (Nees) / Aphidius gifuensis Ashmead & Ephedrus plagiator (Nees)
Pachyneuron aphidis (Bouché) / Aphidius gifuensis Ashmead & Ephedrus nacheri Quillis
Pleotrichophorus glandulosus (Kaltenbach)
Asaphes suspensus (Nees) / Lysaphidus pleotrichophori Takada
Pachyneuron aphidis (Bouché) / Lysaphidus pleotrichophori Takada
Pterocomma sp. on Salix spp.
Asaphes suspensus (Nees) / Aphidius cingulatus Ruthe
Euneura nawai (Ashmead) / Aphidius cingulatus Ruthe
Pachyneuron sapporenses sp. n. / Aphidius cingulatus Ruthe
Rhopalosiphrum padi (Linné)
Asaphes suspensus (Nees) / Aphidiid sp.
Pachyneuron aphidis (Bouché) / Aphidiid sp., Ephedrus sp. & Lipolexis gracilis Foerster
Toxoptera citricidus (Kirkaldy)
Pachyneuron aphidis (Bouché) / Lysiphlebus japonicus Ashmead
Toxoptera odiinae (van der Goot)
Asaphes suspensus (Nees) / Ephedrus plagiator (Nees)
Pachyneuron aphidis (Bouché) / Lysiphlebus japonicus Ashmead
Tuberocephalus sakurae (Matsumura)
Asaphes suspensus (Nees) / Aphidiid sp.
Pachyneuron solitarius (Hartig) / Ephedrus sp.
Unisitobion sorbi (Matsumura)
Asaphes suspensus (Nees) / Praon volucre (Haliday)

Thelaxidae
Doraphis populi (Maskell)
Pachyneuron doraphis sp. n.
Mansakia shirakabae (Monzen)
Pachyneuron sapporenses sp. n. / Calaphidius watanabei (Takada)
<table>
<thead>
<tr>
<th>Primary Parasite/Host Aphid</th>
<th>Hyperparasite List</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aphidiid sp./Acyrthosiphon pisum</em> (Harris)</td>
<td><em>Coruna clavata</em> Walker</td>
</tr>
<tr>
<td><em>Aphidiid sp./Acyrthosiphon syringae</em> (Matsumura)</td>
<td><em>Coruna clavata</em> Walker</td>
</tr>
<tr>
<td><em>Aphidiid sp./Impatientium balsamines</em> (Kaltenbach)</td>
<td><em>Coruna laevis</em> sp. n.</td>
</tr>
<tr>
<td><em>Aphidiid sp./Macrosiphum ibarae</em> Matsumura</td>
<td><em>Coruna clavata</em> Walker</td>
</tr>
<tr>
<td><em>Aphidiid sp./Macrosiphum smilacifolii</em> Takahashi</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidiid sp./Rhopalosiphum padi</em> (Linné)</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidiid sp./Tuberoccephalus sakurae</em> (Matsumura)</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidius sp./Acyrthosiphon muradachi</em> (Shinji)</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidius sp./Hyperomyzus lactucae</em> (Linné)</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidius sp./Impatientium balsamines</em> (Kaltenbach)</td>
<td><em>Coruna clavata</em> Walker</td>
</tr>
<tr>
<td><em>Aphidius sp./Macrosiphum ibarae</em> Matsumura</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidius sp./Macrosiphoniella sanborni</em> (Gillette)</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidius areolatus</em> Ashmead/ <em>Periphyllus californiensis</em> (Shinji)</td>
<td><em>Asaphes pubescens</em> sp. n.</td>
</tr>
<tr>
<td><em>Aphidius cingulatus</em> Ruthe/ <em>Pterocomma</em> sp.</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
<tr>
<td><em>Aphidius salicis</em> Haliday/ <em>Cavariella araliae</em> Takahashi &amp; <em>C. salicicola</em> (Matsumura)</td>
<td><em>Asaphes pubescens</em> sp. n.</td>
</tr>
<tr>
<td><em>Aphidius sicarius</em> Mackauer/ <em>Callipterinella calliptera</em> (Hartig)</td>
<td><em>Asaphes suspensus</em> (Nees)</td>
</tr>
</tbody>
</table>

* Restricted to records in Japan.
Pachyneuron mitsukurii Ashmead

Binodoxys centaureae (Haliday)/ Macrosiphum ibarac Matsumura
Asaphes suspensus (Nees)

Calaphidius watanabei (Takada)/ Mansakia shirakabae (Monzen)
Pachyneuron sapporeense sp. n.

Diaeretiella rapae (M’ Intosh)/ Brevicoryne brassicae (Linné) & Lipaphis erysimi (Kaltenbach)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Diaeretus leucopterus (Haliday)/ Eulachnus thunbergii Wilson
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
Pachyneuron solitarium (Hartig)

Dyscritulus sp./ Periphyllus sp. & P. californiensis (Shinji)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
Pachyneuron solitarium (Hartig)

Ephedrus sp./ Aphis craccivora Koch
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Ephedrus sp./ Aphis nerii Boyer
Asaphes suspensus (Nees)

Ephedrus sp./ Macrosiphum akebiae Shinji
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Ephedrus sp./ Macrosiphum ibarac Matsumura
Asaphes suspensus (Nees)

Ephedrus sp./ Myzus sp.
Asaphes suspensus (Nees)

Ephedrus sp./ Rhopalosiphum padi (Linné)
Pachyneuron aphidis (Bouché)

Ephedrus sp./ Tuberocephalus sakurae (Matsumura)
Pachyneuron solitarium (Hartig)

Ephedrus nacheri Quilis/ Aphis nerii Boyer, Coloradoa artemisiocola Takahashi, Hyalopterus pruni (Geoffroy), Hyperomyzus lactucae (Linné) & Myzus persicae (Sulzer)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
Pachyneuron solitarium (Hartig)

Ephedrus persicae Froggatt/ Capitophorus sp. & C. elaeagni (del Guercio)
Asaphes suspensus (Nees)

Ephedrus plagiaror (Nees)/ Acrithosiphon magnoliae (Essig & Kuwana), A. muradachi (Shinji), Aphis spiraecola Patch, Macrosiphum akebiae Shinji, Melanaphis bambusae (Fullaway), Myzus persicae (Sulzer) & Toxoptera odinae (van der Goot)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
Pachyneuron sapporeense sp. n.

Ephedrus salicicola Takada/ Caviariella salicicola (Matsumura)
Asaphes suspensus (Nees)

Lipolexis gracilis Foerster/ Rhopalosiphum padi (Linné)
Pachyneuron aphidis (Bouché)

Lysaphidus pleotrichophori Takada/ Pleotrichophorus glandulosus (Kaltenbach)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Lysiphlebus japonicus Ashmead / Aphis gossypii Glover, A. spiraeola Patch, Toxoptera citricidus (Kirkaldy) & T. odinae (van der Goot)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Pauesia sp./Cinara sp. on Abies firma
Euneura augarus Walker
Pachyneuron solitarium (Hartig)

Pauesia sp./Cinara sp. on Larix leptolepis
Euneura augarus Walker

Pauesia abietis (Marshall)/Cinara piniti (Koch)
Asaphes suspensus (Nees)
Euneura augarus Walker
Euneura nawai (Ashmead)
Pachyneuron aphidis (Bouché)
Pachyneuron solitarium (Hartig)

Pauesia akamatscucl Takada/Cinara piniti (Koch)
Asaphes suspensus (Nees)
Euneura augarus Walker

Pauesia japonica (Ashmead)/Lachnus tropicalis (van der Goot)
Euneura nawai (Ashmead)

Pauesia konoi (Watanabe)/Cinara longipennis (Matsumura)
Asaphes pubescens sp. n.
Euneura augarus Walker

Pauesia momicola Watanabe & Takada/Cinara sp.
Asaphes suspensus (Nees)
Euneura augarus Walker

Pauesia nopporensis Watanabe & Takada/Cinara longipennis (Matsumura)
Euneura augarus Walker

Pauesia pini (Haliday)/Cinaria laricis (Walker)
Euneura augarus Walker
Pachyneuron solitarium (Hartig)

Pauesia salignae (Watanabe)/Tuberolachnus salignus (Gmelin)
Euneura nawai (Ashmead)

Pauesia unilachni (Gahan)/Schizolachnus sp.
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
Pachyneuron solitarium (Hartig)

Praon sp./Acyrtosiphon ibotum (Essig & Kuwana)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Praon sp./Acyrtosiphon solani (Kaltenbach)
Coruna clavata Walker

Praon sp./Cavariella salicicola (Matsumura)
Asaphes suspensus (Nees)

Praon sp./Hyperomyzus lactucae (Linné)
Asaphes suspensus (Nees)

Praon sp./Myzus malisuctus Matsumura
Asaphes suspensus (Nees)

Praon capitophori Takada/Capitophorus sp.
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

Praon dorsale (Haliday)/Indomegoura indica (van der Goot)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Coruna clavata Walker
Coruna laevis sp. n.
Pachyneuron sapporense sp. n.

Praon flavinode (Haliday)/Euceraphis punctipennis (Zetterstedt)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Coruna laevis sp. n.
Pachyneuron sapporense sp. n.
Pachyneuron solitarium (Hartig)

Praon volucre (Haliday)/Acyrthosiphon magnoliae (Essig & Kuwana), A. solani (Kaltenbach),
A. syringae (Matsumura), Macrosiphum ibarac Matsumura & Unisitobion sorbi (Matsumura)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Coruna clavata Walker
Coruna laevis sp. n.
Pachyneuron sapporense sp. n.

Trioxys euceraphis Takada/Euceraphis punctipennis (Zetterstedt)
Asaphes pubescens sp. n.

Trioxys shivaphis Takada/Shivaphis celli Das
Asaphes suspensus (Nees)

ACKNOWLEDGEMENTS

We wish to express our cordial thanks to Prof. C. Watanabe of Hokkaidō University for his continuous direction and his kindness in reading through this manuscript. Grateful acknowledgement is due to Prof. M. Sasakawa of Kyōto Prefectural University for his encouragement and advice. We are also indebted to Dr. S. Takagi of Hokkaidō University, who read and commented on the manuscript. We are especially obliged to Dr. B. D. Burks of U. S. National Museum of his helpful suggestions and to Dr. V. F. Eastop of British Museum, Dr. M. Miyazaki of the National Grassland Research Institute and Dr. H. Higuchi of Hokkaidō University for their kindness in identifying the host aphids. Many thanks are also due to the following gentlemen for their kindness in offering valuable specimens: Dr. Z. Bouček of British Museum; Dr. Y. Hirose of Kyūshū University; Dr. K. Kusigemati of Kagoshima University; Dr. M. Miyazaki; Dr. S. Takagi, Dr. H. Higuchi and Mr. M. Suwa of Hokkaidō University; Mr. N. Ueda of Kyōto Prefectural University.

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