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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

KAMIJO, K. & TAKADA, H. 1973. Studies on aphid hyperparasites of Japan, II. Aphid hyperparasites of the Pteromalidae occurring in Japan (Hymenoptera). *Ins. matsum.* n. s. 2: 39-76, 3 tabs., 31 figs.

Eleven aphid-hyperparasitic species of *Asaphes* Walker (2 spp.), Asaphinae, 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. sapporensis* and *P. doraphis* are new spp. and *A. suspensus* (Nees), *C. clavata* Walker and *E. augarus* 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.

Authors' addresses. KAMIJO, K.: Hokkaidô Forest Experiment Station, Bibai, Hokkaidô, 079-01 Japan. TAKADA, H.: Entomological Laboratory, Kyôto Prefectural University, Shimogamo, Kyôto, 606 Japan.

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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 oviposit 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, Hokkaidô University, Sapporo.

The present study was partly carried out at the Entomological Institute of Hokkaidô University while the junior author was enrolled at that Institute. This paper constitutes Contribution No. 134 from Entomological Laboratory, Kyôto 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 *Pachyneuron* Walker
- 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].

Parectroma Brèthes, 1913, An. Mus. Nac. Hist. Nat. Buenos Aires 24: 91 [type-species: *Parectroma huebrichi* Brèthes].

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)

Chrysolampus suspensus Nees, 1834, Hym. Ichneum. Affin. Monog. 2: 127.

Asaphes suspensus: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 82.

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.

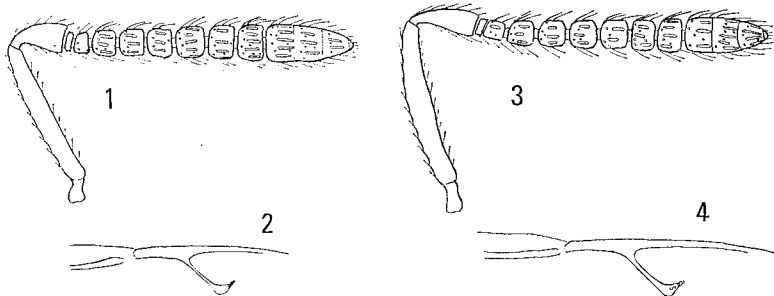


Fig. 1 & 2. *Asaphes suspensus* (Nees), female:

1, antenna—2, fore wing venation.

Fig. 3 & 4. *Asaphes pubescens* sp. n., female:

3, antenna—4, fore wing venation.

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 infusate.

Material and host*: 8♀5♂, Kumamoto—Aphidiid sp./*Macrosiphum smilacifoliae* Takahashi/*Smilax china*; 2♀, Sapporo (K. Kusigemati) & 1♀4♂, Niigata (A. Ôtake)—Aphidiid sp./*Rhopalosiphum padi* (Linné)/*Triticum aestivum*; 1♀, Yakushima—*Tuberocephalus sakurae* (Matsumura)/*Prunus* sp. (cherry); 4♀6♂, Hiko-san—*Aphidius* sp./*Acyrtosiphon muradachi* (Shinji)/*Parabenzoin praecox*; 2♀1♂, Kyôto—*Aphidius* sp./*Hyperomyzus lactucae* (Linné)/*Sonchus oleraceus*; 1♀, Kyôto—*Aphidius* sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 1♂, Kagoshima—*Aphidius* sp./*Macrosiphoniella sanborni* (Gillette)/*Chrysanthemum* sp.; 1♂, Sapporo, 32♀24♂, Kyôto & 1♀, Kumamoto—*Aphidius areolatus* Ashmead/*Periphyllus californiensis* (Shinji)/*Acer* sp.; 1♂, Sapporo—*Aphidius avenae* Haliday/*Macrosiphum akebiae* Shinji/*Triticum aestivum*; 1♀3♂, Sapporo—*Aphidius cingulatus* Ruthe/*Pterocomma* sp./*Salix* sp.; 2♀, Kyôto—*Aphidius gifuensis* Ashmead/*Macrosiphum euphorbiae* (Thomas)/*Solanum tuberosum*; 4♀1♂, Sapporo (*Raphanus sativus* & *Solanum tuberosum*), 4♀1♂, Kyôto (*Brassica oleracea*, *Raphanus sativus* & *Spinacia oleracea*) & 3♂, Kôchi (*Althaea rosea*)—*Aphidius gifuensis* Ashmead/*Myzus persicae* (Sulzer); 1♂, Kagoshima—*Aphidius salicis* Haliday/*Cavariella araliae* Takahashi/*Tetrapanax papyriferus*; 2♂, Tottori & 1♂, Kagoshima—*Aphidius salicis* Haliday/*Cavariella salicicola* (Matsumura)/*Salix* sp.; 9♂, Sapporo—*Aphidius sicarius* Mackauer/*Callipterinella calliptera* (Hartig)/*Betula* sp.; 1♀, Kyôto—*Binodoxys centaureae* (Haliday)/*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 5♀6♂, Kyôto—*Diaeretiella rapae* (M'Intosh)/*Brevicoryne brassicae* (Linné)/*Brassica oleracea*; 3♀, Kyôto—*Diaeretiella rapae* (M'Intosh)/*Lipaphis erysimi* (Kaltenbach)/*Raphanus sativus*; 2♀5♂, Kyôto, 1♀, Sasebo & 3♂ Nobeoka—*Diaeretus leucopterus* (Haliday)/*Eulachnus thunbergii* Wilson/*Pinus thunbergii*; 6♀3♂, Sapporo—*Dyscritulus* sp./*Periphyllus* sp./*Acer* sp.; 7♀3♂, Fukuoka—*Ephedrus* sp./*Aphis craccivora* Koch/*Robinia pseudo-acacia*; 2♀, Fukuoka—*Ephedrus* sp./*Aphis nerii* Boyer/*Nerium indicum*; 5♀8♂, Takarazuka—*Ephedrus* sp./*Macrosiphum akebiae* Shinji/*Stauntonia hexaphylla*; 11♀7♂, Kyôto—*Ephedrus* sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 1♀, Sapporo—*Ephedrus* sp./*Myzus* sp./*Prunus* sp.; 1♀, Fukuoka—*Ephedrus nacheri* Quilis/*Colorado artemisicola* Takahashi/*Artemisia* sp.; 2♀, Kumamoto—*Ephedrus nacheri* Quilis/*Hyalopterus pruni* (Geoffroy)/*Prunus* sp.; 2♀, Kumamoto—*Ephedrus nacheri* Quilis/*Hyperomyzus lactucae* (Linné)/*Sonchus oleraceus*; 2♀6♂, Sapporo—*Ephedrus persicae* Froggatt/Aphidid sp./*Chaenomeles japonica*; 1♀2♂, Kyôto & 2♀4♂, Kumamoto—*Ephedrus persicae* Froggatt/*Capitophorus* sp./*Elaeagnus umbellata*; 1♀, Fukuoka—*Ephedrus plagiator* (Nees)/*Acyrtosiphon muradachi* (Shinji)/*Parabenzoin praecox*; 1♀3♂, Kyôto—*Ephedrus plagiator* (Nees)/*Aphis spiraeicola* Patch/*Spiraea thunbergii*; 1♀1♂, Kyôto—*Ephedrus plagiator* (Nees)/*Macrosiphum akebiae* Shinji/*Stauntonia hexaphylla*; 1♀9♂, Nara—*Ephedrus plagiator* (Nees)/*Melanaphis bambusae* (Fullaway)/Rosaceous sp.; 4♀3♂, Kyôto—*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*.

13♀9♂, Miyazaki & 3♂, Aoshima—*Ephedrus plagiator* (Nees)/*Toxoptera odinae* (van der Goot)/*Pittosporum tobira*; 5♀5♂, Sapporo—*Ephedrus salicicola* Takada/*Cavariella salicicola* (Matsumura)/*Salix vulpina*; 1♀3♂, Kure, 3♀, Matsuyama & 1♂, Fukuoka—*Lysaphidus pleotrichophori* Takada/*Pleotrichophorus glandulosus* (Kaltenbach)/*Artemisia* sp.; 2♀3♂, Sapporo & 1♀3♂, Kyôto—*Lysiphlebus japonicus* Ashmead/*Aphis gossypii* Glover/*Solanum tuberosum*; 1♀, Fukuoka—*Lysiphlebus japonicus* Ashmead/*Aphis spiraeicola* Patch/*Spiraea thunbergii*; 2♀1♂, Kyôto—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 1♀, Kyôto—*Pauesia akamatsucola* Takada/*Cinara pineti* (Koch)/*Pinus densiflora*; 1♀, Kyôto—*Pauesia momicola* Watanabe & Takada/*Cinara* sp./*Abies firma*; 1♀3♂, Kyôto—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*; 1♂, Sapporo—*Praon* sp./Aphidid sp./*Magnolia kobus*; 1♀, Sapporo—*Praon* sp./Aphidid sp./*Stephanandra incisa*; 1♀, Sapporo—*Praon* sp./*Acyrtosiphon ibotum* (Essig & Kuwana)/*Ligustrum obtusifolium*; 1♀2♂, Sapporo—*Praon* sp./*Cavariella salicicola* (Matsumura)/*Salix vulpina*; 3♂, Kumamoto—*Praon* sp./*Hyperomyzus lactucae* (Linné)/*Sonchus oleraceus*; 1♀, Kyôto—*Praon* sp./*Myzus malisuctus* Matsumura/*Malus* sp.; 3♀2♂, Sapporo & 1♀, Kumamoto—*Praon capitophori* Takada/*Capitophorus* sp./*Elaeagnus umbellata*; 11♀8♂, Sapporo—*Praon dorsale* (Haliday)/*Indomegoura indica* (van der Goot)/*Staphylea bumalda*; 1♂, Sapporo—*Praon flavinode* (Haliday)/*Euceraphis punctipennis* (Zetterstedt)/*Betula* sp.; 40♀34♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 3♀3♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon syringae* (Matsumura)/*Syringa emodi* & *S. reticulata*; 3♀2♂, Kyôto—*Praon volucre* (Haliday)/*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 1♀, Sapporo—*Praon volucre* (Haliday)/*Unisitobion sorbi* (Matsumura)/*Sorbaria sorbifolia*; 1♀, Kyôto—*Trioxys shivaphis* Takada/*Shivaphis celti* Das/*Celtis* sp.; 1♀, Toyotomi (K. Kusigemati); 1♂, Mashike (K. Kusigemati); 1♀, Hiroshima (M. Suwa); 8♀5♂, Naganuma; 7♀3♂, Sapporo (H. Higuchi, K. Kusigemati & M. Miyazaki); 1♀1♂, Kumamoto; 3♀1♂, Kagoshima (K. Kusigemati).

Locality in Japan: Hokkaidô—Toyotomi, Mashike, Hiroshima, Naganuma & Sapporo; Honshû—Niigata, Kyôto, Nara, Takarazuka, Tottori & Kure; Shikoku—Kôchi & Matsuyama; Kyûshû—Fukuoka, Hiko-san, Kumamoto, Sasebo, Nobeoka, Miyazaki, Aoshima, Kagoshima & Yakushima.

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. Postocellar line more than twice as long as ocellocular 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)/*Acyrtosiphon 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 spiraeicola* Patch/*Viburnum suspensum*; 1♀, Yuni—*Pauesia konoii* (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)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 1♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon syringae* (Matsumura)/*Syringa emodi*; 1♀, Sapporo—*Trioxyys euceraphis* Takada/*Euceraphis punctipennis* (Zetterstedt)/*Betula* sp.

Locality in Japan: Hokkaidô—Yuni & Sapporo; Honshû—Kyôto; Shikoku—Takamatsu & Kôchi.

Geographical distribution: Japan.

Genus *Coruna* Walker

Coruna Walker, 1833, Ent. Mag. 1: 371, 379 [type-species: *Coruna clavata* Walker].

Coryna Walker, 1846, List Hym. Ins. Brit. Mus. 1, p. 29 [invalid emendation; preoccupied].

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); antennae dark brown with scape yellowish brown; in male fourth to sixth tergites distinctly 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

Coruna clavata Walker, 1833, Ent. Mag. 1: 380.

Coruna clavata: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 845.

Through the kindness of Dr. Bouček, we have been able to examine 2 specimens 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

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

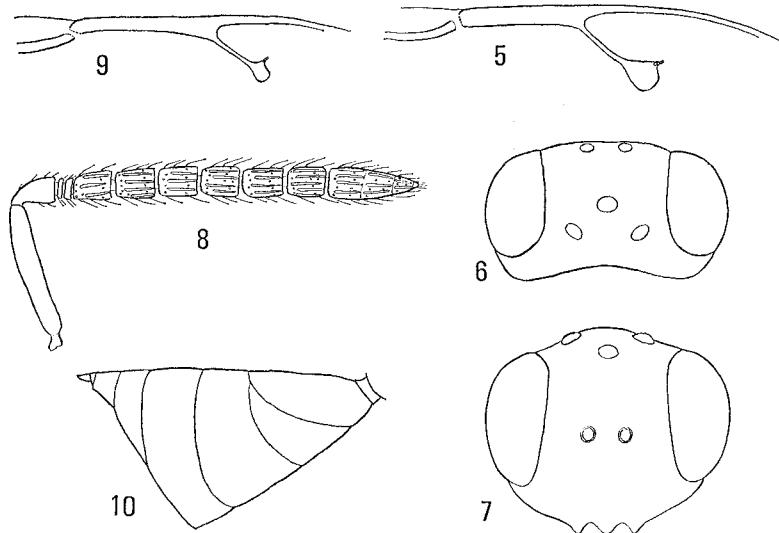


Fig. 5. *Coruna clavata* Walker, female: fore wing venation.
Fig. 6–10. *Coruna laevis* sp. n., female: 6, head in dorsal view—7, head in front view—8, antenna—9, fore wing venation—10, gaster in lateral view.

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 bronzy 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./*Acyrtosiphon pisum* (Harris)/*Glycine max*; 1♂, Sapporo—Aphidiid sp./*Acyrtosiphon syringae* (Matsumura)/*Syringa reticulata*; 1♂, Sapporo—Aphidiid sp./*Macrosiphum ibarae* 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./*Acyrtosiphon solani* (Kaltenbach)/*Impatiens* sp.; 1♂, Sapporo—*Praon dorsale* (Haliday)/*Indomegoura indica* (van der Goot)/*Staphylea bumalda*; 6♀3♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 1♀, Sapporo—*Praon volucre* (Haliday)/*Macrosiphum ibarae* Matsumura/*Rosa* sp.

Locality in Japan: Hokkaidō—Nukabira & Sapporo; Honshū—Morioka.

Geographical distribution: Japan; Europe; North America.

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 weakly 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.

Holotype: ♀, Sapporo, 30. vi. 1962, *Praon volucre* (Haliday)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*.

Material & host: 1♂, Soranuma-dake—Aphidiid sp./*Impatiens balsamines* (Kaltenbach)/*Impatiens* sp.; 1♀, Sapporo—Aphidiid sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 1♀, Sapporo—*Praon dorsale* (Haliday)/*Indomegoura indica* (van der Goot)/*Staphylea bumalda*; 3♀ 8♂, Sapporo—*Praon flavinode* (Haliday)/*Euceraphis punctipennis* (Zetterstedt)/*Betula* sp.; 3♀ 6♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 1♀ 1♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon solani* (Kaltenbach)/*Cornus* sp.; 1♀ 2♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon syringae* (Matsumura)/*Syringa reticulata*; 1♀ 1♂, Sapporo.

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

Geographical distribution: Japan.

Genus *Pachyneuron* Walker

Pachyneuron Walker, 1833, Ent. Mag. 1: 371, 380 [type-species: *Pachyneuron formosum* Walker].

Serimus Brèthes, 1913, An. Mus. Nac. Hist. Nat. Buenos Aires 24: 90 [type-species: *Serimus argentinus* Brèthes].

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

Nepachyneuron Girault, 1917, Des. Hym. Chalcidoid. Var. Cum Observ. 5, p. 9 [type-species: *Pachyneuron eros* Girault].

Atrichoptilus Delucchi, 1955, Z. Angew. Ent. 38: 141 [type-species: *Pachyneuron aeneum* Masi].

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 *doraphis* 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 *sapporensis* 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 *aphidis* (Bouché)
- 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

Pachyneura [sic] *mitsukurii* Ashmead, 1904, J. New York Ent. Soc. 12: 158.
 ? *Pachyneuron coeruleum* Delucchi, 1955, Z. Angew. Ent. 38: 131.
Pachyneuron umbratum Delucchi, 1955, Z. Angew. Ent. 38: 132. Syn. n.
Pachyneuron umbratum: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 834.

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 (= *Lysaphidus 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♀1♂, Iki; 1♀, Tokunoshima (K. Kamijo).

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

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 sapporensis 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

reflections on hind ones; tibiae sometimes infusate.

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)/*Eucraphis punctipennis* (Zetterstedt)/*Betula* sp.

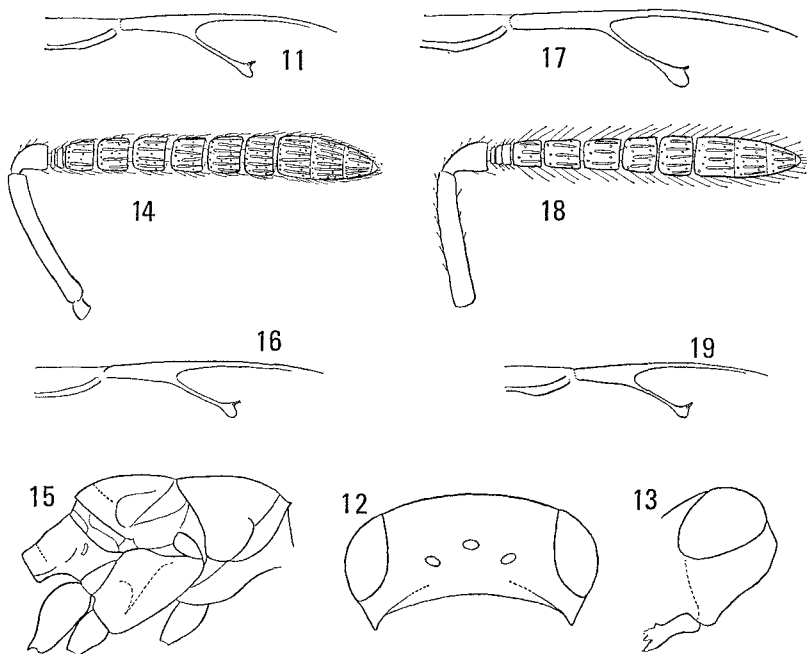


Fig. 11. *Pachyneuron mitsukurii* Ashmead, female: fore wing venation.

Fig. 12–16. *Pachyneuron sapporensis* 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)/*Eucraphis punctipennis* (Zetterstedt)/

Betula sp.; 3♀7♂, Sapporo—*Praon volucre* (Haliday)/*Acyrtosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 1♀1♂, Sapporo.

Locality in Japan: Hokkaidō—Sapporo.

Geographical distribution: Japan.

This species seems to be allied to *P. cremifaniae* 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. (nec *Ichneumon coccorum* Linné, 1758).

Chrysolampus solitarius Hartig, 1838, Jahresb. Forstwiss. Forst. Naturk. 1: 250.

Pachyneuron solitarium: Bouček, 1965, Acta Faun. Ent. Mus. Nat. Pragae 11: 18.

Pachyneuron solitarium: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 838.

Pteromalus concolor Förster, 1841, Beitr. Monogr. Pterom. 1: 28.

Pachyneuron concolor: Delucchi, 1955, Z. Angew. Ent. 38: 136.

Pachyneuron concolor: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 840.

Pachyneuron nawai: Ishii, 1938, Kontyû 7: 103 [host: egg of *Dendrolimus superans* Butler].

Pachyneuron nawai: Tabata and Tamanuki, 1939, Karafuto Cent. Expt. Sta. Bull. 33(2), 11: 8 [host: egg of *Dendrolimus superans* Butler].

Pachyneuron siculum Delucchi, 1955, Z. Angew. Ent. 38: 135.

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 subtruncate, 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 infusate.

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 sakurae* (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 leptolepis*; 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♂, Minô (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*; 4♀ 6♂, Fukuoka (Y. Murakami), from *Phenacoccus aceris* Signoret (Homoptera, Pseudococcidae); 29♀ 6♂, Fukuoka (Y. Hirose), *Trichogramma dendrolimi* Matsumura (Hymenoptera, Trichogrammatidae)/eggs of *Dendrolimus spectabilis* Butler (Lepidoptera, Lasiocampidae)/*Pinus thunbergii*.

Locality in Japan: Hokkaidô—Sôunkyô, Asahikawa & Sapporo; Honshû—Nagano, Kyôto, Nara, Minô (Ôsaka-fu) & Kôbe; Kyûshû—Fukuoka, Sasebo, Kumamoto & Yakushima.

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)

Diplolepis Aphidis Bouché, 1834, Naturg. d. Insekt. p. 170.

Pachyneuron aphidis: Reinhard, 1859, Stettin. Ent. Ztg. 20: 195.

Pachyneuron aphidis: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 842.

Pteromalus minutissimus Förster, 1841, Beitr. Monog. Pterom. 1: 28.

Pachyneuron minutissimum: Delucchi, 1955, Z. Angew. Ent. 38: 137.

Pachyneuron gifuensis [sic] Ashmead, 1904, J. New York Ent. Soc. 12: 158. Syn. n.

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. Scape 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 infusate 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: 1♀1♂, Sapporo (K. Kusigemati)—*Aphidiid* sp./*Rhopalosiphum padi* (Linné)/*Poaceus* sp.; 2♀, Kyôto—*Aphidius gifuensis* Ashmead/*Myzus persicae* (Sulzer)/*Raphanus sativus*; 3♀3♂, Tottori & 1♀2♂, Kagoshima—*Aphidius salicis* Haliday/*Cavariella salicicola* (Matsumura)/*Salix* sp.; 3♀7♂, Sapporo—*Aphidius sicarius* Mackauer/*Callipterinella calliptera* (Hartig)/*Betula* sp.; 3♀4♂, Kyôto & 16♀15♂, Takarazuka—*Diaeretiella rapae* (M'Intosh)/*Brevicoryne brassicae* (Linné)/*Brassica oleracea*; 1♀1♂, Kyôto—*Diaeretiella rapae* (M'Intosh)/*Lipaphis erysimi* (Kaltenbach)/*Raphanus sativus*; 2♂, Sasebo & 1♂, Kagoshima—*Diaeretus leucopterus* (Haliday)/*Eulachnus thunbergii* Wilson/*Pinus thunbergii*; 1♀1♂, Fukuoka—*Dyscritulus* sp./*Periphyllus* sp./*Acer* sp.; 1♀1♂, Fukuoka—*Ephedrus* sp./*Aphis craccivora* Koch/*Robinia pseudo-acacia*; 1♀, Takarazuka—*Ephedrus* sp./*Macrosiphum akebiae* Shinji/*Stauntonia hexaphylla*; 2♀1♂, Kyôto—*Ephedrus* sp./*Rhopalosiphum padi* (Linné)/*Triticum aestivum*; 76♀♂, Fukuoka—*Ephedrus nacheri* Quilis/*Aphis nerii* Boyer/*Nerium indicum* & *Robinia pseudo-acacia*; 5♀2♂, Kumamoto—*Ephedrus nacheri* Quilis/*Hyalopterus pruni* (Geoffroy)/*Prunus* sp.; 7♀9♂, Sapporo—*Ephedrus nacheri* Quilis/*Myzus persicae* (Sulzer)/*Prunus* sp.; 1♂, Kagoshima—*Ephedrus persicae* Froggatt/*Capitophorus elaeagni* (del Guercio)/*Elaeagnus umbellata*; 2♂, Sapporo—*Lipolexis gracilis* Foerster/*Rhopalosiphum padi* (Linné)/*Zea mays*; 1♀1♂, Kure & 1♂, Matsuyama—*Lysiphidus pleotrichophori* Takada/*Pleotrichophorus glandulosus* (Kaltenbach)/*Artemisia* sp.; 1♀, Sapporo—*Lysiphlebus japonicus* Ashmead/*Aphis gossypii* Glover/*Solanum tuberosum*; 4♀1♂, Yasugesshô (T. Kato)—*Lysiphlebus japonicus* Ashmead/*Toxoptera citricidus* (Kirkaldy)/*Citrus deliciosa*; 2♂, Miyazaki—*Lysiphlebus japonicus* Ashmead/*Toxoptera odinae* (van der Goot)/*Pittosporum tobira*; 5♀, Kôbe—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 1♂, Kyôto—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*; 1♀3♂, Sapporo (K. Kusigemati)—*Praon* sp./*Acyrtosiphon ibotum* (Essig & Kuwana)/*Ligustrum obtusifolium*; 2♀, Kumamoto—*Praon capitophori* Takada/*Capitophorus* sp./*Elaeagnus umbellata*; 1♀, Sapporo (K. Kusigemati); 1♀1♂, Kyôto; 17♀♂, Fukuoka.

Locality in Japan: Hokkaidô—Sapporo; Honshû—Gifu (after Ashmead, 1904),

Kyôto, Takarazuka, Kôbe, Tottori, Kure & Yasugeshô (Yamaguchi-ken); Shikoku—Matsuyama; Kyûshû—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;

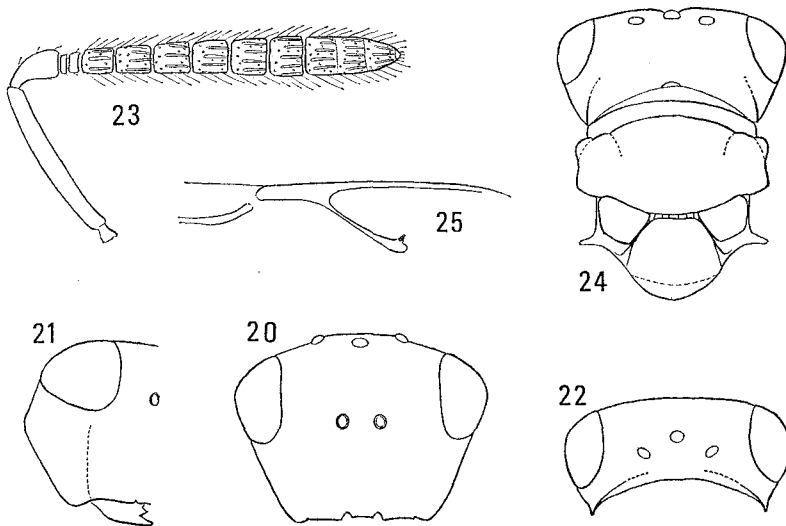


Fig. 20-25. *Pachyneuron doraphis* sp. n., female: 20, head in front view—21, head in profile—22, head in dorsal view—23, antenna—24, head and thorax in dorsal view—25, fore wing venation.

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 quadrate 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

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: Hokkaidō—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

Euneura Walker, 1844, Ann. Mag. Nat. Hist. 14: 331 [type-species: *Euneura augarus* Walker].

Hypsicamara Förster, 1856, Hym. Stud. 2, pp. 52, 54 [type-species: *Hypsicamara ratzeburgi* Reinhard].

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) *augarus* 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) *nawai* (Ashmead)

Euneura augarus Walker

Euneura augarus Walker, 1844, Ann. Mag. Nat. Hist. 14: 331.

Euneura augurus [sic]: Delucchi, 1955, Z. Angew. Ent. 38: 144.

Euneura augarus: Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 844.

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, *augarus* 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 pineti* (Koch)/*Pinus densiflora*; 5♀ 5♂, Naganuma (*Abies sachalinensis*) & 2♀ 2♂, Kyōto (*Abies firma*)—*Pauesia konoi* (Watanabe)/*Cinara longipennis* (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—

Pauesia pini (Haliday)/*Cinaria laricis* (Walker)/*Larix leptolepis*; 7♀8♂, Bibai (K. Kamijo).

Locality in Japan: Hokkaidô—Bibai, Naganuma, Nopporo, Sapporo, Soranuma-dake & Tôya; Honshû—Kyôto, Nara, Hirakata (Ôsaka-fu) & Kôbe.

Geographical distribution: Japan; Europe.

Euneura nawai (Ashmead), comb. n.

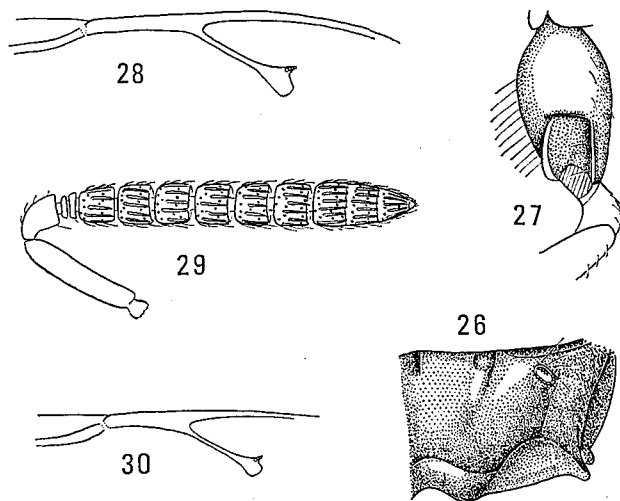
Pachyneura [sic] *nawai* Ashmead, 1904, J. New York Ent. Soc. 12: 158.

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

Euneura laeviuscula Graham, 1969, Bull. Brit. Mus. (Nat. Hist.) Ent. Suppl. 16: 844 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



Figs. 26-28. *Euneura augarus* Walker, female: 26, propodeum—27, right hind coxa in profile—28, fore wing venation.

Figs. 29-30. *Euneura nawai* (Ashmead), female: 29, antenna—30, fore wing venation.

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 *laeviuscula* and a European specimen (♀, Italia, 13. ix. 1969, Z. Bouček) identified as *laeviuscula* 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-

ments quadrate, with last two segments sometimes slightly transverse (Fig. 29). Face finely reticulate; clypeus radiately strigose, with anterior margin shallowly 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 *augarus*. 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: 21♀12♂, Sapporo—*Aphidius cingulatus* Ruthe/*Pterocomma* sp./*Salix* sp.; 2♀, Yamabe (K. Kamijo)—*Pauesia* sp./*Cinara* sp./*Larix leptolepis*; 10♀15♂, Kyôto—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 5♀1♂, Kyôto—*Pauesia japonica* (Ashmead)/*Lachnus tropicalis* (van der Goot)/*Quercus* sp.; 11♀9♂, Mashike (K. Kusigemati), 10♀1♂, Sapporo (S. Takagi), 1♀1♂, Nagano (N. Ueda), 5♀7♂, Hamada (A. Machida) & 11♀15♂, Kagoshima (K. Kusigemati)—*Pauesia salignae* (Watanabe)/*Tuberolachnus salignus* (Gmelin)/*Salix* spp.

Locality in Japan: Hokkaidô—Mashike, Yamabe & Sapporo; Honshû—Atami & Gifu (after Ashmead, 1904), Nagano, Kyôto & Hamada; Kyûshû—Fukuoka (after Yasumatsu et al., 1946) & Kagoshima.

Geographical distribution: Japan; Europe.

BIOLOGICAL NOTES

Geographical distribution

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 Hokkaidô, Honshû and Shikoku, while 3 other species are recorded only from Hokkaidô. None of them may be truly 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.

Species	Locality				
	Japan				Other countries
	Hokkaidô	Honshû	Shikoku Kyûshû	Ryûkyû	
<i>Asaphes suspensus</i>	+	+	+		Korea ⁶ ; North & Central Europe ⁵
<i>A. pubescens</i>	+	+	+		
<i>Coruna clavata</i>	+	+ ^N			Korea ⁶ ; North & Central Europe ⁵ ; Northern North America (Alaska & B. C. ⁴ ; N. B., Main & Wash. ²)
<i>C. laevis</i>	+				
<i>Pachyneuron mitsukurii</i>	+	+	+	+	North & Central Europe ⁵
<i>P. sapporense</i>	+				
<i>P. solitarium</i>	+	+	+		Saghalien ¹ ; Korea ⁶ ; Israel ⁵ ; wide areas of Europe ⁵
<i>P. aphidis</i>	+	+	+		Korea ⁶ ; Taiwan ⁶ ; Israel ³ ; wide areas of Europe ⁵ ; Hawaii ⁶
<i>P. doraphis</i>	+				
<i>Euneura augarus</i>	+	+			North & Central Europe ⁵
<i>E. nawai</i>	+	+	+		Italy & Czechoslovakia ⁵

1, Tabata & Tamanuki, 1939; 2, Peck, 1963; 3, Rosen, 1966; 4, Krombein & Burks, 1967; 5, Graham, 1969; 6, Unpublished data. +^N Recorded only from the northern area.

Asaphes suspensus, *Pachyneuron mitsukurii*, *P. solitarium*, *P. aphidis*, *Euneura augarus* 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

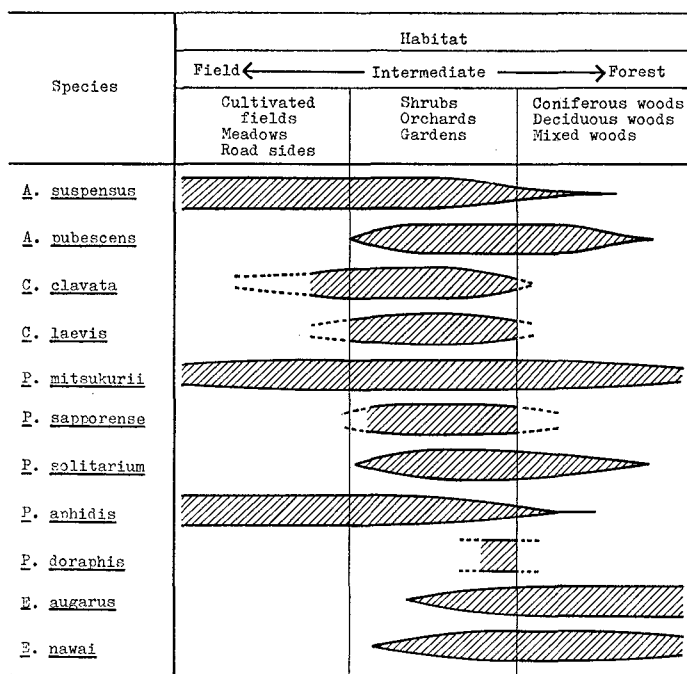


Fig. 31. Habitat distribution of aphid hyperparasites of Pteromalidae occurring in Japan.

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; *sapporensis* 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 sapporensis*. (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.

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

Capsule	Real Host	Species
Aphid mummy	Aphidiidae (Prepupae & pupae)	<i>mitsukurii</i> <i>sapporensis</i> <i>solitarium</i> <i>aphidis</i>
Coccid mummy	Encyrtidae (Pupae)	<i>mitsukurii</i> <i>solitarium</i>
Egg shell of <i>Dendrolimus</i>	<i>Trichogramma</i> , <i>Ooencyrtus</i> & <i>Telenomus</i>	<i>solitarium</i>
Puparium of Syrphidae	Syrphidae (Pupae)	<i>mitsukurii</i>

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 3. Host range of aphid hyperparasites of Pteromalidae occurring in Japan.

Species	Host		
	Aphids	Lachnidae Aphididae <i>Pterocomma</i>	Chaitophoridae, Callaphididae, Aphididae & "Aphid-type" Thelaxidae
Primary parasites	Aphidiidae <i>Pauesia</i> , <i>Diaeretus</i> & <i>A. cingulatus</i>	Aphidiidae Most genera except for <i>Pauesia</i> & <i>Diaeretus</i>	Encyrtidae ?
<i>Asaphes suspensus</i>	+	++	
<i>A. pubescens</i>	+	++	
<i>Coruna clavata</i>		++	
<i>C. laevis</i>		++	
<i>Pachyneuron mitsukurii</i>		(+)	
<i>P. sapporense</i>		+	
<i>P. solitarium</i>	+	+	
<i>P. aphidis</i>	+	++	
<i>P. doraphis</i>			+
<i>Euneura augarus</i>	++		
<i>E. nawai</i>	++		

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 momicola* Watanabe & Takada
Euneura augarus Walker/*Pauesia momicola* 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 konoii* (Watanabe)
Euneura augarus Walker/*Pauesia konoii* (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)
- Eulachnus 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)
- Tuberolachnus 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 mitsukurii Ashmead/*Aphidius sicarius* Mackauer
Euceraphis punctipennis (Zetterstedt)
Asaphes pubescens sp. n./*Praon flavinode* (Haliday) & *Trioxyys 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)/*Trioxyys shivaphis* Takada

Aphididae

Aphidid sp. on *Cercidiphyllum japonicum*
Asaphes pubescens sp. n./*Praon* sp.
Aphidid sp. on *Chaenomeles japonica*
Asaphes suspensus (Nees)/*Ephedrus persicae* Froggatt
Aphidid sp. on *Stephanandra incisa*
Asaphes suspensus (Nees)/*Praon* sp.
Aphidid sp. on *Magnolia kobus*
Asaphes suspensus (Nees)/*Praon* sp.
Acyrtosiphon ibotum (Essig & Kuwana)
Asaphes suspensus (Nees)/*Praon* sp.
Pachyneuron aphidis (Bouché)/*Praon* sp.
Acyrtosiphon 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)
Acyrtosiphon muradachi (Shinji)
Asaphes suspensus (Nees)/*Aphidius* sp. & *Ephedrus plagiator* (Nees)
Acyrtosiphon pisum (Harris)
Coruna clavata Walker/*Aphidiid* sp.
Acyrtosiphon solani (Kaltenbach)
Coruna clavata Walker/*Praon* sp.
Coruna laevis sp. n./*Praon volucre* (Haliday)
Acyrtosiphon syringae (Matsumura)
Asaphes pubescens sp. n./*Praon volucre* (Haliday)
Asaphes suspensus (Nees)/*Praon volucre* (Haliday)
Coruna clavata Walker/*Aphidiid* sp.
Coruna laevis sp. n./*Praon volucre* (Haliday)
Amphorophora amurensis (Mordvilko)

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 spiraeicola 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)
Capitophorus sp. on *Elaeagnus umbellata*
Asaphes suspensus (Nees)/*Ephedrus persicae* Froggatt & *Praon capitophori* Takada
Pachyneuron aphidis (Bouché)/*Praon capitophori* Takada
Capitophorus elaeagni (del Guercio)
Pachyneuron aphidis (Bouché)/*Ephedrus persicae* Froggatt
Cavariella araliae 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 pruni (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.
Impatiens balsamines (Kaltenbach)
Coruna clavata Walker/*Aphidius* sp.
Coruna laevis sp. n./*Aphidiid* 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 sapporensis sp. n./*Praon dorsale* (Haliday)
Lipaphis erysimi (Kaltenbach)
Asaphes suspensus (Nees)/*Diaeretiella rapae* (M'Intosh)
Pachyneuron aphidis (Bouché)/*Diaeretiella rapae* (M'Intosh)
Macrosiphoniella sanborni (Gillette)
Asaphes suspensus (Nees)/*Aphidius* sp.
Macrosiphum akebiae Shinji

Asaphes suspensus (Nees)/ *Aphidius avenae* Haliday, *Ephedrus* sp. & *E. plagiator* (Nees)
Pachyneuron aphidis (Bouché)/ *Ephedrus* sp.
Macrosiphum euphorbiae (Thomas)
Asaphes suspensus (Nees)/ *Aphidius gifuensis* Ashmead
Macrosiphum ibarae Matsumura
Asaphes suspensus (Nees)/ *Binodoxys centaureae* (Haliday), *Ephedrus* sp. & *Praon volucre* (Haliday)
Coruna clavata Walker/ Aphidiid sp. & *Praon volucre* (Haliday)
Coruna laevis sp. n./ Aphidiid sp.
Macrosiphum 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* Quilis
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 sapporense sp. n./ *Aphidius cingulatus* Ruthe
Rhopalosiphum 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 odinae (van der Goot)
Asaphes suspensus (Nees)/ *Ephedrus plagiator* (Nees)
Pachyneuron aphidis (Bouché)/ *Lysiphlebus japonicus* Ashmead
Tuberocephalus sakurae (Matsumura)
Asaphes suspensus (Nees)/ Aphidiid sp.
Pachyneuron solitarium (Hartig)/ *Ephedrus* sp.
Unisitobion sorbi (Matsumura)
Asaphes suspensus (Nees)/ *Praon volucre* (Haliday)

Thelaxidae

Doraphis populi (Maskell)
Pachyneuron doraphis sp. n.
Mansakia shirakabae (Monzen)
Pachyneuron sapporense sp. n./ *Calaphidius watanabei* (Takada)

PRIMARY PARASITE / HOST APHID—HYPERPARASITE LIST*

- Aphidiid sp./ *Acyrtosiphon pisum* (Harris)
Coruna clavata Walker
- Aphidiid sp./ *Acyrtosiphon syringae* (Matsumura)
Coruna clavata Walker
- Aphidiid sp./ *Impatiatinum balsamines* (Kaltenbach)
Coruna laevis sp. n.
- Aphidiid sp./ *Macrosiphum ibarae* Matsumura
Coruna clavata Walker
Coruna laevis sp. n.
- Aphidiid sp./ *Macrosiphum smilacifoliae* Takahashi
Asaphes suspensus (Nees)
- Aphidiid sp./ *Rhopalosiphum padi* (Linné)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
- Aphidiid sp./ *Tuberocephalus sakurae* (Matsumura)
Asaphes suspensus (Nees)
- Aphidius* sp./ *Acyrtosiphon muradachi* (Shinji)
Asaphes suspensus (Nees)
- Aphidius* sp./ *Hyperomyzus lactucae* (Linné)
Asaphes suspensus (Nees)
- Aphidius* sp./ *Impatiatinum balsamines* (Kaltenbach)
Coruna clavata Walker
- Aphidius* sp./ *Macrosiphum ibarae* Matsumura
Asaphes suspensus (Nees)
- Aphidius* sp./ *Macrosiphoniella sanborni* (Gillette)
Asaphes suspensus (Nees)
- Aphidius areolatus* Ashmead / *Periphyllus californiensis* (Shinji)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Pachyneuron solitarium (Hartig)
- Aphidius avenae* Haliday / *Macrosiphum akebiae* Shinji
Asaphes suspensus (Nees)
- Aphidius cingulatus* Ruthe / *Pterocomma* sp.
Asaphes suspensus (Nees)
Euneura nawai (Ashmead)
Pachyneuron sapporensis sp. n.
- Aphidius gifuensis* Ashmead / *Macrosiphum euphorbiae* (Thomas) & *Myzus persicae* (Sulzer)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
- Aphidius lonicerae* Marshall / *Amphorophora amurensis* (Mordvilko)
Coruna clavata Walker
- Aphidius salicis* Haliday / *Cavariella araliae* Takahashi & *C. salicicola* (Matsumura)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)
- Aphidius sicarius* Mackauer / *Callipterinella calliptera* (Hartig)
Asaphes suspensus (Nees)
Pachyneuron aphidis (Bouché)

* Restricted to records in Japan.

Pachyneuron mitsukurii Ashmead
Binodoxys centaureae (Haliday)/*Macrosiphum ibarae* Matsumura
Asaphes suspensus (Nees)
Calaphidius watanabei (Takada)/*Mansakia shirakabae* (Monzen)
Pachyneuron sapporense 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 ibarae* 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 artemisicola* 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)
Pachyneuron aphidis (Bouché)
Ephedrus plagiator (Nees)/*Acyrtosiphon magnoliae* (Essig & Kuwana), *A. muradachi* (Shinji), *Aphis spiraeicola* Patch, *Macrosiphum akebiae* Shinji, *Melanaphis bambusae* (Fullaway), *Myzus persicae* (Sulzer) & *Toxoptera odinae* (van der Goot)
Asaphes pubescens sp. n.
Asaphes suspensus (Nees)
Pachyneuron sapporense sp. n.
Ephedrus salicicola Takada/*Cavariella 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. spiraeicola* 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
Euneura nawai (Ashmead)
Pauesia abietis (Marshall)/*Cinara pineti* (Koch)
Asaphes suspensus (Nees)
Euneura augarus Walker
Euneura nawai (Ashmead)
Pachyneuron aphidis (Bouché)
Pachyneuron solitarium (Hartig)
Pauesia akamatsucola Takada/*Cinara pineti* (Koch)
Asaphes suspensus (Nees)
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)/*Acyrtosiphon magnoliae* (Essig & Kuwana), *A. solani* (Kaltenbach),
A. syringae (Matsumura), *Macrosiphum ibarae* 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 celti* Das
Asaphes suspensus (Nees)

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