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<th>STUDIES ON APHID HYPERPARASITES OF JAPAN, 1 - APHID HYPERPARASITES OF THE GENUS DENDROCERUS RATZEBURG OCCURRING IN JAPAN (HYMENOPTERA : CERAPHRONIDAE)</th>
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<td>Takada, Hajimu</td>
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STUDIES ON APHID HYPERPARASITES OF JAPAN, I
APHID HYPERPARASITES OF THE GENUS DENDROCERUS
RATZEBURG OCCURRING IN JAPAN
(HYMENOPTERA : CERAPHRONIDAE)

By Hajimu Takada

Abstract


Six aphid-hyperparasitic species of Dendrocerus occurring in Japan are dealt with. A key to the species, redescriptions, illustrations and biological notes are given on the basis of about 1,300 specimens reared. Host aphid—hyperparasite/primary parasite and primary parasite/host aphid—hyperparasite lists are added. D. laticeps (Hedicke), D. laevis (Ratzeburg) and D. bicolour (Kieffer) are new to Japan. Lygocerus koebelei Ashmead is synonymized with D. carpenteri (Curtis), and L. japonicus Ashmead and D. ratzeburgi Ashmead with D. ramicornis (Boheman). D. laevis is recorded as an aphid hyperparasite for the first time. As hosts of these hyperparasites 50 species of aphids in 35 genera and 36 species of aphidiids in 12 genera are recorded, and 118 different host aphid—primary parasite—hyperparasite relationships are recognized. Most species are widely associated with various groups of Aphidoidea and Aphidiidae, though ramicornis is reared only from lachnid aphids through Pauesia- and Diaeretus-species and this association is unknown for laticeps. Dendrocerus widely inhabits field- to forest-type habitats, but each species shows definite preference of habitats.

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INTRODUCTION

It is well known that the primary parasites of aphids are also parasitized by various groups of hyperparasites, and that the latter often reduce the effectiveness of the former in regulating the population of aphids. In the course of his study on Aphidiidae of Japan a lot of specimens of hyperparasites as well as primary parasites have been reared from many kinds of aphids by the present author. This paper, in which the species belonging to the genus *Dendrocerus* Ratzeburg are reported, is the first part of serial works on taxonomy, distribution and host range of aphid hyperparasites occurring in Japan.

Table 1. Capsule—real host relationship in *Dendrocerus*-species.

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<tr>
<th>Capsule</th>
<th>Real host</th>
<th>Species</th>
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<tr>
<td>Psylliidae</td>
<td>Encyrtidae</td>
<td><em>serricornis</em> (Boheman)</td>
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<tr>
<td>Mummy</td>
<td>Aphidiidae &amp;</td>
<td><em>aphidum</em> (Rondani) ;</td>
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<tr>
<td>Aphidoidea Mummy</td>
<td>Aphelinidae (Larva &amp; pupa)</td>
<td><em>attentus</em> (Muesebeck) ;</td>
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<td>Psylliidae</td>
<td>Encyrtidae</td>
<td><em>bicolor</em> (Kieffer) ;</td>
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<td>Mummy</td>
<td>Aphidiidae &amp;</td>
<td><em>bifoveatus</em> (Kieffer) ;</td>
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<td>Aphidoidea Mummy</td>
<td>Aphelinidae (Larva &amp; pupa)</td>
<td><em>breadalbimensis</em> (Kieffer) ;</td>
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<tr>
<td>Coccoidea Mummy</td>
<td>Encyrtidae</td>
<td><em>carpenteri</em> (Curtis) ;</td>
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<tr>
<td>Coccoidea Mummy</td>
<td>Coniopterygidae (Larva &amp; pupa)</td>
<td><em>floridanus</em> (Ashmead) ;</td>
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<tr>
<td>Hemerobiidae Cocoon</td>
<td>Coniopterygidae</td>
<td><em>incompletus</em> (Muesebeck) ;</td>
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<tr>
<td>Coniopterygidae Cocoon</td>
<td>Coniopterygidae (Larva &amp; pupa)</td>
<td><em>laevis</em> (Ratzeburg) ;</td>
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<tr>
<td>Hemerobiidae Cocoon</td>
<td>? Hemerobiidae</td>
<td><em>laticeps</em> (Hedicke) ;</td>
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<td>Chrysopidae Cocoon</td>
<td>? Chrysopidae</td>
<td><em>liebscheri</em> (Dessart) ;</td>
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<td>Coniopterygidae (Larva &amp; pupa)</td>
<td><em>longispinus</em> (Yasumatsu &amp; Moritsu) ;</td>
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<td>Coleoptera</td>
<td>Encyrtidae</td>
<td><em>ramicornis</em> (Boheman) ;</td>
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<td>Coccinellidae Mummy</td>
<td>Encyrtidae</td>
<td><em>serricornis</em> (Boheman) ;</td>
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<tr>
<td>Diptera</td>
<td>Encyrtidae</td>
<td><em>serricornis</em> (Boheman) ;</td>
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<td>Cecidomyiidae Gall</td>
<td>Syrphidae (Pupa)</td>
<td><em>triticum</em> (Taylor) ;</td>
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<td><em>puparum</em> (Boheman) ;</td>
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<td>Chamaemyiidae (Pupa)</td>
<td><em>leucopidis</em> (Muesebeck) ;</td>
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<td>Chamaemyiidae Puparium</td>
<td>Chamaemyiidae (Pupa)</td>
<td><em>pinicola</em> (Muesebeck) ;</td>
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1, Ashmead, 1904; 2, Yasumatsu & Moritsu, 1947; 3, Ishii, 1951; 4, Muesebeck & Walkley, 1951; 5, Muesebeck, 1959; 6, Dessart, 1972; 7, Dessart, 1972 a; 8, Present confirmation.
The genus *Dendrocerus* is a relatively large group and almost cosmopolitan. The available host records indicate that the species of this genus are either primary parasites of Neuroptera and Diptera or hyperparasites upon Homoptera and Coleoptera through various Hymenoptera. Practically the members of this genus prefer as hosts larvae or pupae that are concealed within small capsules of some kinds (Clausen, 1940). In Table 1 the relationship between the real hosts of *Dendrocerus* and the capsules is given for the species of which the exact host relationship has been determined. When developing as hyperparasites of aphids, the species of *Dendrocerus* are exclusively external and solitary in habit, though a few species are known to be gregarious on other groups of hosts. They oviposit only into mummified aphids containing mature larvae or pupae of Aphidiidae and Aphelinidae (Hagen & van den Bosch, 1968).

Recently, as most of the European species of this genus have been revised and redescribed by Dessart (1972) the author has been able to identify the Japanese forms correctly. So far as he is aware 3 species have been known to occur in Japan as aphid hyperparasites (Ashmead, 1904; Yasumatsu et al., 1946; Yasumatsu & Moritsu, 1947). Furthermore, there are 2 other species which are not hyperparasitic on aphids (Ishii, 1951). In the course of the present study 3 other aphid-hyperparasitic species, which are new to Japan, have been found. In this paper redescriptions, synonymy, some biological notes and host lists of aphid-hyperparasitic *Dendrocerus* occurring in Japan will be given. The host aphids were identified by Dr. V. F. Eastop, Dr. M. Miyazaki and Dr. H. Higuchi and the aphidiids, primary parasites, by the author. The material used in this study are deposited in the collections of the Entomological Institute of Hokkaido University and the Entomological Laboratory of Kyoto Prefectural University.

The present study was partly carried out while the author was enrolled at the Entomological Institute of Hokkaido University, and was resumed at the Entomological Laboratory of Kyoto Prefectural University. This paper constitutes Contribution No. 133 from Entomological Laboratory, Kyoto Prefectural University.

**Classification**

Genus *Dendrocerus* Ratzeburg


This genus is here understood after Dessart (1966 & 1972). In this sense *Lygocerus* Förster, *Prodendrocerus* Kieffer, *Aritonellus* Kieffer and *Neolygocerus* Ishii may be suppressed as synonyms of this genus.

The Japanese aphid-hyperparasitic species may be distinguished by the following key:

1. Mesoscutum (Fig. 23) with notaulices incomplete
2. Mesoscutum (Figs. 21 & 22) with notaulices complete

Key to the aphid-hyperparasitic species of *Dendrocerus* occurring in Japan (♀ & ♂):
2 Base of 3rd tergite with fine longitudinal striae; fore wing (Fig. 30) with stigma narrow, 1.9—2.1 times as long as wide; legs with coxae yellow; antenna (♀, Fig. 15) with flagellar segments weakly serrate ........................................... laticeps (Hedicke)

- Base of 3rd tergite with coarse longitudinal striae; fore wing (Fig. 31) with stigma wider, 1.8—1.9 times as long as wide; legs with coxae black; antenna (♂, Fig. 16) with flagellar segments more deeply serrate ........................................... laevis (Ratzeburg)

3 Fore wing (Fig. 32) with stigma narrow, 1.9—2.0 times as long as wide; ocellocular line a little shorter than postocellar line, 85—93 (♀) or 77—79 (♂): 100; legs with coxae yellow; abdomen (♀) yellow at basal half; antenna (♀, Fig. 17) with flagellar segments weakly serrate ........................................... bicolor (Kieffer)

- Fore wing (Figs. 33—35) with stigma wider, 1.3—1.7 times as long as wide; ocellocular line much shorter than postocellar line, 58—78: 100 (♀ & ♂); legs with coxae black; abdomen (♀) black entirely .................................................. 4

4 Head in lateral view (Fig. 8) with vertex moderately convex; mesoscutum (Fig. 22) with notaulices converging posteriorly and joining together at posterior end; face in frontal view (Fig. 6) with upper edge of clypeus same level as lower edge of antennal socket and with facial line shorter (♀) than, or equal in length (♂) to, interantennal line; propodeum (Fig. 24) with postcentral area edged semicircular by carinae; antenna with pedicel (♀, Fig. 14) longer than 1st flagellar segment and with flagellar segments (♂, Fig. 18) moderately serrate. Legs entirely black .............................. carpenteri (Curtis)

- Head in lateral view (Fig. 7) with vertex strongly convex; mesoscutum (Fig. 21) with notaulices almost parallel and not joining at posterior end ........................................... 5

5 Face in frontal view (Fig. 3) with upper edge of clypeus below lower edge of antennal socket and with facial line almost equal in length (♀) to, or longer (♂) than, interantennal line; propodeum (Fig. 25) with postcentral area edged almost trapezoidal by carinae; fore wing (Fig. 34) with stigma rather triangular; antenna with pedicel (♀, Fig. 12) longer than 1st flagellar segments and with first 5 flagellar segments (♂, Fig. 19) deeply serrate; legs largely dark brown (♀ & ♂) ........................................................................ longispinus (Yasumatsu & Moritsu)

- Face in frontal view (Fig. 2) with upper edge of clypeus above, or same level as, lower edge of antennal socket and with facial line shorter than interantennal line (♀ & ♂); propodeum (Fig. 26) with postcentral area edged pentagonal by carinae; fore wing (Fig. 35) with stigma semicircular; antenna with pedicel (♀, Fig. 13) shorter than 1st flagellar segment and with first 5 flagellar segments (♂, Fig. 20) branched; legs, excluding coxae, yellow (♀) or largely dark brown (♂) ........................................ ramicornis (Boheman)

Dendrocerus laticeps (Hedicke)


This species is new to Japan. The specimens listed below agree completely with Dessart’s (1972) redescription of laticeps.

Redescription: Female—Head in lateral view (Fig. 9) with vertex weakly convex and with frons almost flat; eye comparatively large; ocellocular line about 4/5 as long as postocellar line, 79—86: 100; face in frontal view (Fig. 4) with upper edge of clypeus below lower edge of antennal socket and with facial line almost equal in length to interantennal line, 98—105: 100. Antenna (Fig. 10) with pedicel distinctly shorter than 1st flagellar segment, 84—96: 100 and with 2nd to 8th flagellar segments comparatively slender, 1.5—2.1 times as long as wide. Mesoscutum (Fig. 23) with notaulices incomplete; propodeum (Fig. 27)
with postcentral area smooth and edged semicircular by carinae. Base of 3rd tergite with fine longitudinal striae; genitalia with ovipositor sheath (Fig. 37) slender, 5 times as long as wide and acutely pointed at tip. Fore wing (Fig. 30) with stigma narrow, 1.9—2.1 times as long as wide.

Black. Antenna more or less brownish, with scape yellowish brown basally; mouthparts brown. Legs, including coxae, yellow. Wings hyaline, with veins yellowish brown.

Length. Body 1.2—1.6 mm., antenna 0.9—1.3 mm., fore wing 1.0—1.4 mm.

Male—Same as the female except for the following characters.

Facial line longer than interantennal line, 112—121 : 100. Antenna (Fig. 15) with scape slender, 4.7—6.1 times as long as wide and with flagellar segments weakly serrate. Genitalia (Fig. 42) as in figure. Wings with veins darker.

Length. Body 1.3—1.7 mm., antenna 1.4—1.7 mm., fore wing 1.1—1.3 mm.

Material & host*: 1♀1♂, Niigata (A. Ōtake)—Aphidiid sp./Rhopalosiphum padi (Linne)/Triticum aestivum; 1♂, Sapporo (M. Suwa)—Aphidius sp./Aphid sp./Beta vulgaris var. rapa; 3♀2♂, Amami-ōshima—Aphidius amamioshimensis Takada/Acyrthosiphon akebiae Shinji/Oryza sativa; 8♀3♂, Kyōto (N. Ueda)—Aphidius gifuensis Ashmead/Myzus persicae (Sulzer)/Raphanus sativus; 1♀, Amami-ōshima (H. Takizawa)—Aphidius longipetiolus Takada/Macrosiphoniella grandicauda Takahashi & Moritsu/Artemisia sp.; 2♀1♂, Kyōto (N. Ueda)—Diaeretiella rapae (M’Intosh)/Lipaphis erysimi (Kaltenbach)/Raphanus sativus; 3♀4♂, Kyōto—Diaeretiella rapae (M’Intosh)/Myzus persicae (Sulzer)/Raphanus sativus; 1♀, Kumamoto—Ephedrus persicae Froggatt/Capitophorus sp./Elaeagnus umbellata; 1♀, Aoshima—Ephedrus plagiator (Nees)/Toxoptera odorata (van der Goot)/Pittosporum tobira; 1♀, Sapporo (K. Kusigemati); 1♀, Amami-ōshima (M. Miyazaki).

In Europe, too, this species is reared from various aphids through Aphidiidae and Aphelinidae (after Dessart, 1972 a).

Locality in Japan: Hokkaidō—Sapporo; Honshū—Niigata & Kyōto; Kyushū—Kumamoto, Aoshima (Miyazaki-ken) & Kagoshima; Ryūkyū—Amami-ōshima.

Geographical distribution: Japan; Europe.

Dendrocerus laevis (Ratzeburg)


On account of the following features the present material may be identified with the species, which is new to Japan.

* Unless otherwise stated the specimens were collected by the author. Primary parasite (= real host), host aphid 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.
Redescription: **Male**—Head in lateral view with vertex moderately convex and with frons weakly convex; eye small; ocellocular line about 2/3 as long as postocular line, 61—77 : 100; face in frontal view with upper edge of clypeus below lower edge of antennal socket; facial line longer than interantennal line, 113—126 : 100. Antenna (Fig. 16) with scape 3.4—4.4 times as long as wide and with flagellar segments moderately serrate. Mesoscutum with notaulices incomplete; propodeum (Fig. 28) with postcentral area smooth and edged almost triangular by carinae. Base of 3rd tergite with coarse longitudinal striae; genitalia (Fig. 43) as in figure. Fore wing (Fig. 31) with stigma a little narrow, 1.8—1.9 times as long as wide.

Black. Antenna more or less brownish, with scape yellowish brown at basal half; mouthparts yellowish brown. Legs, excluding coxae black, yellow to yellowish brown, with trochanters, femora and tibiae more or less blackish dorsally. Wings hyaline, with veins dark brown.

Length. Body 1.2 mm., antenna 1.1 mm., fore wing 1.0 mm.

Material & host: 2♀, **Kyōto**—**Trioxys shivaphis** Takada/ **Shivaphis celti** Das/ **Celtis** sp.

So far as the author is aware, this is the first host record of the species as a hyperparasite of aphids. According to Dessart (1972) in Europe this species is hyperparasitic on coccids through encyrtid primary parasites.

Locality in Japan: Honshū—Kyōto.

Geographical distribution: Japan; Europe; North Africa.

**Dendrocerus bicolor** (Kieffer)


This species is new to Japan. The present material agree well with Dessart's (1972) redescription of the species, except that the relative length of the 1st flagellar segment to the 2nd is shorter.

Redescription: **Female**—Head in lateral view with vertex weakly convex and with frons almost flat; eye large; ocellocular line a little shorter than postocular line, 85—93 : 100; face in frontal view (Fig. 5) with upper edge of clypeus below lower edge of antennal socket and with facial line a little shorter, or equal in length to, interantennal line, 84—100 : 100. Antenna (Fig. 11) with pedicel distinctly shorter than 1st flagellar segment, 78—85 : 100 and with 2nd to 8th flagellar segments comparatively slender, 1.3—1.9 times as long as wide. Mesoscutum with notaulices complete, converging posteriorly and joining together at posterior end; propodeum (Fig. 29) with postcentral area smooth (in larger specimens slightly rugose) and edged almost triangular by carinae. Base of 3rd tergite with coarse longitudinal striae; genitalia with ovipositor sheath (Fig. 38) quite slender, 6 times as long as wide and moderately pointed at tip. Fore wing (Fig. 32) with stigma narrow, 1.9—2.0 times as long as wide.

Black. Antenna more or less brownish, with scape yellowish brown basally; mouthparts brown. Abdomen yellowish at basal half. Legs, including coxae,
yellow. Wings hyaline, with veins yellowish brown.

Length. Body 1.4—2.4 mm., antenna 1.1—1.9 mm., fore wing 0.9—1.7 mm.

**Male**—Same as the female except for the following characters.

Ocellocular line: postocellar line = 77—79 : 100; facial line longer than inter-antennal line, 109—119 : 100. Antenna (Fig. 17) with scape slender, 4.0—4.4 times as long as wide and with flagellar segments weakly serrate. Genitalia (Fig. 44) as in figure. Abdomen entirely black. Wings with veins darker.

Length. Body 1.5—1.7 mm., antenna 1.5—1.7 mm., fore wing 1.2—1.3 mm.

Material & host: 1♀, Wakamiya—Ephedrus sp./Rhopalosiphominus deutzifoliae Shinji/Deutzia crenata; 1♀, Kyōto—Pauesia unilachni (Gahan)/Schizolachnus sp./Pinus densiflora; 6♀1♂, Kagoshima—Praon sp./Aphid sp./Orixa japonica; 1♂, Nopporō (M. Suwa)—Praon dorsale (Haliday)/Acyrthosiphon sp./Trifolium pratense; 1♀, Sapporo (K. Kusigenati) & 1♀, Tōkyō—Praon volucre (Haliday)/Acyrthosiphon magnoliæ (Essig & Kuwana)/Sambucus sieboldiana; 12♀1♂, Sapporo—Praon volucre (Haliday)/Acyrthosiphon syringae (Matsumura)/Syringa reticulata; 1♀, Chitose; 1♂, Sasayama (T. Naito).

Also in Europe this species is known as a hyperparasite of aphids through aphidiids (after Dessart, 1972).

Locality in Japan: Hokkaidō—Sapporo, Chitose & Nopporō; Honshū—Tōkyō, Kyōto & Sasayama; Shikoku—Wakamiya (Kōchi-ken); Kyūshū—Kagoshima.

Geographical distribution: Japan; Europe.

*Dendrocerus carpenteri* (Curtis)

*Ceraphron carpenteri* Curtis, Brit. Ent. 8: 249, 1829.


According to Dessart’s redescription mentioned above and to Muesebeck’s identification of part of the present material with the authentic specimens of *carpenteri* the author can definitely identify the present material with the species, one of the most common species of *Dendrocerus* in the Holarctic and Australian regions.

Furthermore, Muesebeck, who has examined also the type of *koebelei* deposited in the U. S. National Museum, suggested to the author that *koebelei* should be suppressed as a synonym of *carpenteri*.

Redescription: **Female**—Head in lateral view (Fig. 8) with vertex moderately convex and with frons weakly convex; eye small; ocellocular line 3/5 as long as postocular line, 58—61 : 100; face in frontal view (Fig. 6) with upper edge of clypeus same level as lower edge of antennal socket and with facial line shorter than interantennal line, 74—84 : 100. Antenna (Fig. 14) with pedicel longer than
1st flagellar segment, 109—120 : 100 and with 2nd to 8th flagellar segments almost quadratic, 1.2—1.6 times as long as wide. Mesoscutum (Fig. 22) with notaulices complete, converging posteriorly and joining together at posterior end; propodeum (Fig. 24) with postcentral area smooth and edged circular by carinæ. Base of 3rd tergite with coarse longitudinal striae; genitalia with ovipositor sheath (Fig. 39) stout, less than 4 times as long as wide and obtuse at tip. Fore wing (Fig. 33) with stigma almost semicircular, 1.6—1.7 times as long as wide.

Body, including antenna, entirely black. Legs black to dark brown, with femora, tibiae and tarsi brownish partly. Wings hyaline, with veins dark brown.

Length. Body 1.4—2.0 mm., antenna 0.9—1.5 mm., fore wing 1.0—1.6 mm.

Male—Same as the female except for the following characters.

Ocellocular line: postocellar line = 62—72 : 100; facial line almost equal in length to interantennalline, 100—103 : 100. Antenna (Fig. 18) with scape 3.1—3.3 times as long as wide and with flagellar segments moderately serrate. Genitalia (Fig. 46) as in figure.

Length. Body 1.1—2.1 mm., antenna 1.0—1.8 mm., fore wing 0.8—1.5 mm.

Material & host: 1®, Tomakomai—Aphidiid sp./Callaphidid sp./Alnus sp.; 1®, Kagoshima (K. Kusigemati)—Aphidiid sp./Callaphidid sp./Bambusaceous sp.; 1®, Sapporo, 2®, Kyōto & 7®, Fukuoka—Aphidiid sp./Macrosiphum iberiae Matsumura/Rosa sp.; 10®, Sapporo—Aphidius sp./Euceraspis punctipennis (Zetterstedt)/Betula sp.; 1®, Kyōto—Aphidius sp./Hyperomyxus carduellinus (Theobald)/Sonchus oleraceus; 2®, Tōkyō (H. Takizawa)—Aphidius sp./Macrosiphoniella sp./Artemisia sp.; 1®, Sapporo—Aphidius sp./Macrosiphum iberiae Matsumura/Rosa sp.; 1®, Kyōto—Aphidius areolatus Ashmead/Periphyllus sp./Acer sp.; 13®, 2®, Kyōto & 6® & 8®, Kumamoto—Aphidius areolatus Ashmead/Periphyllus californiensis (Shinji)/Acer sp.; 29®, Sapporo—Aphidius avenae Haliday/Macrosiphum akebiae Shinji/Triticum aestivum; 59®, Niigata (Triticum aestivum, A. Ōtake) & 1®, Kyōto (Elesine indica)—Aphidius avenae Haliday/Rhopalosiphum padi (Linné); 3®, Sapporo (H. Torikura)—Aphidius gifuensis Ashmead/Myzus persicae (Sulzer)/Raphanus sativus & Solanum melongena; 1®, Iki—Aphidius longispilotus Takada/Macrosiphoniella grandicauda Takahashi & Moritsu/Astemia sp.; 1®, Fukuoka & 49®, Kagoshima—Aphidius salicis Haliday/Cavariella araliae Takahashi/Tetrapanax papyrifera; 19®, Nagano & 11®, Kōchi—Aphidius salicis Haliday/Cavariella salicicola (Matsumura)/Salix sp.; 49®, Sapporo—Aphidius sicarius Mackauer/Callipterinella calliptera (Hartig)/Betula sp.; 1®, Kyōto—Aphroproa nipponicum Takada/Mindarus japonicus Takahashi/Abies firma; 101®, Sapporo & 11®, Bibai (K. Kamijo)—Callaphidius watamabei (Takada)/Mansakia shirakabae (Monzen)/Betula spp.; 19®, Hatano—Diaeretiellia rapae (M’Intosh)/Brevicoryne brassicae (Linné)/Brassica campestris; 6®, Kyōto (N. Ueda)—Diaeretiellia rapae (M’Intosh)/Lipaphis erysimi (Kaltenbach)/Raphanus sativus; 39®, Kyōto (N. Ueda)—Diaeretiellia rapae (M’Intosh)/Myzus persicae (Sulzer)/Raphanus sativus; 39®, Sapporo, 7®, Kyōto, 2®, Himeji (M. Miyazaki), 3®, Fukuoka, 49®, Sasebo, 1®, Nobeoka & 39®, Kagoshima—Diaeretiellia leucomptera (Haliday)/Eulachmus thunbergii Wilson/Pinus thunbergii; 19®, Sapporo—Dyscritulus sp./Periphyllus
sp./Acer sp.; 26, Sapporo—Ephedrus sp./Aphidid sp./Prunus persica; 19 118, Takamatsu—Ephedrus sp./Aphis sp./Viburnum suspensum; 12, Fukuoka—Ephedrus sp./Aphis craccivora Koch/Robinia pseudo-acacia; 69 56, Fukuoka—Ephedrus sp./Aphis nerii Boyer/Nerium indicum; 53, Sapporo & 29 26, Kyōto—Ephedrus sp./Aphis spiraeola Patch/Spiraea thunbergii; 16, Kyōto—Ephedrus sp./Capitophorus sp./Elaeagnus umbellata; 19, Memambetsu (H. Higuchi)—Ephedrus sp./Dactynotus cephalonopli Takahashi/Breæa setosa; 20 93, Sapporo—Ephedrus sp./Hyaloëpterus pruni (Geoffroy)/Poaceous sp.; 39 13, Takarazuka (Stauntonia hexaphylla) & 29 26, Kagoshima—Triticum aestivum, K. Kusigemati—Ephedrus sp./Macrosiphum akebiae Shinji; 29 13, Naganuma, 39 18, Kyōto & 19, Kagoshima—Ephedrus sp./Macrosiphum ibarae Matsumura/Rosa sp.; 13, Takamatsu—Ephedrus sp./Parachaitophorus spiraeae (Takahashi)/Spiraea thunbergii; 16, Kyōto—Ephedrus sp./Rhopalosiphum padi (Linné)/Triticum aestivum; 19 Makurazaki—Ephedrus sp./Toxoptera odinae (van der Goot)/Pittosporum tobiræ; 79 143, Sapporo (Poaceous sp., K. Kusigemati) & 39 46, Iki (Prunus persica)—Ephedrus nacheri Quilis/Hyaloëpterus pruni (Geoffroy); 89 46, Kyōto—Ephedrus nacheri Quilis/Rhopalosiphominus deutziolaei (Shinji)/Deutzia crenata; 169 128, Kyōto—Ephedrus persicae Froggatt/Aphis spiraeola Patch/Spiraea thunbergii; 19, Kumamoto—Ephedrus persicae Froggatt/Capitophorus sp./Elaeagnus umbellata; 19 48, Fukuoka—Ephedrus persicae Froggatt/Capitophorus hippophae (Walker)/Elaeagnus umbellata; 19, Kyōto—Ephedrus persicae Froggatt/Macrosiphum akebiae Shinji/Stauntonia hexaphylla; 23, Okayama (M. Miyazaki)—Ephedrus persicae Froggatt/Tuberocephalus sp./Prunus sp.; 79 13, Sapporo—Ephedrus plagiator (Nees)/Acyrthosiphon magnoliae (Essig & Kuwana)/Magnolia sieboldiana; 129 118, Kyōto—Ephedrus plagiator (Nees)/Aphis spiraeocola Patch/Spiraea thunbergii; 19, Sapporo & 19 13, Kyōto—Ephedrus plagiator (Nees)/Macrosiphum ibarae Matsumura/Rosa sp.; 59 58, Nara—Ephedrus plagiator (Nees)/Melanaphis bambusae (Fullaway)/Rosaceous sp.; 49 13, Kyōto—Ephedrus plagiator (Nees)/Rhopalosiphominus deutziolaei (Shinji)/Deutzia crenata; 79 118, Miyazaki—Ephedrus plagiator (Nees)/Toxoptera odinae (van der Goot)/Pittosporum tobiræ; 49 103, Sapporo—Ephedrus salicicola Takada/Cavariella salicicola (Matsumura)/Salix sp.; 19 35, Matsuyama—Lysiphidus matsuyamensis Takada/Coloradoa sp./Artemisia sp.; 26, Kyōto, 79 56, Kure, 19, Shōdoshima (M. Miyazaki) & 49 38, Matsuyama—Lysiphidus pleotrichophori Takada/Pleotrichophorus glandulosus (Kaltenbach)/Artemisia sp.; 26, Kagoshima—Lysiphlebus japonicus Ashmead/Toxoptera odinae (van der Goot)/Rhus sp.; 19, Kyōto—Pauësia sp./Cinara sp./Abies firma; 26, Tōkyō (H. Takizawa)—Pauësia sp./Cinara sp./Chamaecyparis pisifera; 89 23, Kyōto—Pauësia abietis (Marshall)/Cinara pineti (Koch)/Pinus densiflora; 19, Kōbe—Pauësia akamatsucola Takada/Cinara pineti (Koch)/Pinus densiflora; 19, Sapporo & 59 26, Tōya (K. Kusigemati)—Pauësia pini (Halday)/Cinara laricis (Walker)/Larix leptolepis; 29, Kagoshima—Pauësia salignae (Watanabe)/Tuberolchnus salignus (Gmelin)/Salix sp.; 19 36, Kyōto, 29 113, Kōbe, 49 36, Kure, 19, Takamatsu & 29 13, Nokeoka—Pauësia unilachni (Gahan)/Schizolchnus sp./Pinus densiflora; 19, Kyōto—Praon sp./Aphidid sp./Chamaemeles speciosa; 49, Kagoshima—Praon sp./Aphidid sp./Orixa japonica; 39 223, Sapporo (K. Kusigemati)—Praon sp./Acyrthosiphon
ibotum (Essig & Kuwana)/Ligustrum obtusifolium; 19, Kyoto—Praon sp./Acyrthosiphon solani (Kaltenbach)/Boehmeria sp.; 129135, Sapporo—Praon sp./Cavariella salicicola (Matsumura)/Salix sp.; 19, Sapporo (H. Torikura)—Praon sp./Dactynotus gobonis (Matsumura)/Arctium lappa; 1933, Takarazuka & 9953, Kagoshima (K. Hashimoto)—Praon sp./Macrosiphum ibarae Matsumura/Rosa sp.; 39153, Kyoto—Praon sp./Myzus boehmeriae Takahashi/Boehmeria sp.; 1918, Ayabe—Praon sp./Myzus varians Davidson/Clematis sp.; 1933, Sapporo—Praon capitophori Takada/Capitophorus sp./Elaeagnus umbellata; 3943, Sapporo—Praon dorsale (Haliday)/Indomegoura indica (van der Goot)/Staphylea bumalda; 9923, Sapporo—Praon flavinodode (Haliday)/Euceraphis punctipennis (Zetterstedt)/Betula sp.; 391185, Sapporo—Praon volucere (Haliday)/Acyrthosiphon magnoliae (Essig & Kuwana)/Sambucus sieboldiana; 28, Sapporo—Praon volucere (Haliday)/Acyrthosiphon syringae (Matsumura)/Syringa reticulata; 1953, Sapporo (M. Miyazaki)—Praon volucere (Haliday)/Unisitobion sorbi (Matsumura)/Sorbaria sorbifolia; 1928, Sapporo—Trioxys euceraphis Takada/Euceraphis punctipennis (Zetterstedt)/Betula sp.; 18, Nemuroshibetsu (H. Torikura); 9953, Sapporo; 19, Naganuma; 1963, Nopporo (M. Suwa); 19, Sendai; 19, Tôkyô (H. Takizawa); 19, Kôbe; 4933, Tottori; 3918, Kagoshima.

In other regions this species has been known to be hyperparasitic on various kinds of aphids through aphidiids (see: Dessart, 1972 & 1972 b).

Locality in Japan: Hokkaidô—Memambetsu, Nemuroshibetsu, Bibai, Naganuma, Sapporo, Nopporo, Tomakomai & Tôya; Honshû—Atami (after Ashmead, 1904), Sendai, Niigata, Tôkyô, Hatano, Kyoto, Ayabe (Kyôto-fu), Nara, Takarazuka, Kôbe, Himeji, Tottori, Okayama & Kure; Shikoku—Shôdo-shima, Takamatsu, Matsuyama & Kôchi; Kyûshû—Fukuoka (after Yasumatsu et al., 1946), Hiko-san (after Yasumatsu, 1947), Kumamoto, Sasebo, Iki, Nobeoka, Miyazaki, Makurazaki & Kagoshima.

Geographical distribution: Japan; Europe; North America; Australia; New Zealand.

Dendrocerus longispinus (Yasumatsu & Moritsu)

Lygoecerus longispinus Yasumatsu & Moritsu, Mushi 17: 90, 1947 [Japan, host: Ephedrus interstitialis Watanabe/Myzus varians Davidson].

This species was originally described on the basis of one male specimen. On account of the antennal structure, the wing venation and the coloration the present material should be identified with the species.

Judging from Dessart’s (1972) redescription this species comes close to serricornis (Boheman, 1832) in the general facies. However, longispinus differs from serricornis in having the stigma of the fore wing less rounded and the flagellar segments of the male more strongly pointed laterally.

Redescription: Female—Head in lateral view (Fig. 7) with vertex strongly convex and with frons weakly convex; eye comparatively small; ocellocular line about 2/3 as long as postocellar line, 62—78: 100; face in frontal view (Fig. 3) with upper edge of clypeus below lower edge of antennal socket and with facial
line almost equal in length to interantennal line, 95—103 : 100. Antenna (Fig. 12) with pedicel longer than 1st flagellar segment, 112—121 : 100 and with 2nd to 8th flagellar segments almost quadrate, 0.9—1.5 times as long as wide. Mesoscutum with notaulices complete, almost parallel and not joining at posterior end; propodeum (Fig. 25) with postcentral area smooth and edged almost trapezoidal (in a few specimens rather triangular) by carinae. Base of 3rd tergite with coarse longitudinal striae; genitalia (Fig. 36) with ovipositor sheath (Fig. 40) slender, 5 times as long as wide and moderately pointed at tip. Fore wing (Fig. 34) with stigma rather triangular, 1.4—1.6 times as long as wide.

Body, including antenna, entirely black. Legs, excluding coxae black, dark brown, with tibiae and tarsis more or less yellowish ventrally. Wings hyaline, with veins dark brown.

Length. Body 1.7—2.9 mm., antenna 1.2—2.0 mm., fore wing 1.3—2.3 mm.

Male—Same as the female except for the following characters.

Facial line longer than interantennal line, 116—119 : 100. Antenna (Fig. 19) with scape stout, 2.6—2.7 times as long as wide and with flagellar segments deeply serrate. Genitalia (Fig. 45) as in figure. Legs darker.

Length. Body 1.6—3.1 mm., antenna 1.3—2.2 mm., fore wing 1.3—2.3 mm.

Material & host: 3♀, Sapporo & 2♀, Sandan-kyō (M. Miyazaki)—*Aphidius areolatus* Ashmead//*Periphyllus* sp./*Acer* sp.; 19♀♀, Sendai & 2♀♀, Takamatsu—*Aphidius areolatus* Ashmead//*Periphyllus californiensis* (Shinji)//*Acer* sp.; 5♀♀, Kyōto—*Diaeretus leucopterus* (Haliday)//*Eulachnus thunbergii* Wilson//*Pinus thunbergii*; 2♀♀, Kyōto—*Ephedrus nacheri* Quilis//*Rhopalosiphoninus deutzia* Shinji//*Deutzia crenata*; 1♀, Kyōto—*Pauesia* sp./*Cinara* sp./*Abies* firma; 3♀, Tōkyō (H. Takizawa)—*Pauesia* sp./*Cinara* sp./*Chamaecyparis pisifera*; 1♀, Sendai—*Pauesia* sp./*Cinara* sp./*Pinus densiflora*; 9♀, Kyōto & 1♀, Kōbe—*Pauesia abietis* (Marshall)//*Cinara pineti* (Koch)//*Pinus densiflora*; 3♀, Yuni—*Pauesia infulata* (Haliday)//*Cinara* sp./*Picea abies*; 19♀♀, Kyōto—*Pauesia japonica* (Ashmead)//*Lachnus tropicalis* (van der Goot)//*Quercus* sp.; 5♀, Yuni—*Pauesia konoi* (Watanabe) (Watanabe)//*Cinara longipennis* (Matsumura)//*Abies sachalinensis*; 1♀, Kyōto, 2♀, Nara & 1♀, Kōbe—*Pauesia momicola* Watanabe & Takada//*Cinara* sp./*Abies firma*; 2♂, Sendai, 45♀♀3♀, Kyōto & 16♀♀8♂, Kōbe—*Pauesia unilachni* (Gahan)//*Schizolachnus* sp./*Pinus densiflora*; 1♀, Sapporo—*Praon capitophori* Takada//*Capitophorus* sp./*Elaeagnus umbellata*; 8♀♀1♂, Sapporo—*Praon volucr* (Haliday)//*Acrinthosiphon magnoliae* (Essig & Kuwana)//*Sambucus sieboldiana*; 1♀, Kyōto—*Trioxys myzocallis* Takada//*Myzocallis pilosus* Takahashi//*Quercus* sp.; 1♀, Mt. Mitake (H. Takizawa); 2♀, Kyōto; 3♀♂, Kagoshima (H. Takizawa).

Locality in Japan: Hokkaidō—Yuni & Sapporo; Honshū—Sendai, Tōkyō, Mt. Mitake (Tōkyō-to), Kyōto, Nara, Kōbe & Sandan-kyō (Hiroshima-ken); Shikoku—Takamatsu; Kyūshū—Fukuoka (after Yasumatsu & Moritsu, 1947) & Kagoshima.

Geographical distribution: Japan.

**Dendrocerus ramicornis** (Bohemian)


Lygocerus japonicus Ashmead, J. N. Y. Ent. Soc. 12: 70, 1904 [Japan, host: Lachnus sp.]. Syn. nov.

Lygocerus japonicus: Yasumatsu et al., Mushi 17: 10, 1946 [Japan, host: Aphidius salignae Watanabe/Tuberolachnus saligna Gmelin].


Prodendrocerus ratzeburgi: Yasumatsu et al., Mushi 17: 11, 1946 [Japan, host: Aphidius salignae Watanabe/Tuberolachnus saligna Gmelin].


The present material agree completely with Dessart's (1972) redescription of ramicornis.

Judging from the original description and host record, japonicus which was described on the basis of 2 female specimens appears to be identical with the present species. Furthermore, Dessart (1966 & 1972) suggested that ratzeburgi might be a synonym of ramicornis. Muesebeck, who has kindly compared representatives of the present material with the types of japonicus and ratzeburgi deposited in the U. S. National Museum, informed the author that the female and male are identical with the types of japonicus and ratzeburgi, respectively, so that both japonicus and ratzeburgi should be suppressed as synonyms of ramicornis.

Redescription: Female—Head in lateral view with vertex strongly convex and with frons weakly convex; eye comparatively small; ocellocular line about 2/3 as long as postocellar line, 63—67 : 100; face in frontal view (Fig. 2) with upper edge of clypeus above, or same level as, lower edge of antennal socket and with facial line much shorter than interantennal line, 62—69 : 100. Antenna (Fig. 13) with pedicel shorter than 1st flagellar segment, 76—93 : 100 and with 2nd to 8th flagellar segments almost quadrate, 1.3—1.7 times as long as wide (scape without a little tooth as Ashmead (1904) pointed out in the original description of ratzeburgi). Mesoscutum (Fig. 21) with notaulices complete, almost parallel and not joining at posterior end; propodeum (Fig. 26) with postcentral area rugose and edged pentagonal by carinae. Base of 3rd tergite with coarse longitudinal striae; genitalia with ovipositor sheath (Fig. 41) slender, 5 times as long as wide and moderately pointed at tip. Fore wing (Fig. 35) with stigma almost semicircular, 1.5—1.8 times as long as wide.

Black. Scape at extreme base and mouthparts brownish. Legs, excluding coxae black, yellow to yellowish brown. Wings hyaline, with veins dark brown.

Length. Body 1.8—3.4 mm., antenna 1.2—2.3 mm., fore wing 1.3—2.4 mm.

Male—Same as the female except for the following characters.

Ocellocular line: postocellar line=58—63 : 100; facial line: interantennal line =81—83 : 100. Antenna (Fig. 20) with scape stout, 2.0—2.5 times as long as wide and with first 5 flagellar segments with lateral branches; 5th lateral branch reaching only base of 7th flagellar segment in small specimens but the apical half in larger ones. Genitalia as figured (Fig. 47). Generally darker in colour. Scape entirely black. Legs dark brown to brown.
Length. Body 1.4—2.4 mm., antenna 1.1—1.7 mm., fore wing 1.2—1.8 mm.

Material & host: 1♂, Sapporo—Diaeretis leucopterus (Haliday)/Eulachnus thunbergii Wilson/Pinus thunbergii; 1♂, Kyōto—*Pauesia* sp./*Cinara* sp./*Abies firma*; 2♀ 1♂, Tōkyō (H. Takizawa)—*Pauesia* sp./*Cinara* sp./*Chamaecyparis pisifera*; 2♀ 1♂, Kyōto & 5♀ 1♂, Kōbe—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 2♀ 2♂, Kyōto—*Pauesia japonica* (Ashmead)/*Lachnus tropicalis* (van der Goot)/*Quercus* sp.; 3♂, Nopporo—*Pauesia jezoensis* (Watanabe)/*Lachniella costata* (Zetterstedt)/*Picea jezoensis*; 3♀, Kyōto—*Pauesia konoi* (Watanabe)/*Cinara longispinus* (Matsumura)/*Abies firma*; 1♀ 1♂, Kyōto—*Pauesia monicolor* Watanabe & Takada/*Cinara sp./*Abies firma*; 1♂, Sapporo—*Pauesia pini* (Haliday)/*Cinaria laricis* (Walker)/*Larix leptolepis*; 5♀, Kyōto—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*.

This species is reared from *Pinus pini* Macq. (Adelgidae) in Finland (Hellen, 1966), which is the only known host of the species in Europe.

Locality in Japan: Hokkaidō—Sapporo & Nopporo; Honshū—Atami (after Ashmead, 1904), Tōkyō, Kyōto & Kōbe; Kyūshū—Fukuoka (after Yasumatsu et al., 1946).

Geographical distribution: Japan; Europe.

Species of *Dendrocerus* not hyperparasitic on aphids

*Dendrocerus (?) chilocori* (Ishii)

*Lygocerus chilocori* Ishii, Ōyō-Dōbuts. Zasshi 16: 95, 1951 [Japan, host: *Homalotylus flaminius* Dalm. (Encyrtidae)/*Chilocorus kawanae* Silv. (Coccinellidae)].


*Dendrocerus (?) koyamae* (Ishii)


**Biological notes**

**Geographical distribution**

The geographical distribution within Japan and in the world of the aphid-hyperparasitic *Dendrocerus*-species occurring in Japan is summarized in Table 2. Except *laevis* which is recorded only from Honshū these species are widely distributed in the main lands of Japan. *Laticeps* is known to occur also in Ryūkyū. Of the 6 species only *longispinus* is endemic in Japan, *carpenteri* is Holarctic and Australian, and the other species are Palaearctic in distribution.

**Habitat distribution**

Like the aphid primary parasites an aphid hyperparasite also shows definite preference for a certain type of habitat. On the basis of the reared material given in the present paper and other sources of data (unpublished) the range of occupied habitats of the aphid-hyperparasitic *Dendrocerus*-species occurring
Table 2. Geographical distribution of aphid hyperparasites of Dendrocerus occurring in Japan.

<table>
<thead>
<tr>
<th>Species</th>
<th>Locality</th>
<th>Japan</th>
<th>Other areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hokkaido</td>
<td>Honshu</td>
</tr>
<tr>
<td>D. laticeps</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>D. laevis</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>D. bicolor</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>D. carpenteri</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>D. longispinus</td>
<td></td>
<td>+</td>
<td></td>
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<tr>
<td>D. ramicornis</td>
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<td>+</td>
<td>+</td>
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</tbody>
</table>

1, Muesebeck & Walkley, 1951; 2, Dessart, 1972; 3, Dessart, 1972b.

FIG. 1. Habitat distribution of aphid hyperparasites of Dendrocerus occurring in Japan.

Species of Dendrocerus widely inhabit field- to forest-type habitats. On the basis of the range of their occupied habitats the Japanese species may be divided into 4 groups as follows:—Species occurring mostly in field- to intermediate-type habitats and rarely in the forest-type: laticeps and carpenteri; Species occurring mostly in intermediate-type habitats: bicolor and perhaps laevis; Species occurring in intermediate- to forest-type habitats and not in the field-type: longispinus; Species occurring mostly in forest-type habitats, less frequently in the intermediate-type and never in the field-type: ramicornis.

**Parasitism and host**

As mentioned in Introduction some species of Dendrocerus are primary...
parasites of Neuroptera and Diptera and others are obligatory hyperparasites of Homoptera and Coleoptera through various Hymenoptera. Such a great diversity in host and mode of parasitism may be understood from their consistent habit: they attack insect larvae or pupae that are concealed under small capsules of some kinds (see: Table 1). When developing as hyperparasites of aphids, species of *Dendrocerus* are external and solitary in habit and oviposit upon the mature larvae or pupae of Aphidiidae and Aphelinidae living in mummified aphids.

The host relationship of the aphid-hyperparasitic *Dendrocerus*-species occurring in Japan is summarized in Table 3. Most species are widely associated with various groups of Aphidoidea and Aphidiidae. However, *ramicornis* which prefers forest-type habitats is hyperparasitic exclusively on lachnid aphids through aphidiids of *Pauesia* and *Diaeretus*. On the other hand, *laticeps* has not been reared from that series of host association.

### Table 3. Host range of aphid hyperparasites of *Dendrocerus* occurring in Japan.

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Lachnidae</td>
</tr>
<tr>
<td>Aphids</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>Aphidiidae</td>
</tr>
<tr>
<td>parasites</td>
<td><em>Pauesia</em> &amp;</td>
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<tr>
<td></td>
<td><em>Diaseretis</em></td>
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<td></td>
<td></td>
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<tr>
<td><em>D. laticeps</em></td>
<td>+</td>
</tr>
<tr>
<td><em>D. laevis</em></td>
<td>+</td>
</tr>
<tr>
<td><em>D. bicolor</em></td>
<td>+</td>
</tr>
<tr>
<td><em>D. carpenteri</em></td>
<td>+</td>
</tr>
<tr>
<td><em>D. longispinus</em></td>
<td>+</td>
</tr>
<tr>
<td><em>D. ramicornis</em></td>
<td>+</td>
</tr>
</tbody>
</table>

Various groups of Aphidoidea and Aphidiidae. However, *ramicornis* which prefers forest-type habitats is hyperparasitic exclusively on lachnid aphids through aphidiids of *Pauesia* and *Diaeretus*. On the other hand, *laticeps* has not been reared from that series of host association.

### Host Aphid—Hyperparasite/Primary Parasite List*

#### Lachnidae

*Cinara* spp. on *Abies firma*

*D. carpenteri* (Curtis)/*Pauesia* sp.

*D. longispinus* (Yasumatsu & Moritsu)/*Pauesia* sp. & *P. momicola* Watanabe & Takada

*D. ramicornis* (Boheman)/*Pauesia* sp. & *P. momicola* Watanabe & Takada

*Cinara* sp. on *Chamaecyparis pisifera*

*D. carpenteri* (Curtis)/*Pauesia* sp.

*D. longispinus* (Yasumatsu & Moritsu)/*Pauesia* sp.

* Restricted to records in Japan.
D. ramicornis (Boheman)/Pauesia sp.
Cinara sp. on Picea abies
  D. longispinus (Yasumatsu & Moritsu)/Pauesia infalata (Haliday)
Cinara sp. on Pinus densiflora
  D. longispinus (Yasumatsu & Moritsu)/Pauesia sp.
Cinara longipennis (Matsumura)
  D. longispinus (Yasumatsu & Moritsu)/Pauesia konoi (Watanabe)
  D. ramicornis (Boheman)/Pauesia konoi (Watanabe)
Cinara pineti (Koch)
  D. carpenteri (Curtis)/Pauesia abietis (Marshall) & P. akamatsucola Takada
  D. longispinus (Yasumatsu & Moritsu)/Pauesia abietis (Marshall)
  D. ramicornis (Boheman)/Pauesia abietis (Marshall)
Cinaria laricis (Walker)
  D. carpenteri (Curtis)/Pauesia pini (Haliday)
  D. ramicornis (Boheman)/Pauesia pini (Haliday)
Eulachnus thombergii (Wilson)
  D. carpenteri (Curtis)/Diaeretus leucopterus (Haliday)
  D. longispinus (Yasumatsu & Moritsu)/Diaeretus leucopterus (Haliday)
  D. ramicornis (Boheman)/Diaeretus leucopterus (Haliday)
Lachnella costata (Zetterstedt)
  D. ramicornis (Boheman)/Pauesia jessoensis (Watanabe)
Lachnus tropicalis (van der Goot)
  D. longispinus (Yasumatsu & Moritsu)/Pauesia japonica (Ashmead)
  D. ramicornis (Boheman)/Pauesia japonica (Ashmead)
Schizolachnus sp.
  D. bicolor (Kieffer)/Pauesia unilachni (Gahan)
  D. carpenteri (Curtis)/Pauesia unilachni (Gahan)
  D. longispinus (Yasumatsu & Moritsu)/Pauesia unilachni (Gahan)
  D. ramicornis (Boheman)/Pauesia unilachni (Gahan)
Tuberolachnus salignus (Gmelin)
  D. carpenteri (Curtis)/Pauesia salignae (Watanabe)
  D. ramicornis (Boheman)/Pauesia salignae (Watanabe)
Chaitophoridae
Parachaitophorus spiraeae (Takahashi)
  D. carpenteri (Curtis)/Ephedrus sp.
Periphyllus spp. on Acer spp.
  D. carpenteri (Curtis)/Aphidius areolatus Ashmead & Dyscritulus sp.
  D. longispinus (Yasumatsu & Moritsu)/Aphidius areolatus Ashmead
Periphyllus californiensis (Shinji)
  D. carpenteri (Curtis)/Aphidius areolatus Ashmead
  D. longispinus (Yasumatsu & Moritsu)/Aphidius areolatus Ashmead
Callaphididae
Callaphidid sp. on Alnus sp.
  D. carpenteri (Curtis)/Aphidiid sp.
Callaphidid sp. on Bambusaceous sp.
  D. carpenteri (Curtis)/Aphidiid sp.
Callipterinella caliptera (Hartig)
  D. carpenteri (Curtis)/Aphidius sicarius Mackauer
Euceraphis punctipennis (Zetterstedt)
  D. carpenteri (Curtis)/Aphidius sp., Praon flavinode (Haliday) & Trioxys euceraphis Takada
Mysocalis pilosus Takahashi
  
  D. longispinus (Yasumatsu & Moritsu)/ Trioxys mysocalis Takada

Shivaphis celti Das
  
  D. laevis (Ratzeburg)/ Trioxys shivaphis Takada

Aphididae

Aphidid sp. on Beta vulgaris var. rapa
  
  D. laticeps (Hedicke)/ Aphidius sp.

Aphidid sp. on Chaenomeles speciosa
  
  D. carpenteri (Curtis)/ Praon sp.

Aphidid sp. on Cinnamomum camphora
  
  D. carpenteri (Curtis)/ Aphidiid sp.

Aphidid sp. on Oriza japonica

  D. bicolor (Kieffer)/ Praon sp.
  
  D. carpenteri (Curtis)/ Praon sp.

Aphidid sp. on Prunus persica

  D. carpenteri (Curtis)/ Ephedrus sp.

Acythosiphon sp. on Trifolium pratense

  D. bicolor (Kieffer)/ Praon dorsale (Haliday)

Acythosiphon ibotum (Essig & Kuwana)
  
  D. carpenteri (Curtis)/ Praon sp.

Acythosiphon magnoliae (Essig & Kuwana)

  D. bicolor (Kieffer)/ Praon volucre (Haliday)
  
  D. carpenteri (Curtis)/ Ephedrus plagiator (Nees) & Praon volucre (Haliday)

  D. longispinus (Yasumatsu & Moritsu)/ Praon volucre (Haliday)

Acythosiphon nipponicus (Essig & Kuwana)

  D. laticeps (Hedicke)/ Aphidius amamioshimensis Takada

Acythosiphon solani (Kaltenbach)

  D. carpenteri (Curtis)/ Praon sp.

Acythosiphon syringae (Matsumura)

  D. bicolor (Kieffer)/ Praon volucre (Haliday)
  
  D. carpenteri (Curtis)/ Praon volucre (Haliday)

Aphis sp. on Viburnum suspensum

  D. carpenteri (Curtis)/ Ephedrus sp.

Aphis craccivora Koch
  
  D. carpenteri (Curtis)/ Ephedrus sp.

Aphis nerii Boyer

  D. carpenteri (Curtis)/ Ephedrus sp.

Aphis spiraeola Patch

  D. carpenteri (Curtis)/ Ephedrus sp., E. persicae Froggatt & E. plagiator (Nees)

Brevicoryne brassicae (Linné)

  D. carpenteri (Curtis)/ Diaeretiella rapae (M’Intosh)

Capitophorus sp. on Elaeagnus umbellata

  D. carpenteri (Curtis)/ Ephedrus sp., E. persicae Froggatt & Praon capitophori Takada

  D. laticeps (Hedicke)/ Ephedrus persicae Froggatt

  D. longispinus (Yasumatsu & Moritsu)/ Praon capitophori Takada

Capitophorus hippochaes (Walker)

  D. carpenteri (Curtis)/ Ephedrus persicae Froggatt

Cavariella aralicae Takahashi

  D. carpenteri (Curtis)/ Aphidius salicis Haliday

Cavariella salicicola (Matsumura)
D. carpenteri (Curtis) / Aphidius salicis Haliday, Ephedrus satvicola Takada & Praon sp.

Coloradoa sp. on Artemisia sp.

D. carpenteri (Curtis) / Lysaphidus matsuyamensis Takada

Dactynotus cephalonopli Takahashi

D. carpenteri (Curtis) / Ephedrus sp.

Dactynotus gobonis (Matsumura)

D. carpenteri (Curtis) / Praon sp.

Hyalopterus pruni (Geoffroy)

D. carpenteri (Curtis) / Ephedrus sp. & E. nacheri Quilis

Hyperomyzus carduellinus (Theobald)

D. carpenteri (Curtis) / Aphidius sp.

Indomegoura indica (van der Goot)

D. carpenteri (Curtis) / Praon dorsale (Haliday)

Lipaphis erysimi (Kaltenbach)

D. carpenteri (Curtis) / Diaeretiella rapae (M’Intosh)

D. laticeps (Hedicke) / Diaeretiella rapae (M’Intosh)

Macrosiphoniella sp. on Artemisia sp.

D. carpenteri (Curtis) / Aphidius sp.

Macrosiphoniella grandicauda Takahashi & Moritsu

D. carpenteri (Curtis) / Ephedrus longipetiolus Takada

D. laticeps (Hedicke) / Aphidius longipetiolus Takada

Macrosiphum akebiae Shinji

D. carpenteri (Curtis) / Aphidius avenae Haliday, Ephedrus sp. & E. persicae Froggatt

D. laticeps (Hedicke) / Aphidius avenae Haliday

Macrosiphum ibarai Matsumura

D. carpenteri (Curtis) / Aphidius sp., Ephedrus sp., E. plagiator (Nees) & Praon sp.

Melanaphis bambusae (Fullaway)

D. carpenteri (Curtis) / Ephedrus plagiator (Nees)

Myzus boehmeriae Takahashi

D. carpenteri (Curtis) / Praon sp.

Myzus persicae (Sulzer)

D. carpenteri (Curtis) / Aphidius gifuensis Ashmead & Diaeretiella rapae (M’Intosh)

D. laticeps (Hedicke) / Aphidius gifuensis Ashmead & Diaeretiella rapae (M’Intosh)

Myzus varians Davidson

D. carpenteri (Curtis) / Praon sp.

D. longispinus (Yasumatsu & Moritsu) / Ephedrus persicae Froggatt

Pleiotrichophorus glandulosus (Kaltenbach)

D. carpenteri (Curtis) / Lysaphidus pleiotrichophori Takada

Rhopalosiphinus deutzijfoliae Shinji

D. bicolor (Kieffer) / Ephedrus sp.

D. carpenteri (Curtis) / Ephedrus nacheri Quilis & E. plagiator (Nees)

D. longispinus (Yasumatsu & Moritsu) / Ephedrus nacheri Quilis

Rhopalosiphum padi (Linné)

D. carpenteri (Curtis) / Aphidius avenae Haliday & Ephedrus sp.

D. laticeps (Hedicke) / Aphidiid sp.

Toxoptera odinae (van der Goot)

D. carpenteri (Curtis) / Ephedrus sp., E. plagiator (Nees) & Lysiphlebus japonicus Ashmead

D. laticeps (Hedicke) / Ephedrus plagiator (Nees)

Tuberoccephalus sp. on Prunus sp.


D. carpenteri (Curtis)/ Ephedrus persicae Froggatt

Tuberocophalus momonis (Matsumura)
D. carpenteri (Curtis)/ Aphidiiid sp.

Unisitobion sorbi (Matsumura)
D. carpenteri (Curtis)/ Praon volucre (Haliday)

Thelaxidae
Mansakia shirakabae (Monzen)
D. carpenteri (Curtis)/ Calaphidius watanabei (Takada)

Mindarus japonicus Takahashi
D. carpenteri (Curtis)/ Areopraon nipponicum Takada

Primary parasite/host aphid—hypeparasite list*

Aphidiid spp./Callaphidid spp. on Alnus & Bambusaceous sp., Macrosiphum ibarae Matsumura & Tuberocophalus momonis (Matsumura)
D. carpenteri (Curtis)

Aphidiid sp./ Rhopolosiphum padi (Linné)
D. laticeps (Hedicke)

Aphidius spp./ Euceraphis punctipennis (Zetterstedt), Hyperomyzus carduellinus (Theobald), Macrosiphoniella sp. & Macroisiphum ibarae Matsumura
D. carpenteri (Curtis)

Aphidius amamioshimensis Takada/Acrythosiphon nipponicus (Essig & Kuwana)
D. laticeps (Hedicke)

Aphidius areolatus Ashmead/ Periphyllus sp. & P. californiensis (Shinji)
D. carpenteri (Curtis)

D. longispinus (Yasumatsu & Moritsu)

Aphidius avenae Haliday/Macroisiphum akebiae Shinji & Rhopolosiphum padi (Linné)
D. carpenteri (Curtis)

D. laticeps (Hedicke)

Aphidius gifuensis Ashmead/ Myzus persicae (Sulzer)
D. carpenteri (Curtis)

D. laticeps (Hedicke)

Aphidius longispilotus Takada/Macroisiphoniella grandicauda Takahashi & Moritsu
D. carpenteri (Curtis)

D. laticeps (Hedicke)

Aphidius salicis Haliday/Cavariella aralae Takahashi & C. salicicola (Matsumura)
D. carpenteri (Curtis)

Aphidius sicarius Mackauer/ Callipterinella calliptera (Hartig)
D. carpenteri (Curtis)

Areopraon nipponicum Takada?/ Mindarus japonicus Takahashi
D. carpenteri (Curtis)

Calaphidius watanabei (Takada)/ Mansakia shirakabae (Monzen)
D. carpenteri (Curtis)

Diaeretiella rapae (M’Intosh)/ Brevicoryne brassicae (Linné), Lipaphis erysimi (Kaltenbach) & Myzus persicae (Sulzer)
D. carpenteri (Curtis)

D. laticeps (Hedicke)

Diaeretus leucopterus (Haliday)/ Eulachnus thunbergii Wilson
D. carpenteri (Curtis)

* Restricted to records in Japan.
D. longispinus (Yasumatsu & Moritsu)  
D. ramicornis (Boheman)  
Dyscritulus sp./Periphyllus sp.  
D. carpenteri (Curtis)  
Ephedrus sp./Rhopalosiphoninus deutzifoliae (Shinji)  
D. bicolor (Kieffer)  
Ephedrus spp./Aphis sp., A. craccivora Koch, A. nerii Boyer, A. spiraecola Patch, Capitophorus sp., Dactynotus cephalonopli Takahashi, Hyalopterus pruni (Geoffroy), Macrosiphum akebiae Shinji, M. ibarae Matsumura, Parachaitophorus spiraeae (Takahashi), Rhopalosiphum padi (Lině) & Toxoptera odinae (van der Goot)  
D. carpenteri (Curtis)  
Ephedrus nacheri Quilis/Hyalopterus pruni (Geoffroy) & Rhopalosiphoninus deutzifoliae (Shinji)  
D. carpenteri (Curtis)  
D. longispinus (Yasumatsu & Moritsu)  
Ephedrus persicae Froggatt/Aphis spiraecola Patch, Capitophorus sp., C. hippophaes (Walker), Macrosiphum akebiae Shinji, Myzus varians Davidson & Tuberocephalus sp.  
D. carpenteri (Curtis)  
D. laticeps (Hedicke)  
D. longispinus (Yasumatsu & Moritsu)  
Ephedrus plagiator (Nees)/Acyrthosiphon magnoliae (Essig & Kuwana), Aphis spiraecola Patch, Macrosiphum ibarae Matsumura, Melanaphis bambusae (Fullaway), Rhopalosiphoninus deutzifoliae (Shinji) & Toxoptera odinae (van der Goot)  
D. carpenteri (Curtis)  
D. laticeps (Hedicke)  
Ephedrus salicicola Takada/Cavariella salicicola (Matsumura)  
D. carpenteri (Curtis)  
Lyaphidus matsuyamensis Takada/Coloradoa sp.  
D. carpenteri (Curtis)  
Lyaphidus pleotrichophori Takada/Pleotrichophorus glandulosus (Kaltenbach)  
D. carpenteri (Curtis)  
Lyaphlebus japonicus Ashmead/Toxoptera odinae (van der Goot)  
D. carpenteri (Curtis)  
Paulesia spp./Cinara spp. on Abies firma  
D. carpenteri (Curtis)  
D. longispinus (Yasumatsu & Moritsu)  
D. ramicornis (Boheman)  
Paulesia sp./Cinara sp. on Chamaecyparis pisifera  
D. carpenteri (Curtis)  
D. longispinus (Yasumatsu & Moritsu)  
D. ramicornis (Boheman)  
Paulesia sp./Cinara sp. on Pinus densiflora  
D. longispinus (Yasumatsu & Moritsu)  
Paulesia abietis (Marshall)/Cinara pineti (Koch)  
D. carpenteri (Curtis)  
D. longispinus (Yasumatsu & Moritsu)  
D. ramicornis (Boheman)  
Paulesia abietis Takada/Cinara pineti (Koch)  
D. carpenteri (Curtis)  
Paulesia infulata (Haliday)/Cinara spp.  
D. longispinus (Yasumatsu & Moritsu)  
Paulesia japonica (Ashmead)/Lachmus tropicalis (van der Goot)
\( D. \) longispinus (Yasumatsu & Moritsu)
\( D. \) ramicornis (Boheman)

\( Paeueia \) jezoensis (Watanabe)/Lachniella costata (Zetterstedt)
\( D. \) ramicornis (Boheman)

\( Paeueia \) konoi (Watanabe)/Cinara longipennis (Matsumura)
\( D. \) longispinus (Yasumatsu & Moritsu)
\( D. \) ramicornis (Boheman)

\( Paeueia \) momicola Watanabe & Takada/Cinara sp.
\( D. \) longispinus (Yasumatsu & Moritsu)
\( D. \) ramicornis (Boheman)

\( Paeueia \) pini (Haliday)/Cinaria laricis (Walker)
\( D. \) carpen teri (Curtis)
\( D. \) ramicornis (Boheman)

\( Paeueia \) salignae (Watanabe)/Tuberolachnus salignus (Gmelin)
\( D. \) carpen teri (Curtis)
\( D. \) ramicornis (Boheman)

\( Paeueia \) unilachni (Gahan)/Schizolachnus sp.
\( D. \) bicolor (Kieffer)
\( D. \) carpen teri (Curtis)
\( D. \) longispinus (Yasumatsu & Moritsu)
\( D. \) ramicornis (Boheman)

\( Praon \) spp./Acyrhosiphon ibotum (Essig & Kuwana), A. solani (Kaltenbach), Cavariella saliciola (Matsumura), Dactynotus gobonis (Matsumura), Macrosiphum ibararae Matsumura, Myzus bohmeriae Takahashi & M. varians Davidson
\( D. \) carpen teri (Curtis)

\( Praon \) capitophori Takada/Capitophorus sp.
\( D. \) carpen teri (Curtis)
\( D. \) longispinus (Yasumatsu & Moritsu)

\( Praon \) dorsale (Haliday)/Acyrhosiphon sp. & Indomegoura indica (van der Goot)
\( D. \) bicolor (Kieffer)
\( D. \) carpen teri (Curtis)

\( Praon \) flavinode (Haliday)/Euceraphis punctipennis (Zetterstedt)
\( D. \) carpen teri (Curtis)

\( Praon \) volucre (Haliday)/Acyrhosiphon magnoliae (Essig & Kuwana), A. syringae (Matsumura) & Unisitobion sorbi (Matsumura)
\( D. \) bicolor (Kieffer)
\( D. \) carpen teri (Curtis)
\( D. \) longispinus (Yasumatsu & Moritsu)

\( Trioxys \) euceraphis Takada/Euceraphis punctipennis (Zetterstedt)
\( D. \) carpen teri (Curtis)

\( Trioxys \) myzocallis Takada/Myzocallis pilosus Takahashi
\( D. \) longispinus (Yasumatsu & Moritsu)

\( Trioxys \) shivaphis Takada/Shivaphis celti Das
\( D. \) laevis (Ratzeburg)

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PLATES
Plate I

Head of female in frontal view (Figs. 2-6) and in lateral view (Figs. 7-9).

Fig. 2. *D. ramicornis*, ♀. a: interantennal line. b: facial line.

Fig. 3. *D. longispinus*, ♀.
Fig. 4. *D. laticeps*, ♀.
Fig. 5. *D. bicolor*, ♀.
Fig. 6. *D. carpenteri*, ♀.
Fig. 7. *D. longispinus*, ♀.
Fig. 8. *D. carpenteri*, ♀.
Fig. 9. *D. laticeps*, ♀.
Scale: 0.5 mm.
Plate II

Antennae of female (Figs. 10–14) and of male (Figs. 15–20).

Fig. 10. D. laticeps, ♀.
Fig. 11. D. bicolor, ♀.
Fig. 12. D. longispinus, ♀.
Fig. 13. D. ramicornis, ♀.
Fig. 14. D. carpenteri, ♀.
Fig. 15. D. laticeps, ♂.
Fig. 16. D. laevis, ♂.
Fig. 17. D. bicolor, ♂.
Fig. 18. D. carpenteri, ♂.
Fig. 19. D. longispinus, ♂.
Fig. 20. D. ramicornis, ♂.
Scale: 0.5 mm.
Plate III

Mesoscutum of female (Figs. 21–23) and propodeum of female (Figs. 24–27 & 29) and of male (Fig. 28).

Fig. 21.  *D. ramicornis*, ♀.
Fig. 22.  *D. carpenteri*, ♀.
Fig. 23.  *D. laticeps*, ♀.
Fig. 24.  *D. carpenteri*, ♀. A: postcentral area.
Fig. 25.  *D. longispinus*, ♀.
Fig. 26.  *D. ramicornis*, ♀.
Fig. 27.  *D. laticeps*, ♀.
Fig. 28.  *D. laevis*, ♂.
Fig. 29.  *D. bicolor*, ♀.
Scale: 0.5 mm.
Plate IV

Fore wing of female (Figs. 30 & 32-35) and of male (Fig. 31).

Fig. 30. D. laticeps, ♀.
Fig. 31. D. laevis, ♂.
Fig. 32. D. bicolor, ♀.
Fig. 33. D. carpenteri, ♀.
Fig. 34. D. longispinus, ♀.
Fig. 35. D. ramicornis, ♀.
Scale: 0.5 mm.
Female genitalia (Fig. 36), ovipositor sheath (Figs. 37-41) and male genitalia (Figs. 42 & 43).

Fig. 36. *D. longispinus*, ♀.
Fig. 37. *D. laticeps*, ♀.
Fig. 38. *D. bicolor*, ♀.
Fig. 39. *D. carpenteri*, ♀.
Fig. 40. *D. longispinus*, ♀.
Fig. 41. *D. ramicornis*, ♀.
Fig. 42. *D. laticeps*, ♂.
Fig. 43. *D. laevis*, ♂.

Scale: 0.1 mm. (Figs. 36, 42 & 43);
0.025 mm. (Figs. 37-41).
Male genitalia.

Fig. 44. *D. bicolor*, ♂.
Fig. 45. *D. longispinus*, ♂.
Fig. 46. *D. carpenteri*, ♂.
Fig. 47. *D. ramicornis*, ♂.
Scale: 0.1 mm.