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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

TAKADA, H. 1973. Studies on aphid hyperparasites of Japan, I. Aphid hyperparasites of the genus *Dendrocerus* Ratzeburg occurring in Japan (Hymenoptera: Ceraphronidae). *Ins. matsum. n. s.* 2: 1—37, 3 tabs., 47 figs. (1 text-fig., 6 pls.).

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. bicolor* (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.

Capsule		Real host	Species
Homoptera	Psyllidae Mummy	Encyrtidae	*serricornis* (Boheman)[6]
	Aphidoidea Mummy	Aphidiidae & Aphelinidae (Larva & pupa)	*aphidum* (Rondani)[6]; *attentus* (Muesebeck)[5]; *bicolor* (Kieffer)[6]; *bifoveatus* (Kieffer)[6]; *breadalbimensis* (Kieffer)[6]; *carpenteri* (Curtis)[6]; *floridanus* (Ashmead)[4]; *incompletus* (Muesebeck)[5]; *laevis* (Ratzeburg)[8]; *laticeps* (Hedicke)[7]; *liebscheri* (Dessart)[6]; *longispinus* (Yasumatsu & Moritsu)[2]; *ramicornis* (Boheman)[1]
	Coccoidea Mummy	Encyrtidae	*laevis* (Ratzeburg)[6]; *smirnoffi* (Ghesquière)[6]
Neuroptera	Coniopterygidae Cocoon	Coniopterygidae (Larva & pupa)	*conwentziae* Gahan[4]; *halidayi* (Curtis)[6]; *indicus* (Mani)[6]
	Hemerobiidae Cocoon	? Hemerobiidae	*latifrons* (Muesebeck)[5]
	Chrysopidae Cocoon	? Chrysopidae	*breadalbimensis* (Kieffer)[6]
Coleoptera	Coccinellidae Mummy	Encyrtidae	*chilocori* (Ishii)[3]; *ergensis* (Ghesquière)[6]
Diptera	Cecidomyiidae Gall	? Cecidomyiidae	*serricornis* (Boheman)[6]; *triticum* (Taylor)[4]
	Syrphidae Puparium	Syrphidae (Pupa)	*puparum* (Boheman)[6]
	Chamaemyiidae Puparium	Chamaemyiidae (Pupa)	*leucopidis* (Muesebeck)[5]; *pinicola* (Muesebeck)[5]; *serricornis* (Boheman)[6]

1, Ashmead, 1904; 2, Yasumatsu & Moritsu, 1947; 3, Ishii, 1951; 4, Muesebeck & Walkley, 1951; 5, Muesebeck, 1959; 6, Dessart, 1972; 7, Dessart, 1972a; 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 Hokkaidô University and the Entomological Laboratory of Kyôto Prefectural University.

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

Classification

Genus *Dendrocerus* Ratzeburg

Dendrocerus Ratzeburg, 1852. Ichn. d. Forstins. 3: 180 [type-species: *Dendrocerus lichtensteinii* Ratzeburg].

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

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

Key to the aphid-hyperparasitic species of *Dendrocerus* occurring in Japan (♀ & ♂)

1 Mesoscutum (Fig. 23) with notaulices incomplete 2
– Mesoscutum (Figs. 21 & 22) with notaulices complete 3

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)

Atritomellus laticeps Hedicke, Z. Wiss. Ins. Biol. 24: 59–61, 1929.
Dendrocerus laticeps: Dessart, Mém. Soc. R. Belge Ent. 32: 186–192, 1972.

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. Ôtake)—Aphidiid sp./*Rhopalosiphum padi* (Linné)/*Triticum aestivum*; 1♂, Sapporo (M. Suwa)—*Aphidius* sp./Aphidid sp./*Beta vulgaris* var. *rapa*; 3♀2♂, Amami-ôshima—*Aphidius amamioshimensis* Takada/*Acyrthosiphon nipponicus* (Essig & Kuwana)/*Paederia scandens* var. *mairei*; 2♀1♂, Kagoshima (K. Kusigemati)—*Aphidius avenae* Haliday/*Macrosiphum akebiae* Shinji/*Oryza sativa*; 8♀3♂, Kyôto (N. Ueda)—*Aphidius gifuensis* Ashmead/*Myzus persicae* (Sulzer)/*Raphanus sativus*; 1♀, Amami-ôshima (H. Takizawa)—*Aphidius longipetiolus* Takada/*Macrosiphoniella grandicauda* Takahashi & Moritsu/*Artemisia* sp.; 2♀1♂, Kyôto (N. Ueda)—*Diaeretiella rapae* (M'Intosh)/*Lipaphis erysimi* (Kaltenbach)/*Raphanus sativus*; 3♀4♂, Kyôto—*Diaeretiella rapae* (M'Intosh)/*Myzus persicae* (Sulzer)/*Raphanus sativus*; 1♂, Kumamoto—*Ephedrus persicae* Froggatt/*Capitophorus* sp./*Elaeagnus umbellata*; 1♂, Aoshima—*Ephedrus plagiator* (Nees)/*Toxoptera odinae* (van der Goot)/*Pittosporum tobira*; 1♀, Sapporo (K. Kusigemati); 1♂, Amami-ôshima (M. Miyazaki).

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

Locality in Japan: Hokkaidô—Sapporo; Honshû—Niigata & Kyôto; Kyûshû—Kumamoto, Aoshima (Miyazaki-ken) & Kagoshima; Ryûkyû—Amami-ôshima.

Geographical distribution: Japan; Europe.

Dendrocerus laevis (Ratzeburg)

Ceraphron laevis Ratzeburg, Ichn. d. Forstins. 3: 180, 1852.
Dendrocerus laevis: Dessart, Mém. Soc. R. Belge Ent. 32: 176-185, 1972.

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

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* 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 postocellar 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♂, Kyôto—*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: Honshû—Kyôto.

Geographical distribution: Japan; Europe; North Africa.

Dendrocerus bicolor (Kieffer)

Lygocerus bicolor Kieffer, In André, Spec. Hym. Eur. Alg. 10: 62, 1907.
Dendrocerus bicolor: Dessart, Mém. Soc. R. Belge Ent. 32: 74-88, 1972.

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 postocellar 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 interantennal 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./*Rhopalosiphoninus deutziafoliae* Shinji/*Deutzia crenata*; 1♀, Kyôto—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*; 6♀1♂, Kagoshima—*Praon* sp./Aphidid sp./*Orixa japonica*; 1♂, Nopporo (M. Suwa)—*Praon dorsale* (Haliday)/*Acyrthosiphon* sp./*Trifolium pratense*; 1♀, Sapporo (K. Kusigemati) & 1♀, Tôkyô—*Praon volucre* (Haliday)/*Acyrthosiphon magnoliae* (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: Hokkaidô—Sapporo, Chitose & Nopporo; Honshû—Tôkyô, Kyôto & Sasayama; Shikoku—Wakamiya (Kôchi-ken); Kyûshû—Kagoshima.

Geographical distribution: Japan; Europe.

Dendrocerus carpenteri (Curtis)

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

Dendrocerus carpenteri: Dessart, Mém. Soc. R. Belge Ent. 32: 105-120, 1972.

Lygocerus koebelei Ashmead, J. N. Y. Ent. Soc. 12: 70, 1904 [Japan, host: an unknown aphid]. Syn. nov.

Lygocerus koebelei: Yasumatsu et al., Mushi 17: 10-11, 1946 [Japan, host: *Aphidius salignae* Watanabe/*Tuberolachnus saligna* Gmelin]; Yasumatsu, Mushi 17: 113-114, 1947 [Japan, host: *Aphidius granarius* Marshall/*Macrosiphum granarium* (Kirby)].

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 postocellar 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 quadrate, 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 carinae. 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 interantennal line, 100—103 : 100. Antenna (Fig. 18) with scape 3.1—3.8 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♀, Kyôto & 7♀5♂, Fukuoka—Aphidiid sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 10♀12♂, Sapporo—*Aphidius* sp./*Euceraphis punctipennis* (Zetterstedt)/*Betula* sp.; 1♂, Kyôto—*Aphidius* sp./*Hyperomyzus carduellinus* (Theobald)/*Sonchus oleraceus*; 2♂, Tôkyô (H. Takizawa)—*Aphidius* sp./*Macrosiphoniella* sp./*Artemisia* sp.; 1♂, Sapporo—*Aphidius* sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 1♀, Kyôto—*Aphidius areolatus* Ashmead/*Periphyllus* sp./*Acer* sp.; 13♀8♂, Kyôto & 6♀8♂, Kumamoto—*Aphidius areolatus* Ashmead/*Periphyllus californiensis* (Shinji)/*Acer* sp.; 2♀1♂, Sapporo—*Aphidius avenae* Haliday/*Macrosiphum akebiae* Shinji/*Triticum aestivum*; 5♀4♂, Niigata (*Triticum aestivum*, A. Ôtake) & 1♀, Kyôto (*Eleusine indica*)—*Aphidius avenae* Haliday/*Rhopalosiphum padi* (Linné); 3♀2♂, Sapporo (H. Torikura)—*Aphidius gifuensis* Ashmead/*Myzus persicae* (Sulzer)/*Raphanus sativus* & *Solanum melongena*; 1♀, Iki—*Aphidius longipetiolus* Takada/*Macrosiphoniella grandicauda* Takahashi & Moritsu/*Artemisia* sp.; 1♂, Fukuoka & 4♀3♂, Kagoshima—*Aphidius salicis* Haliday/*Cavariella araliae* Takahashi/*Tetrapanax papyriferus*; 1♀1♂, Naganuma & 11♀3♂, Kôchi—*Aphidius salicis* Haliday/*Cavariella salicicola* (Matsumura)/*Salix* sp.; 4♀12♂, Sapporo—*Aphidius sicarius* Mackauer/*Callipterinella calliptera* (Hartig)/*Betula* sp.; 1♀, Kyôto—? *Areopraon nipponicum* Takada/*Mindarus japonicus* Takahashi/*Abies firma*; 101♀29♂, Sapporo & 11♀5♂, Bibai (K. Kamijo)—*Calaphidius watanabei* (Takada)/*Mansakia shirakabae* (Monzen)/*Betula* spp.; 1♀6♂, Hatano—*Diaeretiella rapae* (M'Intosh)/*Brevicoryne brassicae* (Linné)/*Brassica campestris*; 6♀6♂, Kyôto (N. Ueda)—*Diaeretiella rapae* (M'Intosh)/*Lipaphis erysimi* (Kaltenbach)/*Raphanus sativus*; 3♀5♂, Kyôto (N. Ueda)—*Diaeretiella rapae* (M'Intosh)/*Myzus persicae* (Sulzer)/*Raphanus sativus*; 3♀3♂, Sapporo, 7♀7♂, Kyôto, 2♀1♂, Himeji (M. Miyazaki), 3♀, Fukuoka, 4♀5♂, Sasebo, 1♂, Nobeoka & 3♀8♂, Kagoshima—*Diaeretus leucopterus* (Haliday)/*Eulachnus thunbergii* Wilson/*Pinus thunbergii*; 1♀, Sapporo—*Dyscritulus* sp./*Periphyllus*

sp./*Acer* sp.; 2♂, Sapporo—*Ephedrus* sp./Aphidid sp./*Prunus persica*; 15♀11♂, Takamatsu—*Ephedrus* sp./*Aphis* sp./*Viburnum suspensum*: 1♂, Fukuoka—*Ephedrus* sp./*Aphis craccivora* Koch/*Robinia pseudo-acacia*; 6♀5♂, Fukuoka—*Ephedrus* sp./*Aphis nerii* Boyer/*Nerium indicum*; 5♂, Sapporo & 2♀2♂, Kyôto—*Ephedrus* sp./*Aphis spiraecola* Patch/*Spiraea thunbergii*; 1♂, Kyôto—*Ephedrus* sp./*Capitophorus* sp./*Elaeagnus umbellata*; 1♀, Memambetsu (H. Higuchi)—*Ephedrus* sp./*Dactynotus cephalonopli* Takahashi/*Breea setosa*; 20♀9♂, Sapporo—*Ephedrus* sp./*Hyalopterus pruni* (Geoffroy)/Poaceous sp.; 3♀1♂, Takarazuka (*Stauntonia hexaphylla*) & 2♀2♂, Kagoshima (*Triticum aestivum*, K. Kusigemati)—*Ephedrus* sp./*Macrosiphum akebiae* Shinji; 2♀1♂, Naganuma, 3♀1♂, Kyôto & 1♀, Kagoshima—*Ephedrus* sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 1♂, Takamatsu—*Ephedrus* sp./*Parachaitophorus spiraeae* (Takahashi)/*Spiraea thunbergii*; 1♂, Kyôto—*Ephedrus* sp./*Rhopalosiphum padi* (Linné)/*Triticum aestivum*; 1♀ Makurazaki—*Ephedrus* sp./*Toxoptera odinae* (van der Goot)/*Pittosporum tobira*; 7♀14♂, Sapporo (Poaceous sp., K. Kusigemati) & 3♀4♂, Iki (*Prunus persica*)—*Ephedrus nacheri* Quilis/*Hyalopterus pruni* (Geoffroy); 8♀4♂, Kyôto—*Ephedrus nacheri* Quilis/*Rhopalosiphoninus deutzifoliae* (Shinji)/*Deutzia crenata*; 16♀12♂, Kyôto—*Ephedrus persicae* Froggatt/*Aphis spiraecola* Patch/*Spiraea thunbergii*; 1♀, Kumamoto—*Ephedrus persicae* Froggatt/*Capitophorus* sp./*Elaeagnus umbellata*; 1♀4♂, Fukuoka—*Ephedrus persicae* Froggatt/*Capitophorus hippophaes* (Walker)/*Elaeagnus umbellata*; 1♀, Kyôto—*Ephedrus persicae* Froggatt/*Macrosiphum akebiae* Shinji/*Stauntonia hexaphylla*; 2♂, Okayama (M. Miyazaki)—*Ephedrus persicae* Froggatt/*Tuberocephalus* sp./*Prunus* sp.; 7♀1♂, Sapporo—*Ephedrus plagiator* (Nees)/*Acyrthosiphon magnoliae* (Essig & Kuwana)/*Magnolia sieboldiana*; 12♀11♂, Kyôto—*Ephedrus plagiator* (Nees)/*Aphis spiraecola* Patch/*Spiraea thunbergii*; 1♀, Sapporo & 1♀1♂, Kyôto—*Ephedrus plagiator* (Nees)/*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 5♀5♂, Nara—*Ephedrus plagiator* (Nees)/*Melanaphis bambusae* (Fullaway)/Rosaceous sp.; 4♀1♂, Kyôto—*Ephedrus plagiator* (Nees)/*Rhopalosiphoninus deutzifoliae* (Shinji)/*Deutzia crenata*; 7♀11♂, Miyazaki—*Ephedrus plagiator* (Nees)/*Toxoptera odinae* (van der Goot)/*Pittosporum tobira*; 4♀10♂, Sapporo—*Ephedrus salicicola* Takada/*Cavariella salicicola* (Matsumura)/*Salix* sp.; 1♀3♂, Matsuyama—*Lysaphidus matsuyamensis* Takada/*Coloradoa* sp./*Artemisia* sp.; 2♂, Kyôto, 7♀5♂, Kure, 1♀, Shôdoshima (M. Miyazaki) & 4♀3♂, Matsuyama—*Lysaphidus pleotrichophori* Takada/*Pleotrichophorus glandulosus* (Kaltenbach)/*Artemisia* sp.; 2♀, Kagoshima—*Lysiphlebus japonicus* Ashmead/*Toxoptera odinae* (van der Goot)/*Rhus* sp.; 1♀, Kyôto—*Pauesia* sp./*Cinara* sp./*Abies firma*; 2♂, Tôkyô (H. Takizawa)—*Pauesia* sp./*Cinara* sp./*Chamaecyparis pisifera*; 8♀2♂, Kyôto—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 1♀, Kôbe—*Pauesia akamatsucola* Takada/*Cinara pineti* (Koch)/*Pinus densiflora*; 1♀, Sapporo & 5♀2♂, Tôya (K. Kusigemati)—*Pauesia pini* (Haliday)/*Cinaria laricis* (Walker)/*Larix leptolepis*; 2♀, Kagoshima—*Pauesia salignae* (Watanabe)/*Tuberolachnus salignus* (Gmelin)/*Salix* sp.; 1♀3♂, Kyôto, 20♀11♂, Kôbe, 4♀3♂, Kure, 1♀, Takamatsu & 2♀1♂, Nobeoka—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*; 1♀, Kyôto—*Praon* sp./Aphidid sp./*Chaenomeles speciosa*; 4♀, Kagoshima—*Praon* sp./Aphidid sp./*Orixa japonica*; 33♀22♂, Sapporo (K. Kusigemati)—*Praon* sp./*Acyrthosiphon*

ibotum (Essig & Kuwana)/*Ligustrum obtusifolium*; 1♀, Kyôto—*Praon* sp./*Acyrthosiphon solani* (Kaltenbach)/*Boehmeria* sp.; 12♀13♂, Sapporo—*Praon* sp./*Cavariella salicicola* (Matsumura)/*Salix* sp.; 1♀, Sapporo (H. Torikura)—*Praon* sp./*Dactynotus gobonis* (Matsumura)/*Arctium lappa*; 1♀3♂, Takarazuka & 9♀5♂, Kagoshima (K. Hashimoto)—*Praon* sp./*Macrosiphum ibarae* Matsumura/*Rosa* sp.; 3♀5♂, Kyôto—*Praon* sp./*Myzus boehmeriae* Takahashi/*Boehmeria* sp.; 1♀1♂, Ayabe—*Praon* sp./*Myzus varians* Davidson/*Clematis* sp.; 1♀3♂, Sapporo—*Praon capitophori* Takada/*Capitophorus* sp./*Elaeagnus umbellata*; 3♀4♂, Sapporo—*Praon dorsale* (Haliday)/*Indomegoura indica* (van der Goot)/*Staphylea bumalda*; 9♀2♂, Sapporo—*Praon flavinode* (Haliday)/*Euceraphis punctipennis* (Zetterstedt)/*Betula* spp.; 39♀18♂, Sapporo—*Praon volucre* (Haliday)/*Acyrthosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 2♂, Sapporo—*Praon volucre* (Haliday)/*Acyrthosiphon syringae* (Matsumura)/*Syringa reticulata*; 1♀5♂, Sapporo (M. Miyazaki)—*Praon volucre* (Haliday)/*Unisitobion sorbi* (Matsumura)/*Sorbaria sorbifolia*; 1♀2♂, Sapporo—*Trioxys euceraphis* Takada/*Euceraphis punctipennis* (Zetterstedt)/*Betula* sp.; 1♂, Nemuroshibetsu (H. Torikura); 9♀5♂, Sapporo; 1♀, Naganuma; 1♀6♂, Nopporo (M. Suwa); 1♀, Sendai; 1♀, Tôkyô (H. Takizawa); 1♀, Kôbe; 4♀3♂, Tottori; 3♀1♂, Kagoshima.

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

Locality in Japan: Hokkaidô—Memambetsu, Nemuroshibetsu, Bibai, Naganuma, Sapporo, Nopporo, Tomakomai & Tôya; Honshû—Atami (after Ashmead, 1904), Sendai, Niigata, Tôkyô, Hatano, Kyôto, 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)

Lygocerus 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 tarsi 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-kyô (M. Miyazaki)—*Aphidius areolatus* Ashmead/*Periphyllus* sp./*Acer* sp.; 1♀3♂, Sendai & 2♀2♂, Takamatsu—*Aphidius areolatus* Ashmead/*Periphyllus californiensis* (Shinji)/*Acer* sp.; 5♀4♂, Kyôto—*Diaeretus leucopterus* (Haliday)/*Eulachnus thunbergii* Wilson/*Pinus thunbergii*; 2♀2♂, Kyôto—*Ephedrus nacheri* Quilis/*Rhopalosiphoninus deutziafoliae* Shinji/*Deutzia crenata*; 1♀, Kyôto—*Pauesia* sp./*Cinara* sp./ *Abies firma*; 3♂, Tôkyô (H. Takizawa)—*Pauesia* sp./*Cinara* sp./*Chamaecyparis pisifera*; 1♂, Sendai—*Pauesia* sp./*Cinara* sp./*Pinus densiflora*; 9♀, Kyôto & 1♀, Kôbe—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 3♀, Yuni—*Pauesia infulata* (Haliday)/*Cinara* sp./*Picea abies*; 1♀1♂, Kyôto—*Pauesia japonica* (Ashmead)/*Lachnus tropicalis* (van der Goot)/*Quercus* sp.; 5♀, Yuni—*Pauesia konoi* (Watanabe)/*Cinara longipennis* (Matsumura)/*Abies sachalinensis*; 1♀, Kyôto, 2♀, Nara & 1♀, Kôbe—*Pauesia momicola* Watanabe & Takada/*Cinara* sp./*Abies firma*; 2♂, Sendai, 45♀33♂, Kyôto & 16♀8♂, Kôbe—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*; 1♂, Sapporo—*Praon capitophori* Takada/*Capitophorus* sp./*Elaeagnus umbellata*; 8♀1♂, Sapporo—*Praon volucre* (Haliday)/*Acyrthosiphon magnoliae* (Essig & Kuwana)/*Sambucus sieboldiana*; 1♂, Kyôto—*Trioxys myzocallis* Takada/*Myzocallis pilosus* Takahashi/*Quercus* sp.; 1♀, Mt. Mitake (H. Takizawa); 2♀, Kyôto; 3♀1♂, Kagoshima (H. Takizawa).

Locality in Japan: Hokkaidô—Yuni & Sapporo; Honshû—Sendai, Tôkyô, Mt. Mitake (Tôkyô-to), Kyôto, Nara, Kôbe & Sandan-kyô (Hiroshima-ken); Shikoku—Takamatsu; Kyûshû—Fukuoka (after Yasumatsu & Moritsu, 1947) & Kagoshima.

Geographical distribution: Japan.

Dendrocerus ramicornis (Boheman)

Ceraphron ramicornis Boheman, K. Vet.-Acad. Handl. 1831: 329-330, 1832.

Dendrocerus ramicornis: Dessart, Bull. Ins. R. Sci. Nat. Belg. 42: 5, 6 & 12, 1966 &

Mém. Soc. Belge Ent. 32: 233-244, 1972.

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].

Dendrocerus ratzeburgi Ashmead, J. N. Y. Ent. Soc. 12: 70-71, 1904 [Japan, host: an aphid]. Syn. nov.

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

Dendrocerus ratzeburgi: Dessart, Bull. Ins. R. Sci. Nat. Belg. 42: 1, 3, 8, 9 & 12, 1966 & Mém. Soc. R. Belge Ent. 32: 244-246, 1972.

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—*Diaeretus leucopterus* (Haliday)/*Eulachnus thunbergii* Wilson/*Pinus thunbergii*; 1♂, Kyôto—*Pauesia* sp./*Cinara* sp./*Abies firma*; 2♀1♂, Tôkyô (H. Takizawa)—*Pauesia* sp./*Cinara* sp./*Chamaecyparis pisifera*; 20♀12♂, Kyôto & 5♀1♂, Kôbe—*Pauesia abietis* (Marshall)/*Cinara pineti* (Koch)/*Pinus densiflora*; 2♀2♂, Kyôto—*Pauesia japonica* (Ashmead)/*Lachnus tropicalis* (van der Goot)/*Quercus* sp.; 3♂, Nopporo—*Pauesia jezoensis* (Watanabe)/*Lachniella costata* (Zetterstedt)/*Picea jezoensis*; 3♀, Kyôto—*Pauesia konoi* (Watanabe)/*Cinara longipennis* (Matsumura)/*Abies firma*; 1♀1♂, Kyôto—*Pauesia momicola* Watanabe & Takada/*Cinara* sp./*Abies firma*; 1♂, Sapporo—*Pauesia pini* (Haliday)/*Cinaria laricis* (Walker)/*Larix leptolepis*; 5♂, Kyôto—*Pauesia unilachni* (Gahan)/*Schizolachnus* sp./*Pinus densiflora*.

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

Locality in Japan: Hokkaidô—Sapporo & Nopporo; Honshû—Atami (after Ashmead, 1904), Tôkyô, Kyôto & Kôbe; Kyûshû—Fukuoka (after Yasumatsu et al., 1946).

Geographical distribution: Japan; Europe.

Species of *Dendrocerus* not hyperparasitic on aphids

Dendrocerus (?) *chilocori* (Ishii)

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

? *Dendrocerus chilocori*: Dessart, Mém. Soc. R. Belge Ent. 32: 121, 1972.

Dendrocerus (?) *koyamae* (Ishii)

Neolygocerus koyamae Ishii, Ôyô-Dôbuts. Zasshi 16: 94, 1951 [Japan, host: Dipterous larva on *Juglans Sieboldiana*].

Dendrocerus (*Neolygocerus*) *koyamae*: Dessart, Bull. Ins. R. Sci. Nat. Belg. 42: 1, 9, 11 & 14, 1966 & Mém. Soc. R. Belge Ent. 32: 176, 1972.

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 Honshû these species are widely distributed in the main lands of Japan. *Laticeps* is known to occur also in Ryûkyû. 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.

Species	Locality				
	Japan				Other areas
	Hokkaidô	Honshû	Shikoku Kyûshû	Ryûkyû	
D. laticeps	+	+	+	+	Sweden, Germany & Belgium[2]
D. laevis		+			North to south Europe & North Africa[2]
D. bicolor	+	+	+		North to south Europe[2]
D. carpenteri	+	+	+		North & central Europe[2]; Northern North America[1·2·3]; Australia & New Zealand[3]
D. longispinus	+	+	+		
D. ramicornis	+	+	+		Sweden, Finland & England[2]

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

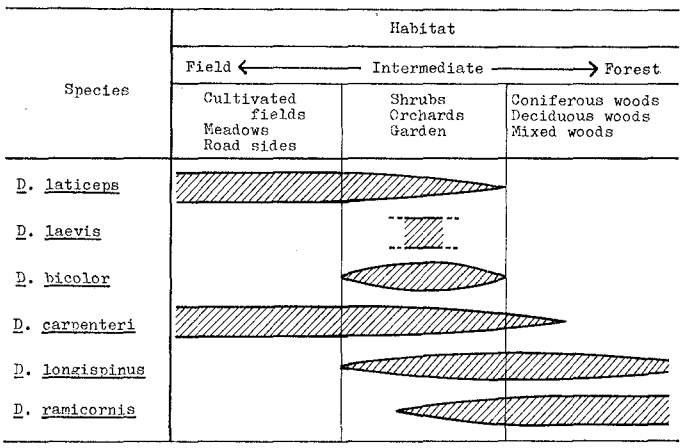

Fig. 1. Habitat distribution of aphid hyperparasites of *Dendrocerus* occurring in Japan.

in Japan is shown in Figure 1.

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

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

Species	Host	
Aphids	Lachnidae	Chaitophoridae Callaphididae Aphididae & Thelaxidae
Primary parasites	Aphidiidae *Pauesia* & *Diaeretus*	Aphidiidae Most genera except for *Pauesia* & *Diaeretus*
D. laticeps		++
D. laevis		+
D. bicolor	+	++
D. carpenteri	+	++
D. longispinus	+	+
D. ramicornis	++	

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 infulata* (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 thunbergii (Wilson)

D. carpenteri (Curtis)/*Diaeretus leucopterus* (Haliday)

D. longispinus (Yasumatsu & Moritsu)/*Diaeretus leucopterus* (Haliday)

D. ramicornis (Boheman)/*Diaeretus leucopterus* (Haliday)

Lachniella costata (Zetterstedt)

D. ramicornis (Boheman)/*Pauesia jezoensis* (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 calliptera (Hartig)

D. carpenteri (Curtis)/*Aphidius sicarius* Mackauer

Euceraphis punctipennis (Zetterstedt)

D. carpenteri (Curtis)/*Aphidius* sp., *Praon flavinode* (Haliday) & *Trioxys euceraphis* Takada

Myzocallis pilosus Takahashi
D. longispinus (Yasumatsu & Moritsu)/*Trioxys myzocallis* 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 *Orixa japonica*
D. bicolor (Kieffer)/*Praon* sp.
D. carpenteri (Curtis)/*Praon* sp.
Aphidid sp. on *Prunus persica*
D. carpenteri (Curtis)/*Ephedrus* sp.
Acyrthosiphon sp. on *Trifolium pratense*
D. bicolor (Kieffer)/*Praon dorsale* (Haliday)
Acyrthosiphon ibotum (Essig & Kuwana)
D. carpenteri (Curtis)/*Praon* sp.
Acyrthosiphon 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)
Acyrthosiphon nipponicus (Essig & Kuwana)
D. laticeps (Hedicke)/*Aphidius amamioshimensis* Takada
Acyrthosiphon solani (Kaltenbach)
D. carpenteri (Curtis)/*Praon* sp.
Acyrthosiphon 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 spiraecola 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 hippophaes (Walker)
D. carpenteri (Curtis)/*Ephedrus persicae* Froggatt
Cavariella araliae Takahashi
D. carpenteri (Curtis)/*Aphidius salicis* Haliday
Cavariella salicicola (Matsumura)

D. carpenteri (Curtis)/*Aphidius salicis* Haliday, *Ephedrus salicicola* 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)/*Aphidius 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 ibarae 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

Pleotrichophorus glandulosus (Kaltenbach)

D. carpenteri (Curtis)/*Lysaphidus pleotrichophori* Takada

Rhopalosiphoninus deutzifoliae 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)

Tuberocephalus sp. on *Prunus* sp.

D. carpenteri (Curtis)/*Ephedrus persicae* Froggatt
Tuberocephalus momonis (Matsumura)
D. carpenteri (Curtis)/Aphidiid 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 & *Tuberocephalus momonis* (Matsumura)
D. carpenteri (Curtis)
Aphidiid sp./*Rhopalosiphum padi* (Linné)
D. laticeps (Hedicke)
Aphidius spp./*Euceraphis punctipennis* (Zetterstedt), *Hyperomyzus carduellinus* (Theobald), *Macrosiphoniella* sp. & *Macrosiphum ibarae* Matsumura
D. carpenteri (Curtis)
Aphidius amamioshimensis Takada/*Acyrthosiphon nipponicus* (Essig & Kuwana)
D. laticeps (Hedicke)
Aphidius areolatus Ashmead/*Periphyllus* sp. & *P. californiensis* (Shinji)
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)
Aphidius avenae Haliday/*Macrosiphum akebiae* Shinji & *Rhopalosiphum padi* (Linné)
D. carpenteri (Curtis)
D. laticeps (Hedicke)
Aphidius gifuensis Ashmead/*Myzus persicae* (Sulzer)
D. carpenteri (Curtis)
D. laticeps (Hedicke)
Aphidius longipetiolus Takada/*Macrosiphoniella grandicauda* Takahashi & Moritsu
D. carpenteri (Curtis)
D. laticeps (Hedicke)
Aphidius salicis Haliday/*Cavariella araliae* 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* (Linné) & *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)

Lysaphidus matsuyamensis Takada/*Coloradoa* sp.
D. carpenteri (Curtis)

Lysaphidus pleotrichophori Takada/*Pleotrichophorus glandulosus* (Kaltenbach)
D. carpenteri (Curtis)

Lysiphlebus japonicus Ashmead/*Toxoptera odinae* (van der Goot)
D. carpenteri (Curtis)

Pauesia spp./*Cinara* spp. on *Abies firma*
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)
D. ramicornis (Boheman)

Pauesia sp./*Cinara* sp. on *Chamaecyparis pisifera*
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)
D. ramicornis (Boheman)

Pauesia sp./*Cinara* sp. on *Pinus densiflora*
D. longispinus (Yasumatsu & Moritsu)

Pauesia abietis (Marshall)/*Cinara pineti* (Koch)
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)
D. ramicornis (Boheman)

Pauesia akamatsucola Takada/*Cinara pineti* (Koch)
D. carpenteri (Curtis)

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

Pauesia japonica (Ashmead)/*Lachnus tropicalis* (van der Goot)

D. longispinus (Yasumatsu & Moritsu)
D. ramicornis (Boheman)

Pauesia jezoensis (Watanabe)/*Lachniella costata* (Zetterstedt)
D. ramicornis (Boheman)

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

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

Pauesia pini (Haliday)/*Cinaria laricis* (Walker)
D. carpenteri (Curtis)
D. ramicornis (Boheman)

Pauesia salignae (Watanabe)/*Tuberolachnus salignus* (Gmelin)
D. carpenteri (Curtis)
D. ramicornis (Boheman)

Pauesia unilachni (Gahan)/*Schizolachnus* sp.
D. bicolor (Kieffer)
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)
D. ramicornis (Boheman)

Praon spp./*Acyrthosiphon ibotum* (Essig & Kuwana), *A. solani* (Kaltenbach), *Cavariella salicicola* (Matsumura), *Dactynotus gobonis* (Matsumura), *Macrosiphum ibarae* Matsumura, *Myzus boehmeriae* Takahashi & *M. varians* Davidson
D. carpenteri (Curtis)

Praon capitophori Takada/*Capitophorus* sp.
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)

Praon dorsale (Haliday)/*Acyrthosiphon* sp. & *Indomegoura indica* (van der Goot)
D. bicolor (Kieffer)
D. carpenteri (Curtis)

Praon flavinode (Haliday)/*Euceraphis punctipennis* (Zetterstedt)
D. carpenteri (Curtis)

Praon volucre (Haliday)/*Acyrthosiphon magnoliae* (Essig & Kuwana), *A. syringae* (Matsumura) & *Unisitobion sorbi* (Matsumura)
D. bicolor (Kieffer)
D. carpenteri (Curtis)
D. longispinus (Yasumatsu & Moritsu)

Trioxys euceraphis Takada/*Euceraphis punctipennis* (Zetterstedt)
D. carpenteri (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.

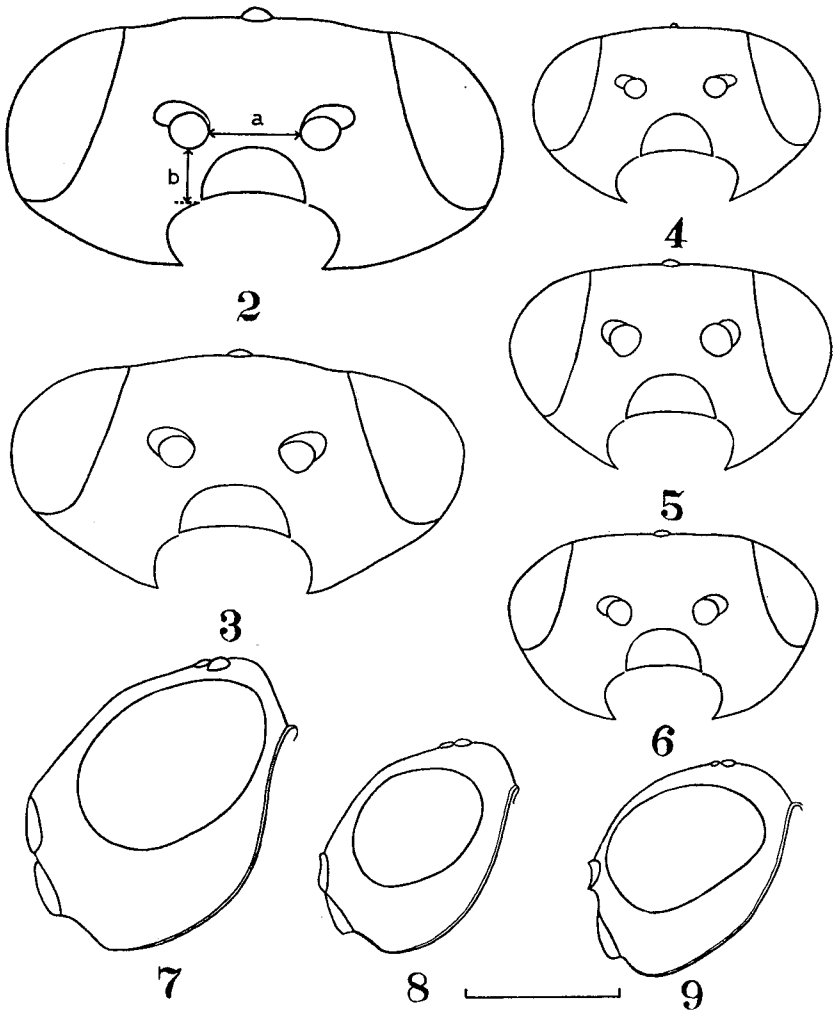
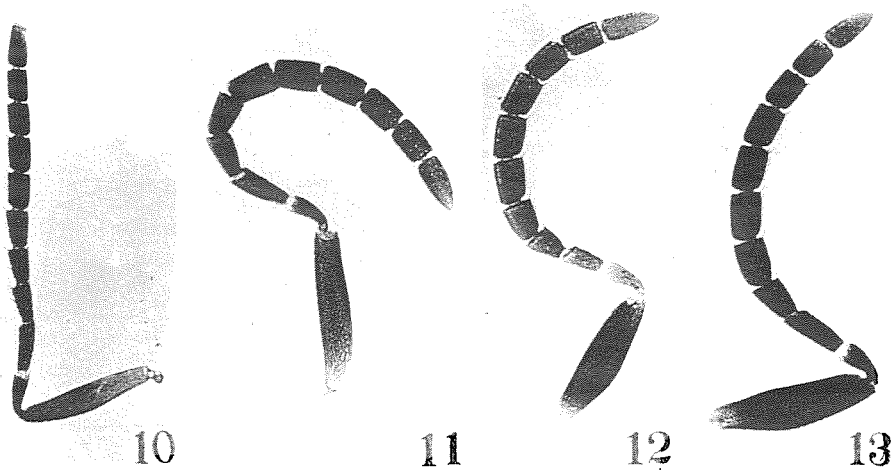

a
b
2
3
4
5
6
7
8
9

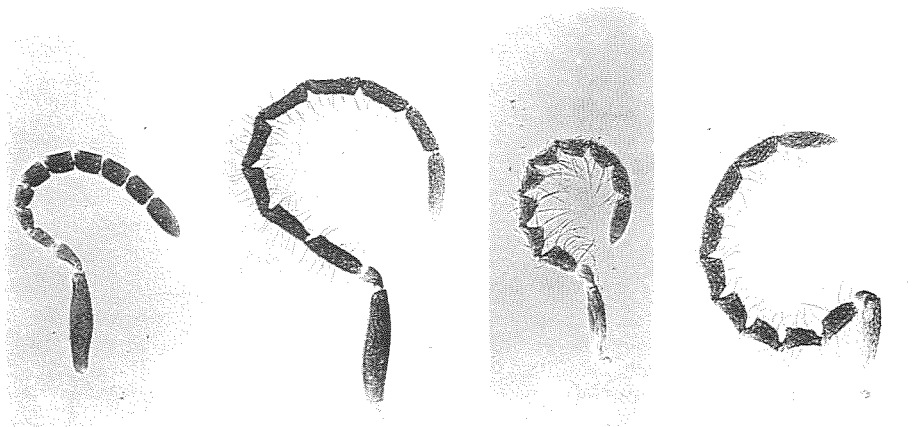
Plate II

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

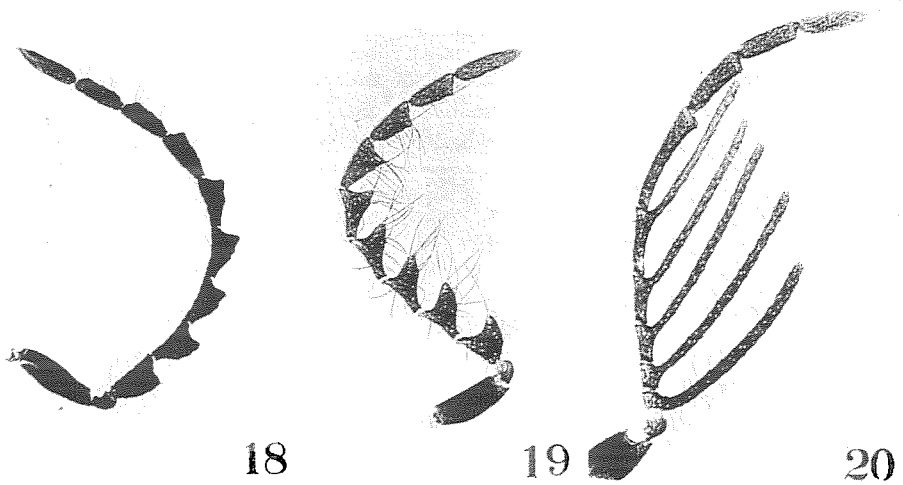
Fig. 10. *D. laticeps*, ♀.
Fig. 11. *D. bicolor*, ♀.
Fig. 12. *D. longispinus*, ♀.
Fig. 13. *D. ramicornis*, ♀.
Fig. 14. *D. carpenteri*, ♀.
Fig. 15. *D. laticeps*, ♂.
Fig. 16. *D. laevis*, ♂.
Fig. 17. *D. bicolor*, ♂.
Fig. 18. *D. carpenteri*, ♂.
Fig. 19. *D. longispinus*, ♂.
Fig. 20. *D. ramicornis*,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



10 11 12 13



14 15 16 17



18 19 20

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.

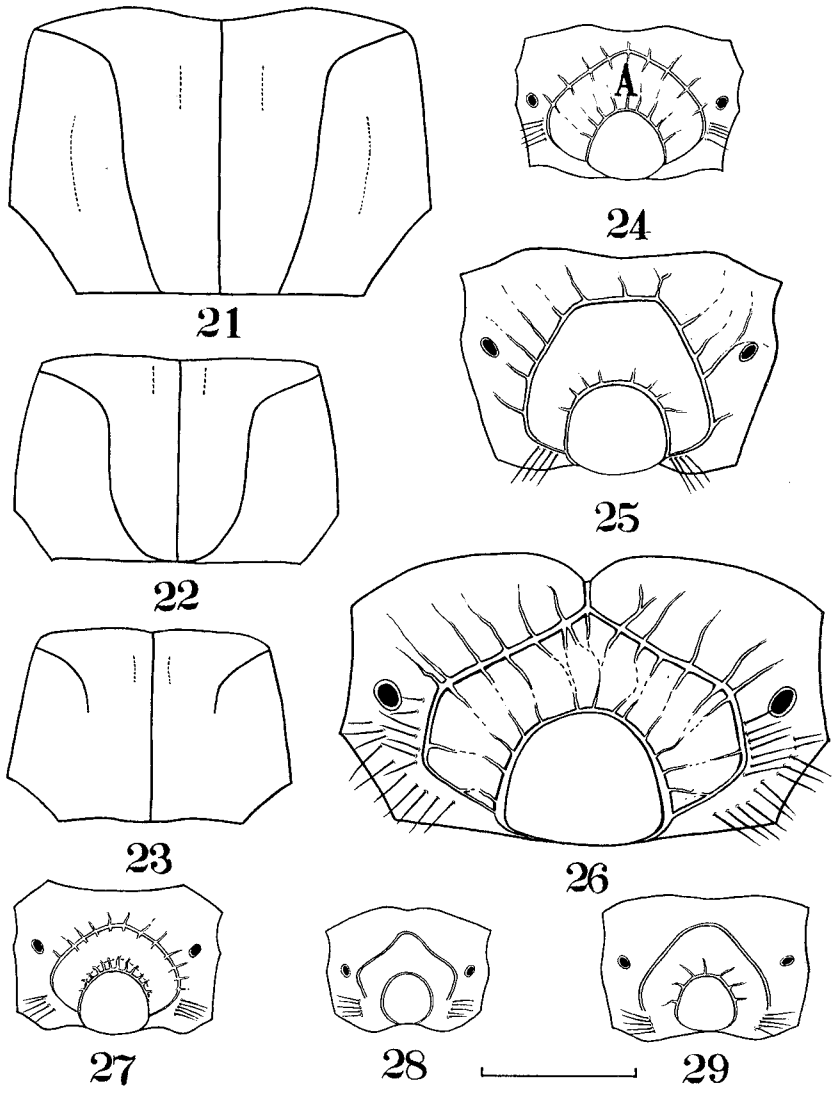

A
21
24
25
22
26
23
27
28
29

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.

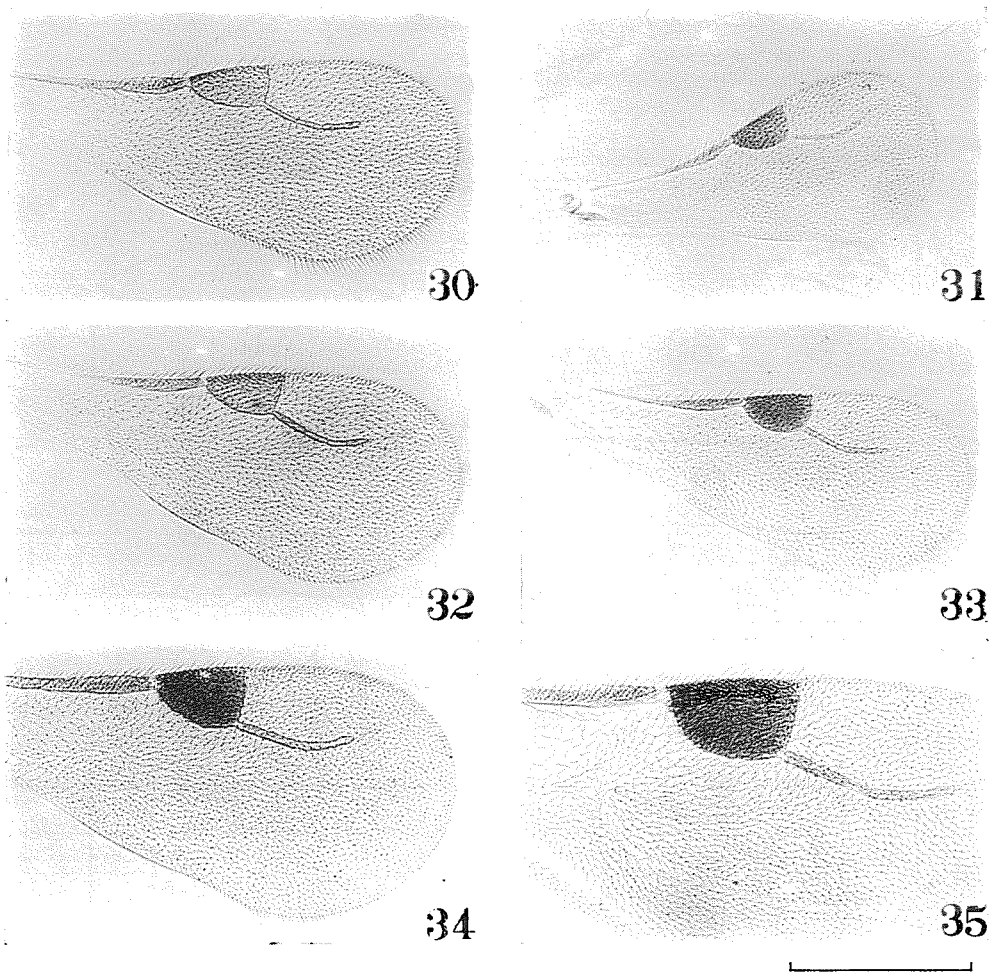
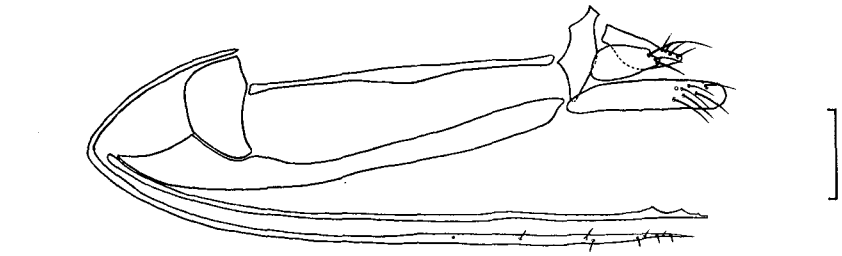

30
31
32
33
34
35

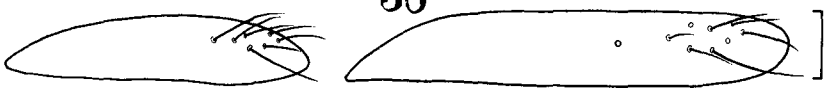
Plate V

Female genitalia (Fig. 36), ovipositor sheath (Figs. 37–41) and male genitalia (Figs. 42 & 43).

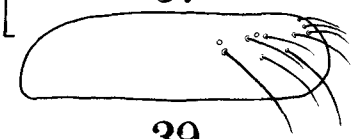
Fig. 36. *D. longispinus*, ♀.
Fig. 37. *D. laticeps*, ♀.
Fig. 38. *D. bicolor*, ♀.
Fig. 39. *D. carpenteri*, ♀.
Fig. 40. *D. longispinus*, ♀.
Fig. 41. *D. ramicornis*, ♀.
Fig. 42. *D. laticeps*, ♂.
Fig. 43. *D. laevis*, ♂.
Scale : 0.1 mm. (Figs. 36, 42 & 43);
0.025 mm. (Figs. 37–41).



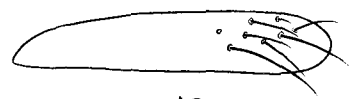
36



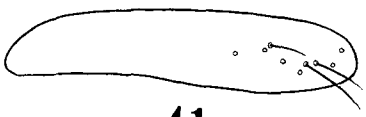
37 38



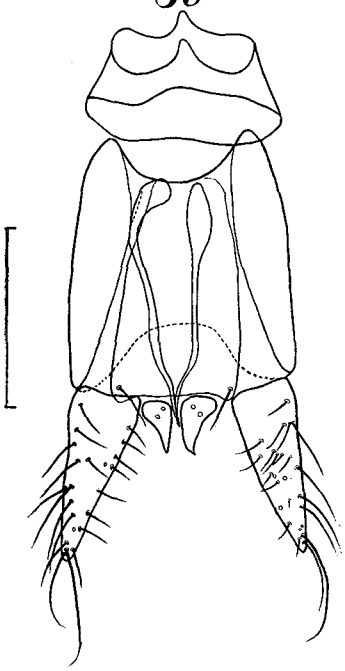
39



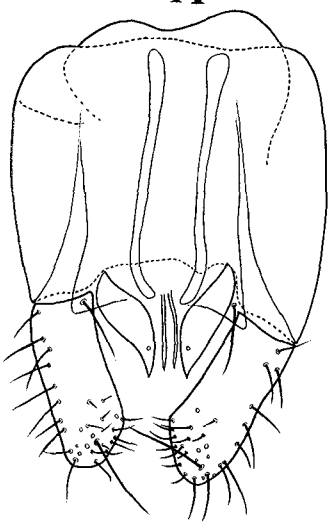
40



41



42

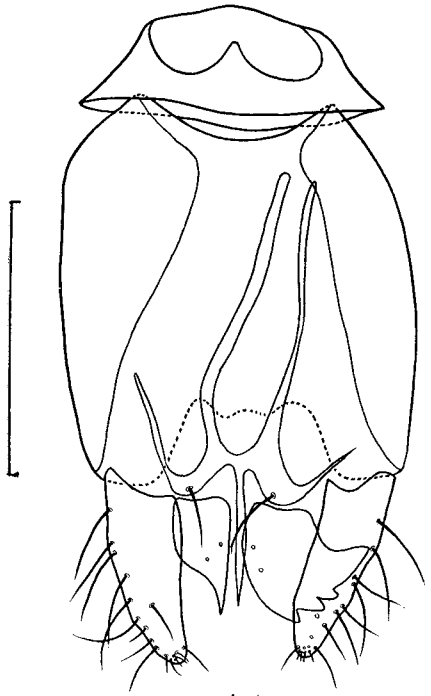


43

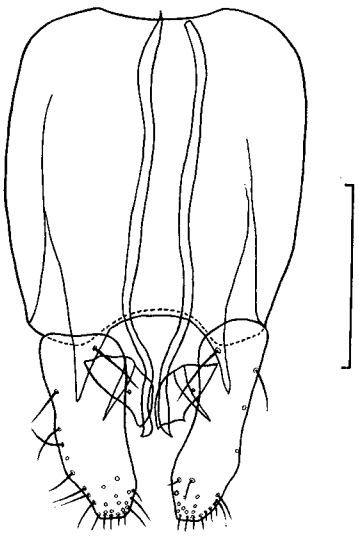
Plate VI

Male genitalia.

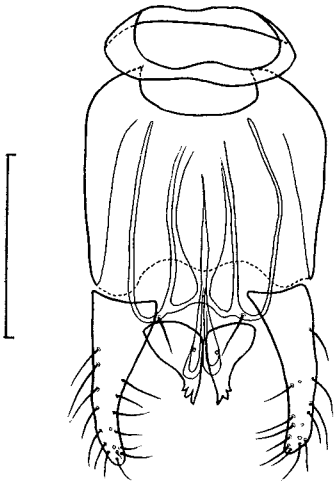
Fig. 44. *D. bicolor*, ♂.
Fig. 45. *D. longispinus*, ♂.
Fig. 46. *D. carpenteri*, ♂.
Fig. 47. *D. ramicornis*, ♂.
Scale: 0.1 mm.



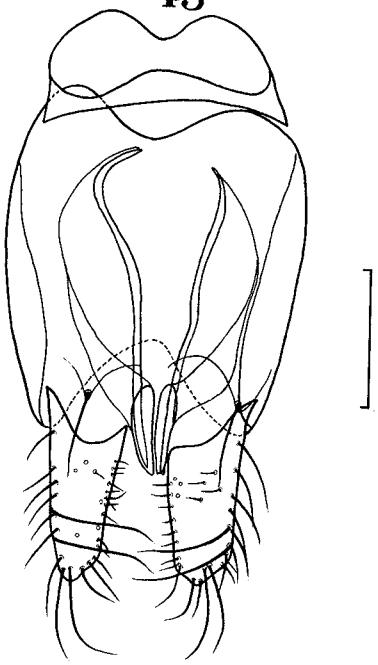
44



45



46



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