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Review of the Nearctic species of *Leiophron* and *Peristenus* (Hymenoptera: Braconidae: Euphorinae) parasitizing *Lygus* (Hemiptera: Miridae: Mirini)

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Abstract

Plant bugs belonging to the genus *Lygus* Hahn (Hemiptera: Miridae) are important pests of a wide variety of North American crops. Efforts to use biological control as one strategy in an integrated pest management approach have been impeded by a poor understanding of the endoparasitoids, particularly species of the genera *Leiophron* Nees and *Peristenus* Foerster (Hymenoptera: Braconidae) many of which parasitize the nymphal stages of *Lygus*, among other Miridae. The taxonomy of *Leiophron* and *Peristenus* species associated with agricultural habitats is reviewed based on reared material contributed by numerous researchers. Sixteen species of the two genera were found parasitizing *Lygus* nymphs, including the following eight species described as new, *Leiophron australis* Goulet, *L. simoni* Goulet, *Peristenus braunae* Goulet, *P. broadbenti* Goulet, *P. carcamoi* Goulet, *P. dayi* Goulet, *P. gillespiei* Goulet and *P. otaniae* Goulet. The species are differentiated in a key, described and illustrated. Two names are newly placed in synonymy, *L. trigonotylidis* Loan, 1974 under *Leiophron lygivorus* (Loan 1970) and *Brachistes nocturnus* Viereck, 1905 under *P. mellipes* (Cresson 1872). *Euphorus mellipes* Cresson is removed from synonymy with *P. pallipes* (Curtis). Most of the endoparasitoid species are known to be associated only with *Lygus* spp. and appear to be distinct in their distribution and their biology. Analysis of the endoparasitoid complex in southern Quebec shows that of the six species that occur in alfalfa and hay fields, four species use *Lygus lineolaris* (Palisot) as the main host. The introduced *Peristenus digoneutis* Loan has recently established in southern Quebec and although its numbers have increased substantially it has not yet had an evident impact on reducing *L. lineolaris* population levels.

Key words: *Leiophron*, *Peristenus*, biology, economic impact, key, description, *Lygus*, Nearctic

Introduction

Adults and nymphs of *Lygus* spp. cause significant economic damage to stems, leaves, fruits and seeds of a wide variety of crops in North America. Intensive research in Canada and the United States on *Lygus* bug endoparasitoids showed that euphorine braconid wasps play a role in their control (Ashfaq *et al.* 2004; Ball *et al.* 2000; Braun *et al.* 2001; Broadbent *et al.*1999; Carigan *et al.* 1995; Day 1996, 1999; Day *et al.* 1990, 1992, 1996, 1998, 1999, 2000, 2003; Haye *et al.* 2005, 2006 ; Lachance *et al.* 2001; Lim *et al.* 1976; Loan 1965, 1970, 1974a, 1980; Loan *et al.* 1976, 1987; Picket *et al.* 1998, 2000, 2001, 2002, 2003, 2005; Tillmon *et al.* 2000). The endoparasitoids belong to species of *Leiophron* and *Peristenus*. However, there is a great need to clarify the known endoparasitoid species, establish new synonymies, name new species, and produce keys to enable species identification.

In North America, 19 *Leiophron* species and 29 *Peristenus* species are known, and additional species await description. Cresson (1872) described the first Nearctic species, *L. scitulus* and *P. mellipes* under the genus *Euphorus*. Muesebeck (1936) keyed out and characterized nine species in the genera *Euphoriana* Gahan and *Euphorus* Nees. Muesebeck and Walkley (1951) catalogued the same species. Today, seven of these

species are transferred to *Leiophron* and two to *Peristenus*. Loan (1965, 1970, 1974a) described 11 species of *Leiophron* and 24 species of *Peristenus*. Marsh (1979) listed 19 species of *Leiophron* and 25 of *Peristenus*. Thereafter, only four species of *Peristenus* were added to the nomenclature to the end of the Twentieth Century.

The species of *Lygus* were recently revised (Schwartz and Foottit 1998), but the species of *Leiophron* Nees and *Peristenus* Foerster (Hymenoptera: Braconidae) from North America and Europe were revised 30 years ago (Loan 1974a, 1974b). Of the eight species of *Leiophron* and *Peristenus* Loan and Shaw (1987) recognized in Europe and North America as endoparasitoids of *Lygus*, four are North American. However, the taxonomy of *Leiophron* and *Peristenus* remains unsatisfactory because many cryptic or sibling species exist and the taxonomic resolution of such cryptic species requires biological information, as shown by Loan (1970) in his work on *P. pseudopallipes* (Loan).

The central taxonomic problem in clarifying the status of *Lygus* endoparasitoids is *P. pallipes*. Loan (1974a, 1974b) was aware that this was a species complex but was also very confused about it (based on his identified specimens). In addition to *P. pallipes*, only *P. pseudopallipes* (Loan) and *P. howardi* Shaw were previously recognized species of the complex. The Loan collection, new material reared from *Lygus* spp., and biological data accumulated during the last 15 years provided a basis for more rigorous taxonomic study to be undertaken. The diversity of *Leiophron* and *Peristenus* parasitizing *Lygus* in North America was determined to be much greater than previously thought. Numerous closely related species present an identification challenge to the user. Understanding character variation in reared specimens from a known host is the key in clarifying species in the complex. Collaborators, particularly W.H. Day, understood the need to resolve the systematic problems with biological data and provided reared specimens from a wide variety of mirid hosts. From their efforts, they learned about host range, and helped the senior author in clarifying species.

The life cycle of *Leiophron* and *Peristenus* species consists of the egg, three larval instars, pupa, and adult stages (Carigan *et al.* 1995). The immature stages of *Leiophron* and *Peristenus* spp. are structurally similar (Bilewicz-Pawinska 1974; Carigan *et al.* 1995), and therefore, cannot be separated morphologically. However, adults and immature stages of some species have been successfully identified using molecular techniques (Tilmon *et al.* 2000; Mowry *et al*. 2004; Gariepy *et al.* 2005) and future studies are likely to include this type of analysis.

The taxonomic objectives of this work are to review the species of *Leiophron* and *Peristenus* associated with *Lygus* spp. and, using morphological and biological information, to determine their status and produce keys to adults.

Accurate knowledge of the biology, economic impact and species of *Lygus* and their parasitoids is crucial for any integrated pest management or biocontrol research program. Much is known about parasitoid and *Lygus* associations, but nothing is known about adult presence, abundance and sex ratio thoughout the season on a weekly basis. Thus, a second

objective of this work is to compare the biologies of the most common host, *L. lineolaris* (Palisot), and its endoparasitoids (one species of *Leiophron* and four species of *Peristenus*), characterize and compare the life cycle and phenology of *L. lineolaris* with that of the parasitoid species, discuss the efficacy of various parasitoids in controlling *Lygus*, describe changes in the relative abundance of the native parasitoids since the arrival of the introduced *P. digoneutis* in southern Quebec, and define which nymphal generations are present at the time of the greatest abundance of various parasitoids.

Material and methods

Sampling of *Lygus* bugs. Sampling nymphs and adults of *Lygus* bugs for this study was limited to alfalfa, hay, or fallow fields in eastern Ontario and southwestern Quebec. At two sites, Ste. Clotilde, Agriculture and Agri-Food Canada (AAFC) field station, and Hemmingford in southern Quebec, fields were sampled using a standard net swept in an 180º arc 200 times (four sets of 50 sweeps) while walking forward. At the Ste. Clotilde site we sampled an alfalfa field where only half of the field was cut at the proper time and the second half was cut three weeks later. This later cutting causes much less disturbance to *Lygus* bugs and parasitoids.

Nymphs of various *Lygus* instars and adults were aspirated from each sample and stored in 1 litre plastic containers with alfalfa leaves and kept cool (away from direct sunlight) until processed in the laboratory. All instar nymphs and adults were then counted and many of these specimens were dissected to evaluate levels of parasitism; the remaining specimens were reared for adult parasitoids and for taxonomic study using methods described by Whistlecraft et al. (1999).

Sampling of parasitoids. Adults of *Leiophron* and *Peristenus* species were sampled weekly at the Ste. Clotilde and Hemmingford sites in hay and alfalfa fields from 2000 to 2002. A total of about 10,000 sweeps was made weekly at each site over the three year study. The samples were transferred into a separation box, (photoecclector) where the phototropically positive insects segregated themselves in the lighted, cooler chamber of the photoecclector and dropped into 70% ethanol. Because the parasitoids are uncommon, 100–300 sweeps are needed to collect a single specimen even at peak times of abundance. Collections were also made using Malaise and yellow pan traps at Frelighsburg (the AAFC field site) from 1993–1996 and at two vineyards (Iberville and Dunham) in southern Quebec from 1997–1999. All collected specimens from southern Quebec provided the data about the weekly abundance of adults throughout the season. The euphorine parasitoids obtained by sweeping or the passive collecting techniques were subsequently segregated from other insects in the laboratory. Sweep sampling using a photoecclector was also used by the senior author to collect parasitoids at other sites across Canada. Numerous locations were sampled around Ottawa (Ontario) and in Quebec

throughout the study. Collecting expeditions were also made at the following locations: Fraser valley, British Columbia, in June 2000 and July 2001; Beaverlodge, Alberta, in July 2001; western Alberta from Lethbridge to Fort Vermillion in June 2003, Lethbridge, Alberta in 2005; a 650 kilometre transect from Gatineau to Matagami, Quebec in 2003; the Maritime region of Atlantic Canada in June 2004; and the Okanagan valley, British Columbia in May 2005. Collaborators also made available numerous reared parasitoids from the Fraser valley, British Columbia (D. Gillespie), Beaverlodge, Alberta (J. Otani), Lethbridge, Alberta (H. Cárcamo), Saskatoon, Saskatchewan (L. Braun), London, Ontario (B. Broadbent and J. Whistlecraft), Newark, Delaware (W. H. Day), and locations in California (C. Pickett).

Altogether, 6203 specimens of *Leiophron* and *Peristenus* were studied, of which 4165 specimens were from North America. The remaining 2038 specimens were of three European species introduced into North America.

Measurements. Between 37 and 48 linear measurements were recorded from each specimen, resulting in 16–18 ratios. Unless noted otherwise, ten males and ten females were measured for each species. The following describes the orientation of the body part when measured, defines the types of measurements recorded, including method of each measurement, and the abbreviation used for each measurement and ratio.

Flagellum (Fl)

Flagellomeres were measured beginning with the first one after the pedicel, as Fl 1, Fl 2, etc., or beginning with the preapical flagellomere, back to the 6th preapical flagellomere as Fl –1, Fl –2, etc. (Fig. 86). The middle flagellomere, Fl mid, is the one midway between the first and the last flagellomeres. For each flagellomere, the length from the base to apex along the middle axis, Fl # (L), was measured for all flagellomeres (Fig. 86). The width of some flagellomeres, Fl # (W), was measured at the widest point, (Fig. 86). All the measurements were made with the flagellum oriented in a lateral position. This is essential when measuring preapical flagellomeres in females of *Peristenus* as they are clearly compressed laterally. The lateral view is correctly observed in females of *Peristenus* when the basal petiolate constriction of each preapical flagellomere is clearly on the dorsal half of the flagellomere (Fig. 71). The total length of the flagellum, as Fl (L), is the sum of the lengths of all flagellomeres.

The following nine ratios were determined: Fl 1 (L/W), Fl mid (L/W), Fl –6 (L/W), Fl –5 (L/W), Fl –4 (L/W), Fl –3 (L/W), Fl –2 (L/W), Fl –1 (L/W) and Fl (L)/ (MxHdW).

Head capsule

A lateral view of the head capsule is obtained when the median ocellus is visible, but the occiput is not, and when the occipital carinae on either side merge into one when the head is tilted and rotated. The following measurements were made: genal length (GL), taken midway between the top and the bottom of an eye from the posterior eye edge to the

occipital carina, the line is at 90º with the posterior eye edge (Fig. 81); eye length (EyL) from the posterior edge to anterior edge of the eye at the same level as GL, the line is at 90º with the posterior eye edge (Fig. 81); eye height (EyH), between lowest and highest eye edges (Fig. 82).

A frontal view of the head capsule is obtained when the median ocellus is visible dorsally and the eyes are of equal width. The following measurement was made (Figs. 79, 80): the minimum distance between inner eye margins (MnEy-Ey).

A dorsal view of the head capsule is obtained when the occiput is not visible as the head capsule is tilted backward, and the eyes are equal. The following measurements were recorded: the maximum width (MxGW) between both genae behind eyes (Fig. 84); the maximum head width (MxHdW) between the outermost edges of eyes (Fig. 84); the distance between the nearest edges of the lateral and median ocelli (LOL) (Fig. 83); the distance between the nearest edges of the lateral ocelli (POL) (Fig. 83); the distance between the nearest edges of the lateral ocellus and the eye (OOL) (Fig. 83).

Six ratios were determined: MxGW/MxHdW, EyH/MnEy-Ey, Gl/EyW, POL/LOL, OOL/LOL and OOL/POL.

Metasomal tergum 1

All measurements of T1 are in dorsal view when the anterior and posterior margins and the posterolateral corners are all in focus. The following measurements were made (Fig. 87): L, the medial length from the base in the middle of a small circular structure to junction with metasomal tergum 2; MxW, the maximum width of the posterior margin. MnW, the minimum width posterior to the base. Two ratios were determined: L/MxW and MxW/MnW.

Forewing

The wing surface near the stigma was made as flat as possible before measuring and two measurements were recorded (Fig. 85): the maximum length of the radial cell (RcL) is the distance from the inner edges of the united R1 and Rs veins to the stigma, which is often outlined by a small angle on the anterior edge of the wing; the maximum width of the stigma (StW) is measured from the level of the r vein-stigma junction to the anterior margin of the stigma. In air dried specimens, the anterior edge of the stigma is often rolled under. Lighting the surface below the specimen illuminates this fold, which must be added to the width to complete the measurement. A single ratio, recorded as Fw (RcL/StW), was generated from these measurements.

Species descriptions. The paragraph preceding the diagnosis consists of nomenclatural and label data, and information on the condition of the primary type material. Printed words on labels are indicated by regular font, whereas hand written words are in italics. Consequently, a Latin name printed in italic font on a label is given in regular font for type

information.

Under “Material examined and range” we used the American two letter postal codes for states and provinces: AK, Alaska; AB, Alberta; BC, British Columbia; CA, California; CO, Colorado; DE, Delaware; GA, Georgia; ID, Idaho; IL, Illinois; MA, Massachusetts; MB, Manitoba; MD, Maryland; ME, Maine; MI, Michigan; MN, Minnesota; MT, Montana; NB, New Brunswick; NL, Newfoundland & Labrador; NH, New Hampshire; NJ, New Jersey; NS, Nova Scotia; NT, Northwest Territories; NY, New York; OH, Ohio; ON, Ontario; OR, Oregon; PA, Pennsylvania; PI, Prince Edward Island; QC, Quebec; SK, Saskatchewan; VA, Virginia; VE, Vermont; WA, Washington; WY, Wyoming; YT, Yukon Territory.

Collections examined.

CDFA California State Collection of Arthropods, California Department of Food and Agriculture, Sacramento, CA, U.S.A. C. H. Pickett.

CNCI Canadian National Collection of Insects, Ottawa, ON, Canada. H. Goulet.

ESUW Rocky Mountain Systematic Entomology Laboratory, Entomology Section, University of Wyoming, University Station, Laramie, WY, U.S.A. S. R. Shaw.

ITNM A. Gonzalez: Coleción de Insectos, Instituto Tecnologico de Monterrey, Escuela de Agricultura, Monterrey, N.L., Mexico.

USDA Beneficial Insects Research Laboratory, Newark, DE, U.S.A. W. H. Day.

USNM Department of Entomology, National Museum of Natural History, Washington, D.C. U.S.A. D. R. Smith.

Because almost all specimens studied are from CNCI, the acronym is not used under “Material examined and range” unless a sample is from CNCI and one or more other collections.

Illustrations. Images were captured using a Nikon coolpix 4500 on a Nikon SMZ-U stereomicroscope and on a Nikon Eclipse E800 compound microscope. The similar images recorded at different focus planes were combined using Combine Z4 designed by Alan Hadley.

Structures. Names of structures and orientation terms follow Huber & Sharkey (1993). However in many keys, the metasomal tergum 1 of *Peristenus* is characterized by its lateral margins “fused” ventrally. Is it really “fused”? In some specimens of various species, the area of “fusion” is broken off. In this situation, the the lateral margins simply touch like the elytra of beetles. A 45 minutes treatment of *P. digoneutis* abdomen in 10% hot KOH showed that the “fused” tergum 1 is in fact not “fused”, but simply meeting or touching. So we used the word “touching”.

Microsculpture features are described differently. Microsculpture in this work excludes punctures. It consists of cell imprint and is free of sensilla. The terms used to

describe the sculpture were first proposed by Allen and Ball (1979). Typically, it is about as long as wide (isodiametric) and varies between 5 to 10 µm in length and width. The outline typically appears by an engraved polygonal furrow creating a net-like pattern. The furrow pattern is termed mesh or meshes. The cell-like surface is termed sculpticell. Features of meshes and sculpticells are described independently of each other (e.g., the mesh may be isodiametric or transverse and the sculpticells may be convex or scale-like).

Origin of new species names. Elucidating biological information such as host range, period of attack and distribution patterns requires great effort and time. For this reason most of the newly described species are named in honour of the collaborators who worked so hard to obtain the information and rear the parasitoids necessary to build a reference collection sufficient to adequately analyze structural variation. The very close collaboration between many biological control experts and taxonomists has been essential to the success of this study.

Introductory remarks on use of key. Some portions of the keys may be difficult, thus the following should be noted. For those couplets differentiating species of the *P. pallipes* complex (beginning with couplet 8), the key was designed to incorporate geographical and biological information necessary to correctly identify specimens. Before using the key, note the region where the specimen was collected and, if possible, the generation of the *Lygus* host from which the parasitoid emerged, or was associated with if field collected. When these are known it is possible to identify reared or associated adult parasitoids from almost all regions except central Idaho and Washington where *P. howardi* and *P. broadbenti* occur together in summer.

The specimen should be clean (if possible it should be critical point dried, chemical dried or freeze dried before mounting), correctly pinned and labelled.

To observe character states clearly with minimum glare it is necessary to interpose a small (4 by 7 cm) piece of translucent film such as that used by graphic designers (e.g., Mylar) between the light source and the specimen, about 10–15 mm from the specimen. The film can be inserted vertically on an eraser, foam square, piece of modelling clay or other object that can be positioned easily. The light should also be adjusted for best viewing of the specimen. For viewing wing, tarsomere and antennal features, transmitted light from below produces a silhouette effect that makes these structures clearer.

Because many measurements or ratios between two species differ by less than two standard deviations between the means, the data were presented differently in the key to increase the accuracy in sorting specimens. If two means differ by two standard deviations from each other, the probability of an incorrect identification or association is about 1%. In differentiating species between couplets, two standard deviations were added to the lower mean, and two standard deviations were subtracted from the higher mean. The overlapping ranges would likely consist of specimens of both taxa, but specimens outside the overlapping zone would very likely consist of one species, and thus, be correctly (99%)

associated. For specimens in the overlapping zone, look carefully at other characters, when possible. Usually more than one such character is given. It is not necessary to look at all such characters. Simply accept the character when your specimen measurements or counts fall ouside the overlapping range.

Forewing veins and cells are illustrated in Figures 52a and 52b and, hind wing veins and cells in Figures 65 and 66.

It is not easy to differentiate males from females in *Leiophron* and *Peristenus* because the ovipositor is as short as or even shorter than the extruded portion of the male genitalia. Furthermore, in air dried specimens it is often not possible to see the genitalic differences because the last metasomal segments are telescoped within the metasoma. We found many features that differentiate males from females, but if the specimen is in alcohol or has been air dried, any of the following four characters will work:

Female.

1) Either ovipositor sheath (round margin at apex) or ovipositor stylets visible (Fig. 77).

2) Last metasomal sternum clearly longer than preceding sterna and covered with many setae (Fig. 77).

3) Eye in lateral view larger and more bulged in its ventral half (Fig. 81) and, in frontal view, eyes clearly convergent ventrally, the shortest distance between eyes less than height of an eye (Fig. 79).

4) For species of *Peristenus*, preapical flagellomeres square or almost so (Fig. 71), and flagellomere 1 relatively slender and without linear sensilla (Fig. 73).

Male.

1) Either parameres usually extruded and more or less truncate at apex, or aedeagous between the parameres extends mainly above the parameres (Fig. 78).

2) Last metasomal sternum as short as preceding sterna, and covered with few setae (Fig. 78).

3) Eye in lateral view smaller (Fig. 82) and, in frontal view, eyes almost parallel, the shortest distance between eyes greater than height of an eye (Fig. 80).

4) For species of *Peristenus*, preapical flagellomeres clearly longer than wide (1.5–2.0 times) (Fig. 72), and flagellomere 1 clearly wider and with one or more linear sensilla (Fig. 74).

Within couplets, features were segregated into those that apply to both sexes (when available), followed by those that are sex dependant.

Finally, the first couplet characterizing the two genera refers only to practical and easy characters for the 16 species considered here. A better characterization is given under each genus.

Key to Nearctic species of euphorine parasitoids associated with *Lygus*

1 Both sexes:

a) Notauli not extended into posterior half of mesoscutum, or extended posteriorly and separate posteriorly (Figs. 40–42).

b) Metasomal tergum 1 in ventral view with lateral margins not touching (Fig. 69).

c) Flagellum with 15 or fewer flagellomeres (Fig. 34).

d) Metasomal tergum 2 rounded above spiracle, tergum thus not subdivided into medio- and laterotergites and similar to metasomal tergum 3 (Figs. 1–3).

..... Genus *Leiophron*, go to 2

- **Both sexes:**

A) Notauli clearly extended into posterior half and meeting posteriorly (Figs. 43, 44).

B) Metasomal tergum 1 in ventral view with lateral margins touching anteriorly (Fig. 70).

C) Flagellum with 16 or more flagellomeres (Fig. 37).

D) Metasomal tergum 2 sharply folded above spiracle, tergum thus superficially subdivided into medio- and laterotergites unlike metasomal tergum 3 (Figs. 4–9, 77, 78)

.....Genus *Peristenus*, go to 5

2(1) Both sexes:

a) Mesoscutum with notauli developed in anterior half (Fig. 42).

b) Anterior mesoscutal fovea 4–5 times as wide as long (Fig. 42).

c) Forewing veins RS+M, 1m-cu, 2RS, 1CU and 2CUa developed though rather clear, and wing clear (Figs. 3, 51, 56).

[**Range:** recorded from Prince Edward Island, and southern Quebec and Ontario.]

.....*Leiophron simoni* **n. sp.**

- **Both sexes:**

A) Mesoscutum with notauli developed only anterolaterally (Fig. 40).

B) Anterior mesoscutal fovea 2–3 times as wide as long (Figs. 40–41).

C) Forewing veins 2RS, 1m-cu, 1CU and 2CUa absent (vein RS+M present or not), wing with two lightly coloured bands (not visible in old specimens) aligned with 1st discal cell and below apical 0.7 of stigma (apical band fading to clear toward apex) (Figs. 1, 2, 50, 55).

..... 3

3(2)Both sexes:

a) Forewing with RS+M clearly outlined (as in Fig. 51).

b) Head and thorax (excluding propodeal area in female) reddish brown (Fig. 2).

Female:

c) Propodeum and metasomal tergum 1 brown (Fig. 2).

[**Range:** only known from Newark (Delaware) and southern New York.]

..... *Leiophron australis* **n. sp.**

- **Both sexes:**

A) Forewing with RS+M absent or at most, reduced to a small stub (Figs. 50, 55).

B) Head and thorax (excluding propodeal area in female) very light reddish brown (Fig. 1).

Female:

C) Propodeum brown (north of 38ºN) and metasomal tergum 1 very light reddish brown (Fig. 1). 4

4(3)Both sexes:

a) Mesoscutum smooth, or with a trace of sculpture posteromedially (Fig. 41).

Female:

b) Flagellum more slender in apical 0.3 (Fig. 36).

Male:

b) Height of eye relative to maximum width of head between outer eye margins less than 0.96 (if between 0.96 and 1.01, specimen cannot be identified with certainty).

[Range: warm temperate regions.]

..... *Leiophron uniformis* (Gahan)

- **Both sexes:**

A) Mesoscutum roughly sculptured over much of disc (Fig. 40).

Female:

B) Flagellum slightly thicker (Fig. 35).

Male:

B) Height of eye relative to maximum width of head between outer eye margins more than 1.01 (if between 0.96 and 1.01, specimen cannot be identified with certainty).

[**Range:** eastern Canada (Prince Edward Island, southern Ontario and southern Quebec) and northern United States (Iowa and North Dakota).]

..... *Leiophron lygivorus* (Loan)

5(1)Both sexes:

a) Frons and vertex around ocelli with few, very small punctures (Fig. 22).

b) Mesoscutum with punctures almost entirely restricted to about anterior quarter (Fig. 44).

[**Other features:** body black, hind leg brown and genal carina widely interrupted dorsally. **Range:** intentionally introduced from Europe and established in central and coastal California.]

..... *Peristenus relictus* (Ruthe)

- **Both sexes:**

A) Frons and vertex beside lateral ocellus clearly and densely punctate (as in Fig. 20).

B) Mesoscutum punctate over more than anterior half (Fig. 43).

..... 6

6(5)Both sexes:

a) Genal carinae widely interrupted dorsally (Fig. 32).

b) Face and clypeus light reddish brown and clearly paler than remainder of the head capsule (Figs. 19–21) **or**, if completely black (less than 1% of specimens of *P. digoneutis* in southern Quebec), specimen with coxae and femora straw coloured.

..... 7

- **Both sexes:**

A) Genal carinae either completely outlined dorsally or, usually, narrowly interrupted medially (Fig. 33).

B) Face brown or black (at least clearly darker than clypeus) (Figs. 15–18) specimens with reddish brown clypeus or, if black, metafemur light reddish brown and metacoxa commonly brown or black.

..... 8

7(6)Both sexes:

a) Metacoxa at least at base reddish brown to dark brown (Fig. 46).

Female:

b) Flagellum with 21–24 flagellomeres.

c) Head in lateral view black with clearly outlined red spot behind upper outer margin of eye, and mesosoma black (Figs. 9, 23, 30).

d) Length of radial cell relative to width of stigma less than 0.85 (if between 0.85 and 0.92, specimen cannot be identified with certainty).

Male:

b) Head mostly light reddish brown, but black around ocelli, medioposterior surface of vertex and medial region of occiput (Figs. 21, 24, 29).

c) Flagellum with 21–24 flagellomeres (if with 20 flagellomeres, see next character).

d) Length of radial cell relative to width of stigma less than 0.85 (if between 0.85 and 0.88, specimen cannot be identified with certainty).

[**Range:** intentionally introduced species from Europe and established along the Atlantic coast of eastern United States from Delaware to New York north along the Hudson River and Lake Champlain to southern Quebec.]

..... *Peristenus rubricollis* (Thomson)

- **Both sexes:**

A) Metacoxa straw coloured (Fig. 45).

Female:

B) Flagellum with 17–19 flagellomeres.

C) Head in lateral view black or mostly dark reddish brown, but without distinct and large red spot behind upper outer margin of eye, and mesosoma black or dark brown with nebulous reddish brown spots (Figs. 6, 31, 32).

D) Length of radial cell relative to width of stigma more than 0.92 (if between 0.85 and 0.92, see other characters).

Male:

B) Head mainly dark coloured (usually as in Figs. 19, 31) **or**, head mainly light reddish

brown even on medioposterior surface of vertex and medial region of occiput.

C) Flagellum with 17–19 flagellomeres (if with 20 flagellomeres, see next character).

D) Length of radial cell relative to width of stigma, more than 0.88 (if between 0.75 and 0.88, specimen cannot be identified with certainty).

[**Range:** intentionally introduced species from Europe and established from Delaware and New York along the Atlantic coast to Nova Scotia, north to southern Quebec, and west to southern Ontario and Ohio.]

..... *Peristenus digoneutis* Loan

8(6)Both sexes:

a) Punctures large and dense between inner eye margin and lateral ocellus (Fig. 26).

b) Metatibia straw coloured or pale reddish brown, at most darkened in apical quarter, and metatarsomere 1 straw coloured (Fig. 11).

c) Clypeus dark brown or black (Figs. 15, 17).

Female:

d) Length of flagellum relative to maximum width of head between outer eye margins more than 2.87 (if between 2.79 and 2.87, see next character).

e) Height of eye relative to minimum distance between inner eye margins less than 1.21 (if between 1.21 and 1.23, specimen cannot be identified with certainty).

..... 9

- **Both sexes:**

A) Punctures fine and scattered between inner eye margin and lateral ocellus (Fig. 27).

B) Metatibia dark brown to black in apical 0.6–0.8 at least on dorsal surface (90% of specimens) and metatarsomere 1 darker than following tarsomeres (95% of specimens) (Figs. 10, 12).

C) Clypeus reddish brown, dark brown or black (Figs. 7a, 16, 18).

Female:

D) Length of flagellum relative to maximum width of head between outer eye margins less than 2.79 (if between 2.79 and 2.87, see next character).

E) Height of eye relative to minimum distance between inner eye margins more than 1.23 (if between 1.21 and 1.23, specimen cannot be identified with certainty).

..... 10

9(8)Both sexes:

a) Specimen from temperate regions of eastern North America (from southernmost Ontario and Quebec to Virginia).

b) Mesocoxa and mesofemur straw coloured (as in Fig. 48).

c) Clypeus almost always densely punctate over disc.

d) Punctures on frons dense and surface between punctures rough and mainly matt.

Female:

e) Metacoxa almost always straw coloured or light reddish (as in Fig. 48).

Male:

e) Length of flagellomere 1 less than 130 µm (if between 130 µm and 150 µm, specimen cannot be identified with certainty).

[**Range:** temperate regions of eastern North America.]

..... *Peristenus dayi* **n. sp.**

- **Both sexes:**

A) Specimen from boreal regions including coastal regions along the Atlantic coast, or from western North America.

B) Mesocoxa reddish brown to brown or rarely straw coloured, and almost always darker than mesofemur (as in Fig. 47).

C) Clypeus usually smooth with few or no punctures on disc.

D) Punctures on frons less dense and surface smoother with shiny spaces between punctures.

Female:

E) Metacoxa usually brown to black (Fig. 47), uncommonly straw coloured.

Male:

E) Length of flagellomere 1 more than 150 µm (if between130 µm and 150 µm, specimen cannot be identified with certainty).

[**Range:** cool coastal, boreal and montane regions.]

.....*Peristenus braunae* **n. sp.**

10(8)Both sexes:

a) Clypeus mainly light reddish brown (sometimes dark basally) (Fig. 18).

b) Metacoxa usually straw coloured or rarely reddish brown (Fig. 48).

..... 11

- **Both sexes:**

A) Clypeus completely black, black and brown in apical third or half, or completely dark brown (Fig. 16).

B) Metacoxa brown or black (Fig. 47).

..... 17

11(10)a) If you are uncertain about the type of life cycle of your specimen, choose this alternative (couplets 12–14 stress the range of each species).

..... 12

- A) If you know about the type of life cycle of your specimen, choose this alternative (couplets 15–16 stress the type of life cycle).

..... 15

12(11)Both sexes:

a) Specimen either from boreal region (including ocean coastal margin in eastern Canada), montane region (in the Rocky Mountains) or temperate region west of Saskatchewan.

Females:

b) Flagellum almost always with at most 2 subquadrate preapical flagellomeres (Fig.

39), or rarely with 3 or 4 subquadrate preapical flagellomeres.

.....13

- **Both sexes:**

A) Specimen from temperate regions of North America east of Alberta as far north as the northern limit of sugar maples, *Acer saccharum* Marsh.

Female:

B) Flagellum usually with 3–7 subquadrate preapical flagellomeres (Fig. 38), rarely with 1 or 2 subquadrate preapical flagellomeres (23% of specimens of *P. pseudopallipes* only).

.....14

13(12–16) Both sexes:

a) Specimen from the boreal and montane regions of North America where *Lygus* has only one, or a small or occasional second generation**.**

Female:

b) Flagellum with 18 or fewer flagellomeres (if with 19 or more flagellomeres, see next character).

c) Medial length of metasomal tergum less than 475 μm (if between 475 μm and 500 μm, see next character).

d) Maximum head width including outer eye margins, less than 670 μm (if between 670 μm and 710 μm, see next character).

e) Maximum head width behind eyes, MxGW, less than 635 μm (if between 635 μm and 660 μm, specimen cannot be identified with certainty).

Male:

b) With 20 or fewer flagellomeres (if with 21 or more flagellomeres, specimen cannot be identified with certainty).

[**Note:** the species occurs in boreal or montane zones and seems to be allopatric relative to *P. carcamoi*.]

.....*Peristenus otaniae* **n. sp.**

- **Both sexes:**

A) Specimen from temperate zone in southernmost Alberta and British Columbia and probably southward where *Lygus* has at least two full generations.

Female:

B) Flagellum with 21 or more flagellomeres (if with 20 or fewer flagellomeres, see next character).

C) Medial length of metasomal tergum more than 500 μm (if between 475 μm and 500 μm, see next character).

D) Maximum head width including outer eye margins more than 710 μm (if between 670 μm and 710 μm, see next character).

E) Maximum head width behind eyes more than 660 μm or more (if between 635 μm and 660 μm, specimen cannot be identified with certainty).

Male:

B) With 23 or 24 flagellomeres (if with 22 or fewer flagellomeres, specimen cannot be identified with certainty).

[**Note:** the species does not occur in boreal or montane zones and seems to be allopatric relative to *P. otaniae*.]

..... *Peristenus carcamoi* **n. sp.**

14(12)Both sexes:

a) Specimen reared from or collected at the time of **second** generation of *Lygus* nymphs.

Female:

b) Flagellum with 18 or fewer flagellomeres (if with 19 or 20 flagellomeres see next character).

c) Flagellum length less than 2,170 μm (if between 2,170 μm and 2,315 μm, see next character).

d) Medial length of metasomal tergum 1 relative to its maximum width less than 1.59 (if between 1.59 and 1.75, see next character).

e) Length of flagellum relative to maximum width of head between outer eye margins less than 2.52 (if between 2.52 and 2.65, next other character).

f) Minimum width of metasomal tergum 1 more than 140 μm, (between 120 μm and 140 μm, specimen cannot be identified with certainty).

Male:

b) Flagellum with 21 or fewer flagellomeres (if with 22 or 23 flagellomeres, see other character).

c) Medial length of metasomal tergum 1 relative to its maximum width less than 1.59 (if between 1.59 and 1.75, see other character).

d) Length of flagellum relative to maximum width of head between outer eye margins less than 3.43 (if between 3.43 and 3.60, see other character).

e) Minimum width of metasomal tergum 1 more than 135 μm (if between 120 μm and 135 μm, see other character).

f) Maximum width of metasomal tergum 1 relative to its minimum width less than 2.04 (between 2.04 and 2.24, see other character).

g) Width of stigma less than 195 μm (if between 195 μm and 210 μm, specimen cannot be identified with certainty).

[**Range:** temperate eastern North America from southernmost Quebec to Georgia.]

..... *Peristenus pseudopallipes* (Loan)

- **Both sexes:**

A) Specimen reared from or collected at the time of **first** generation of *Lygus* nymphs.

Female:

B) Flagellum with 21 or more flagellomeres (if with 20 or 19 flagellomeres, see next character).

C) Flagellum length more than 2,315 μm (if between 2,170 μm and 2,315 μm, see next

character).

D) Medial length of metasomal tergum 1 relative to its maximum width more than 1.75 (if between 1.60 and 1.75, see next character).

E) Length of flagellum relative to maximum width of head between outer eye margins more than 2.65 (if between 2.52 and 2.65, see next character).

F) Minimum width of metasomal tergum 1 less than 120 μm (between 120 μm and 140 μm, specimen cannot be identified with certainty).

Males:

B) Flagellum with 24 or more flagellomeres (if with 23 or 22 flagellomeres, see next character).

C) Medial length of metasomal tergum 1 relative to its maximum width more than 1.74 (if between 1.57 and 1.74, see next character).

D) Length of flagellum relative to maximum width of head between outer eye margins more than 3.60 (if between 3.43 and 3.60, next other character).

E) Minimum width of metasomal tergum 1 less than 120 μm (if between 120 μm and 135 μm, see next character).

F) Maximum width of metasomal tergum 1 relative to its minimum width more than 2.24 (if between 2.04 and 2.24, see next character).

G) Width of stigma more than 210 μm (if between 195 μm and 210 μm, specimen cannot be identified with certainty).

[**Range:** temperate regions of eastern North America from southernmost Quebec to Georgia]

..... *Peristenus mellipes* (Cresson)

15(11)a) Specimen reared from or collected at the time of **second** generation of *Lygus* nymphs.

[**Range:** temperate eastern North America from southernmost Quebec to Georgia.]

..... *Peristenus pseudopallipes* (Loan)

- A) Specimen reared from or collected at the time of **first** generation of *Lygus* nymphs.

..... 16

16(15)Both Sexes:

a) Range in temperate regions of eastern North America.

Female:

b) Flagellum with 4–6 subquadrate preapical flagellomeres (if with 3, see next character).

c) Length relative to width of first preapical flagellomere less than 1.07 (if between 1.07 and 1.18, see next character).

d) Length relative to width of second preapical flagellomere less than 1.10 (if between 1.11 and 1.21, see next character).

e) Distance between lateral and median ocelli less than 65 μm (if between 65 μm and 75 μm, specimen cannot be identified with certainty).

[**Range:** temperate eastern North America from southernmost Quebec to Georgia.]
..... *Peristenus mellipes* (Cresson)

- **Both sexes:**

A) Range west of Manitoba, or in boreal regions east of Saskatchewan.

Female:

B) Flagellum with 0–2 subquadrate preapical flagellomeres (if with 3, see next character).

C) Length relative to width of first preapical flagellomere more than 1.18 (if between 1.07 and 1.18, see next character).

D) Length relative to width of second preapical flagellomere more than 1.20 (if between 1.11 and 1.21, see next character).

E) Distance between lateral and median ocelli more than 75 µm (if between 65 µm and 75 µm, specimen cannot be identified with certainty).

..... 13

17(10)a) Specimen reared from or collected at the time of the **first** generation of *Lygus* nymphs.

..... 18

- A) Specimen reared from or collected at the time of the **second** generation of *Lygus* nymphs.

..... 19

18(17)Female:

a) Flagellum with 4–6 subquadrate preapical flagellomeres (if with 2 or 3, see next character).

b) Width of stigma less than 195 µm (if between 195 µm and 208 µm, see next character).

c) Length of flagellum relative to maximum width of head between outer margins of eyes less than 2.51 (if between 2.51 and 2.59, specimen cannot be identified with certainty).

Male:

a) Male unknown.

[**Note:** as far as known the ranges of *P. gillespiei* and *P. howardi* do not overlap. In a sample of many specimens, the forewing vein r is usually (80% of specimens) lacking in *P. howardi* and mostly (95% of specimens) developed in *P. gillespiei*. **Range:** central Idaho and western Washington.]

..... *Peristenus howardi* Shaw

- **Female:**

A) Flagellum with 0 or 1 subquadrate preapical flagellomeres (if with 2 or 3 preapical flagellomeres, see next character).

B) Width of stigma more than 208 µm (if between 195 µm and 208 µm, see next character).

C) Length of flagellum relative to maximum width of head between outer margins of eyes more than 2.59 (if between 2.51 and 2.59, specimen cannot be identified with certainty).

Male:

A) Male known (25% of specimens).

[**Note:** as above. **Range:** along the Pacific coast as far east as the Okanagan valley from the southern third of British Columbia to California.]

..... *Peristenus gillespiei* **n. sp.**

19(17)Female:

a) Flagellum with 4–6 subquadrate preapical flagellomeres (if with 2 or 3, see next character.

b) Length of gena less than 210 μm (if between 210 μm and 230 μm, see next character).

c) Length of radial cell less than 195 μm (if between 195 μm and 215 μm, specimen cannot be identified with certainty).

Male:

a) Male unknown.

[**Note:** as below. **Range:** central Idaho and western Washington.]

..... *Peristenus howardi* Shaw

- **Female:**

A) Flagellum with 0 or 1 subquadrate preapical flagellomeres (if with 2 or 3, see next character).

B) Length of gena more than 230 μm (if between 210 μm and 230 μm, see next character).

C) Length of radial cell more than 215 μm (if between 195 μm and 215 μm, specimen cannot be identified with certainty).

Male:

A) Male known (30% of specimens).

[**Note:** outside the range of *P. howardi*, all specimens can be correctly identified. However, in the range of *P. howardi*, all males and almost all females can be correctly identified after studying characters A, B and C above. **Range:** southwestern Alberta to coastal British Columbia, south to Oregon and Nevada.]

..... *Peristenus broadbenti* **n. sp.**

Leiophron Nees

Diagnosis: Head without medial carina between antennal sockets and median ocellus. Tergum 2 of metasoma rounded above spiracle (Figs. 1–3). Subbasal cell of hind wing narrow: vein 1M 2.0–3.0 times as long as vein cu-a (Fig. 65). Radial cell of forewing usually less than 0.5 times maximum width of stigma (Figs. 50, 51, 55, 56).

For the following characters, there are numerous exceptions in tropical regions. The

following applies to adults of almost all species in temperate and boreal regions of the northern hemisphere. Tergum 1 of metasoma with lateral margins not meeting ventrally (Fig. 69). Wing densely pubescent except in basal cell and surface of 1st submarginal of most species of temperate and boreal regions (Figs. 50, 51, 53).

The occipital carina development mentioned in Shaw (1997) is variable and is not used further.

This is a large worldwide genus, but females of only a few species attack Miridae.

***Leiophron australis* n. sp.**
(Figs. 2 habitus, 13, Table 1)

Type material. Type locality: USA, New York, Greene Co. Holotype, female (USNM), labelled: [White] "USA: NY, Greene Co., Host col.: 14.VI. 1995 Em.: 21.VI.1996 W.H. Day"; [White] "Ex: Lygus lineolaris (Palisot)"; [Red] "HOLOTYPE Leiophron australis Goulet" Condition: excellent. Allotype male labelled: "USA, Delaware, Newark, 22.VII.1982".

Origin of species name. Word derived from Latin meaning "southern". This species is the most southerly species included here.

Diagnosis. Forewing vein RS+M developed, head and thorax reddish brown, and lateral margins of metasomal tergum 1 almost parallel.

Description. FEMALE. Colour. Body generally reddish brown except for small black spot anterior to ocelli; propodeum, metanotum and metasomal tergum 1 brown (Fig. 42), and face and clypeus dark straw coloured (as in Fig. 13) (metasomal tergum 3 is as pale as preceding tergum, but appears brown due to telescoping of the more apical segments under it). Appendages straw coloured except apical third of flagellum fading to brown (Fig. 2). Forewing clear except for two dark coloured bands aligned with 1st discal cell and below apical 0.7 of stigma (apical band fading to clear toward apex) (Fig. 2); radial cell clear, but surrounded by apical dark band. Wing veins light straw coloured, but brown on 1M, 1cu-a, RS R1 and RS+M and on apical 0.7 of stigma.

Structure. Flagellum with 13 flagellomeres. Clypeus with two short and sharp teeth along anterior margin near middle (as in Fig. 14). Length of gena behind eye 1.1 times as long as length of eye. Height of eye 1.8 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal to maximum head width at eye level. Occipital carina either absent in dorsal 0.3 or abruptly reduced to a trace in dorsal 0.3. Mesoscutellar fovea about 2–3 times as wide as long and with 4 septa (as in Fig. 40). Metasomal tergum 1 with lateral margins almost parallel (posterior margin 1.3 times as wide as narrowest width near base), long (length 2.8 times maximum width), and almost meeting ventrally in anterior 0.3. Radial cell near stigma, and forewing vein RS+M developed (as in Fig. 51). Basal cell of forewing with 0–3 setae, clearly less densely setose

than 1st discal cell (as in Fig. 53). Veins 1CU and 1m-cu not usually developed, or if developed then 1st discal cell almost triangular because vein 1m-cu about 0.2 times as long as vein RS+M. Radial cell 0.5 as long as width of stigma (as in Fig. 55). Subbasal cell of hind wing narrow: vein 1M 3.0 times as long as vein cu-a (as in Fig. 65).

Sculpture. Punctures on vertex, frons and mesoscutum about 10 μm in diameter (similar to diameter of ommatidia). Punctures 20–30 μm apart on vertex and frons, 30–60 μm apart on mesoscutum, and 60–80 μm apart on mesopleuron. Clypeus generally glabrous except for row of long setae along anterior margin. Notaulus not outlined in anterior half (as in Fig. 41). Metasomal tergum 1 with about 6 longitudinal ridges.

Frons and anterior region of vertex with very lightly impressed meshes. Mesoscutum with transverse, barely outlined, ridges medially in posterior one quarter. Mesopleuron with weakly outlined parallel ridges slanted downward. Remaining body surfaces smooth.

MALE. Colour. As in female, except propodeum, metanotum and metasomal tergum 1 as pale as body.

Structure. Clypeal anterior margin without teeth near middle (Fig. 13). Height of eye 1.2 times as long as minimum distance between inner eye margins. Tergum 1 of metasoma with sides little divergent (maximum width 1.4 times as long as minimum width), and long (length 2.6 times maximum width). Otherwise structure and sculpture as in female.

Taxonomic notes. This species belongs to the *L. maculipennis* (Ashmead) group as defined by Loan (1974a), based on the shared presence of forewing veins RS+M and the lack of forewing veins 1CU, m-cu and 2RS. Within this group, *L. australis* is closest to *L. maculipennis* because both species share the reduced number of flagellomeres (12 or 13 in females, and 14 or 15 in males) and the lack of submedial teeth on the anterior margin of the clypeus in males. In adults of *L. maculipennis*, flagellomere 1 is short (2.3 times as long as wide), 4–5 preapical flagellomeres are as wide as or wider than long, and the flagellum is completely straw coloured. Freshly collected adults of *L. maculipennis* are darker with a brown metasoma and the body is similarly coloured in both sexes. In *L. australis* flagellomere 1 is long (2.7–3.0 times as long as wide), no preapical flagellomeres are as wide as long, and the flagellum fades to brown in the apical third. Adults are paler with a straw coloured metasoma and the propodeum is brown in females and straw coloured in males.

Adults of *L. australis* differ from those of *L. lygivorus* (Loan) and *L. uniformis* (Gahan) by the body colour pattern and forewing venation.

Adults of *L. australis* differ from those of *L. simoni* by the forewing veins 1CU, m-cu and 2RS, the size of the radial cell relative to the stigmal length, notauli development, and the anterior mesoscutellar fovea proportions. A summary of measurements of *L. australis* is given in Table 1. Because only one male and one female are known, the measurements are not discussed further.

Host and biological notes. The host is *Lygus lineolaris*. The species must be bivoltine as one specimen was collected from a nymph in mid-June from the first nymphal

generation and a second specimen was collected from a nymph in late July from the second nymphal generation.

Material examined and range. Warm temperate regions along the Atlantic coast of the United States (DE and NY). Two reared specimens (1♂ and 1♀) were studied.
USA. NY: Greene Co., (1♀; USNM). **DE:** Newark, 22.VII.1982 (1♂; USDA).

Leiophron lygivorus (Loan)
(Figs. 1 habitus, 14, 28, 34, 35, 40, 50, 53, 55, 64, 65, 69, Table 2)

Euphoriana lygivora Loan, 1970: 193–194. Type locality: Canada, Ontario, Fuller. Holotype, female (CNCI), labelled: [White] "Fuller, Ont., lat. 44º24'N long. 77º25'W C. C. Loan 14.VIII.1969"; [Red] "HOLOTYPE *Leiophron lygivora Loan* CNC No. *11588*". Condition: left antenna, left wings, left mid leg above mesocoxa, and hind leg missing. Loan (1974a) added information not on the original label: "14.VIII.1969 is the emergence date, host *Lygus lineolaris*, nymphs collected on 21.VIII–6.IX.1968 on *Solidago canadensis*".

Leiophron trigonotylidis Loan, 1974a: 834. Type locality: Canada Ontario, VI concession Sidney Township at highway 15. Holotype, female (CNCI), labelled: [White with black edge] *Sidney VI at # 15 2-VI-70*; [White with black edge] *Ex Red clover*; [Red] HOLOTYPE *Leiophron trigonotylidis Loan* CNC No. *13147*. Condition: excellent, though protarsomeres 4 and 5 broken off and glued to right tarsus. In Loan's description, the date was incorrectly recorded as "3.VI.1970". **NEW SYNONYMY**.

Diagnosis. Vein RS+M absent, head and almost all of thorax very light reddish brown, posterior half of discal area of mesoscutum with deeply outlined and irregular transverse microsculpture, most males with 15 flagellomeres.

Description. FEMALE. Colour. Body generally very light reddish brown (Fig. 1); small black spot anterior to ocelli (Fig. 14); propodeum, metanotum and, in many specimens, on metasomal tergum 1 brown (Fig. 1); face and clypeus straw coloured (Fig. 14) (metasomal tergum 3 is as pale as preceding tergum, but appears brown due to telescoping of the more apical segments under it). Appendages straw coloured (Fig. 1); brown on mesotarsomere 5, metatarsomere 5 and in apical 0.5 of metatibia; flagellum fading to brown in apical half. Forewing clear except for two lightly coloured bands (in old specimens bands not visible) aligned with 1st discal cell and below apical 0.7 of stigma (Figs. 1, 50, 55) (apical band fading to clear toward apex); radial cell clear but surrounded by apical dark band. Veins light straw coloured except for brown on forewing veins 1M, 1cu-a, RS and R1, and on apical 0.7 of stigma.

Structure. Flagellum with 13 (87% of specimens) or 14 (13% of specimens) flagellomeres. Clypeus with two short and blunt teeth along anterior margin near middle (Fig. 14). Length of gena behind eye 1.2–1.6 times as long as length of eye. Height of eye 1.4–1.6 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal (0.98–1.02) to maximum head width at eye level. Occipital carina in dorsal 0.3 developed or reduced gradually (often outlined with transverse and

parallel microsculpture on gena near carina). Mesoscutellar fovea about 2–3 times as wide as long and with about 2–8 septa (Fig. 40). Metasomal tergum 1 with lateral margins slightly convergent (posterior margin 1.3–1.7 times as wide as narrowest width near base), elongate (length 2.3–2.6 times as long as maximum width), and not meeting ventrally in anterior 0.3 (Fig. 69). Vein RS+M absent or at most a stub. Basal cell of forewing with about 10–40 setae usually restricted to apical 0.5 of cell (Figs. 50, 55), clearly less setose than 1st discal cell (Fig. 53). Subbasal cell of hind wing narrow: vein 1M 3.0 times as long as vein cu-a (Fig. 65).

Sculpture. Punctures on vertex, frons and mesoscutum about 10 μm in diameter (similar to diameter of ommatidia). Punctures 20–60 μm apart on vertex and frons, 30–60 μm apart on mesoscutum, 60–80 μm apart on mesopleuron except posteroventrally where often 10 μm apart, as on face and legs. Clypeus generally glabrous except for row of long setae along anterior margin. Notaulus not outlined in anterior 0.5 or outline suggested by wide impression (Fig. 40). Metasomal tergum 1 with about 6–8 longitudinal ridges, but these anastomosing distally and forming a puncture-like sculpture (as in Fig. 67).

Frons and anterior portion of vertex usually with clearly outlined isodiametric meshes of microsculpture (about 7 μm in diameter), sculpticels slightly convex. Discal portion of mesoscutum in posterior half with microsculpture forming irregular transverse and convex ridges (Fig. 40). Ventral 0.5 of mesopleuron punctate or with parallel ridges slanted downward anteriorly and slanted horizontally posteriorly, in few specimens a mixture of both types of sculpture. Remaining body surface smooth or almost so.

MALE. Colour. Propodeum and posterior section of metathorax very light reddish brown.

Structure. Height of eye subequal to minimal distance between eyes: 0.98–1.1 times as long as minimum distance between inner eye margins. Otherwise colour, structure and sculpture as in female.

Taxonomic notes. Much time was spent trying to understand what was *L. trigonotylidis*. Adults simply could not be segregated from those of *L. lygivorus*. Loan (1970) thought that *L. lygivorus* was a univoltine species attacking the second generation of *Lygus lineolaris*, but Lachance *et al.* (2001) showed that it was a bivoltine species. Loan (1974a) thought that *L. trigonotylidis* was a univoltine species attacking *Trigonotylus caelestialium* (Kirkaldy) (Stenodemini) in early spring. It was not noted that all his type specimens, except for one that was reared, were field swept. A closer look at the reared specimen resolved this problem. The type series of *P. trigonotylidis* consists of two species. Except for the reared specimen, all others including the holotype belong to *L. lygivorus*. The reared specimen is *L. uniformis*. This last species has been recorded previously from *T. caelestialium*.

Specimens from La Corne in northern Quebec were included, despite a 500 kilometre gap to the next locality in southern Quebec and Ontario. We intensively sampled many sites from the Ottawa River to 160 km north of it over many years and failed to find this

species. This range is reminiscent of species associated with clay soils. Because of the number of specimens and the sex ratio observed in the sample, the La Corne specimens were collected probably at peak time of abundance. Adults of the population match perfectly the cycle of *P. otaniae*, a species clearly associated with *Lygus*. Despite the abundance of specimens of *Leiophron* in our sample, we failed to find any among the 20 dissected cocoons reared from *Lygus borealis*. Though, more field work is needed to better understand the La Corne population, it is best to include the population under *L. lygivorous*.

Adults of *L. lygivorus* are most similar to those of *L. uniformis* and differ by the microsculpture development on the posterior half of the mesoscutum disk, and the host range. A summary of measurement differences between *L. lygivorus* and *L. uniformis* is given in Table 2.

Adults of *L. lygivorus* differ from those of *L. australis* by the body colour pattern, and forewing venation. Because only one male and one female are known, the measurements in Table 1 are not discussed further.

Adults of *L. lygivorus* differ from those of *L. simoni* by the forewing venation, notauli development, and the anterior mesoscutellar fovea proportions. A summary of measurement differences between *L. simoni* and *L. lygivorus* is given in Table 3.

Host and biological notes. Reared specimens have been recorded only from *Lygus lineolaris*. Around Ottawa and southern Quebec adults occur from the third week of May to mid August and with two peaks of abundance from late May to mid June and early August. This is a bivoltine species (Lachance *et al.* 2001). It seems that sites with red clover yielded most of the specimens collected.

Material examined and range. 138 (50♂, 88♀) adults were studied. Of these, 67 were reared from Miridae and 71 were field collected. The species is known from cold temperate regions of eastern North America between North Dakota and Prince Edward Island.

CANADA. ON: 3 km E Fitzroy (3♀); Foxboro (1♀); Fuller (1♀); Guelph (30♂, 7♀); 5 km E Kinburn (4♂, 8♀); Marlborough Forest (1♀); 3 km SE Mountain (3♀); Ottawa, 45º23'28"N 75º42'52"W (3♂, 13♀; CNCI USNM); Ste. Catherine (1♂, 1♀); Sidney (3♂,13♀); Talbotville (1♀); Wallbridge (2♀; USNM). **PE:** Harrington (2♀). **QC:** 1 km N La Corne (6♂, 12♀); 4.5 km E Hemmingford (1♀); Hemmingford, James Fisher Road (1♀); Iberville (2♂, 3♀); Mt. St. Hilaire (1♀); Ste. Clotilde (1♂, 11♀). **USA. IA:** Ames (1♀; USNM). **ND:** Elk Point (1♀; USNM).

Leiophron simoni n. sp.
(Figs. 3 habitus, 42, 51, 56, Table 3)

Type material. Type locality: Canada, Quebec, vicinity of Dunham, 45°07'N 72°51'W. Holotype, female (CNCI), labelled: [White] “QUEBEC: Dunham (Missis[si]quoi),

vignoble L'Orpailleur ECORC/CRDH/Ag-cord"; [Red] "HOLOTYPE Leiophron simoni Goulet CNC No. 23473". Condition of holotype: perfect. Allotype, male, labelled as holotype. Paratypes all specimens studied mentioned under "Material examined and range".

Origin of species name. This species is named in honour of Simon Lachance who clarified the biology of several species of *Leiophron* and *Peristenus*. Simon was also the only person who reared this species.

Diagnosis. Forewing veins RS+M, 2RS, 1m-cu and 1CU spectral, notauli outlined by punctures in at least anterior half, propodeum, mesonotum and metanotum reddish brown to dark brown, wings clear, and anterior mesoscutellar fovea narrow (4–5 times as wide as long) with 5–8 septa.

Description. FEMALE. Colour. Head light reddish brown and face straw coloured; pronotum, light reddish brown, metasomal terga 2–8 brown (metasomal terga 4–9 are telescoped in and are brown to black, but are suspected to be reddish brown); surface near each ocellus, mesothorax, metathorax, propodeum and metasomal tergum 1 reddish brown to dark brown. Appendages straw coloured. Wings clear. Veins almost transparent except light reddish brown forewing veins 1M, C+Sc+R, 1A, RS and brown apical 0.7 of stigma (Fig. 56).

Structure. Flagellum usually with 13 and occasionally 14 flagellomeres. Clypeus with two short and blunt teeth along anterior margin near middle (as in Fig. 14). Length of gena behind eye 1.1–1.4 times as long as length of eye. Height of eye 1.5–1.7 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal (0.92–0.98) to maximum head width at eye level. Occipital carina completely but finely developed dorsally. Mesoscutellar fovea about 4–5 times as wide as long and with about 5–8 septa (Fig. 42). Metasomal tergum 1 in dorsal view with edges convergent (posterior margin 1.5–1.9 times as wide as narrowest width near base), quite short (length 1.6–2.0 times as long as maximum width), and margins clearly separated ventrally (as in Fig. 69). Veins RS+M, 1m-cu, 2RS, 1CU and 2CUa developed but rather clear and spectral (Fig. 51). Basal cell of forewing with about 10–20 setae, clearly less setose than 1st discal cell (Fig. 51). 1st discal cell mainly quadrate and vein 1m-cu about 0.5 of vein RS+M. Radial cell 0.25–0.35 as long as width of stigma. Subbasal cell of hind wing narrow: vein 1M 2.0 times as long as vein cu-a.

Sculpture. Punctures on vertex, frons (at side mainly), lower gena and mesoscutum about 5–7 μm in diameter (a little smaller than diameter of ommatidium). Punctures 20–50 μm apart on vertex, frons and on mesoscutum, and 10–15 μm apart on anterodorsal surface of mesopleuron. Clypeus glabrous except for row of long setae along anterior margin. Notaulus outlined at least in anterior half by row of punctures (15–20 μm). Metasomal tergum 1 with 6–8 longitudinal ridges.

Mesoscutellum with few punctures. Ventral 0.3 of mesopleuron in posterior 0.5 with parallel ridges slanted downward in most specimens, rarely smoother. Remaining body

surfaces smooth.

MALE. Colour. As in female.

Structure. Flagellum occasionally with 13 or usually 14 flagellomeres. Clypeus anterior margin without teeth near middle (as in Fig. 13). Height of eye 1.2 times as long as minimum distance between inner eye margins. Mesosomal tergum 1 of metasoma with sides convergent: maximum width 1.6 times as long as minimum width. Otherwise structure and sculpture as in female.

Taxonomic notes. This species belongs to Loan's (1974a) *L. occipitalis* (Muesebeck) species group as defined by the presence of forewing veins RS+M, 1CU, m-cu and 2RS and the small closed subbasal cell in the hind wing. The above veins are visible but very weakly outlined or spectral.

Within this group, the holotype of *L. brevipetiolatus* Loan is similar to specimens of *L. simoni*. In adults of both species, the wings are clear, the basal cell of the forewing has a few setae, and the postocellar length is shorter than the ocular-ocellar length. The specimen of *L. brevipetiolatus* has a reddish brown mesosoma, no notaulus over the mesoscutal disk; and a wide anterior mesoscutellar fovea (2.5 times as wide as long). The specimens of *L. simoni*, have a light reddish brown pronotum, a reddish brown to brown mesepisternum, and usually dark brown mesosnotum, metanotum and propodeum, a developed notaulus over the mesoscutum, and a narrow anterior mesoscutellar fovea (4–5 times as wide as long).

Adults of *L. simoni* differ from those of *L. lygivorus* and *L. uniformis* in body and forewing colour pattern, notauli development, proportion of mesoscutal fovea, and forewing venation. A summary of measurement differences between *L. simoni* and *L. lygivorus* or between *L. simoni* and *L. uniformis* is given in Table 3.

Adults of *L. simoni* differ from those of *L. australis* by the forewing development of veins 1CU, m-cu and 2RS, the notauli development in posterior half of mesoscutum, and proportions of the anterior mesoscutellar fovea. Because only one male and one female of *L. australis* are known, the measurements in Table 1 are difficult to compare with those of *L. simoni*. However, some means of *L. simoni* (i.e., the relative length of radial cell and stigmal width, the relative length of metasomal tergum 1 and its maximal width, and the relative distance between eyes and the height of the eye for each sex) differ by 4 to 7 standard deviations with the single measurement recorded for the male or female of *L. australis* and are very likely significant differences.

Though easily segregated from known Nearctic species, *L. simoni* is extremely similar to the European *L. deficiens* (Ruthe). Adults of the two species are similar in colour pattern and colour variation, in size range, in structure and in surface sculpture. At first the species seemed to be an accidental introduction from Europe. However in specimens of *P. simoni*, the apical half of the flagellum is mainly pale to reddish whereas in those of *P. deficiens* it is mainly brown to dark brown. There were no other observed differences. Both are known parasitoids of *Lygus* spp. and the life cycle of both species starts earlier in spring and also

sooner in early summer relative to that of parasitoid species normally associated with *Lygus* bugs. Based on field collected specimens, a portion of the adult activity period overlaps with that of *Lygus* spp. It is assumed that females of *L. deficiens* and *L. simoni* usually attack hosts other than *Lygus* nymphs. *Leiophron simoni* is bivoltine, as no other specimens were seen after late August. In mid summer *L. deficiens* was reared mainly from the second generation of *Lygus* nymphs, and most emerged without diapausing suggesting a third generation. *Leiophron deficiens* is a multivoltine species. Therefore, it is justifiable to describe *L. simoni* as new.

Most specimens of *L. simoni* come from sites in southern Quebec and eastern Ontario where wild and cultivated grapes grew in proximity. *Leiophron deficiens* is not associated with grapes.

Host and biological notes. Reared specimens have been recorded from *Lygus lineolaris*. Adults occur from mid May to late August. *L. simoni* is a bivoltine species with two generations a year.

Material examined and range. 52 (19♂ and 33♀) adults were studied. Of these, 5 were reared from Miridae and 47 were field collected. The species is recorded from southern Ontario and Quebec. Five specimens were reared.
CANADA. PE: Harrington (2♂). **QC:** Dunham (13♂, 21♀); Iberville (1♂, 6♀); vicinity of Riviere Ouelle (1♀); Ste. Clotilde (1♀). **ON:** Guelph (2♂, 3♀); London (1♀); Mountain (1♂).

Leiophron uniformis (Gahan)
(Figs. 36, 41, 67, Table 4)

Euphoriana uniformis Gahan, 1913: 433. Type locality: USA, Maryland, Hagerstown. Holotype, male (USNM), labelled: [White] "Hagerstown, Md., *18.vii.1912*" [White] "Webster No. *5967*" [Red] "Type No. *16351* USNM" [White and framed] "*Euphoriana uniformis* ♀ *Type Gahan*". Condition: right flagellum missing last flagellomere.
Leiophron trigonotylidis; Loan, 1974a: 834; (*ex parte*).

Diagnosis. Vein RS+M absent, head and thorax straw coloured, transverse microsculpture on posterior half of discal area of mesoscutum lacking or little developed, and males generally with 14 flagellomeres.

Description. FEMALE. Colour. Body generally very light reddish brown; in many specimens propodeum, metanotum and on metasomal tergum 1 brown (as in Fig. 1); face and clypeus straw coloured (as in Fig. 14) (metasomal tergum 3 is as pale as preceding tergum, but appears brown due to telescoping of the more apical segments under it). Appendages straw coloured (as in Fig. 1); brown on mesotarsomere 5 and metatarsomere 5; fading to brown in apical 0.5 of metatibia and in apical half of flagellum (as in Figs. 1, 34). Forewing clear except for two lightly coloured bands (in old specimens bands not

visible) aligned with 1st discal cell and below apical 0.7 of stigma (as in Figs. 1, 2, 50, 55) (apical band fading to clear toward apex); radial cell clear but surrounded by apical dark band. Veins light straw coloured except for brown on forewing veins 1M, 1cu-a, RS and R1, and on apical 0.7 of stigma.

Structure. Flagellum with 12 or 13 (99% of specimens) or, rarely, 14 (1% of specimens) flagellomeres. Clypeus with two short and blunt teeth along anterior margin near middle (as in Fig. 14). Length of gena behind eye 1.3–1.6 times as long as length of eye. Height of eye 1.3–1.5 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal (0.96–1.02) to maximum head width at eye level. Occipital carina in dorsal 0.3 developed or reduced gradually (often outlined with transverse and parallel microsculpture on gena near carina). Mesoscutellar fovea about 2–3 times as wide as long and with about 2–8 septa (Fig. 41 or as in Fig. 40). Metasomal tergum 1 with lateral margins slightly convergent (posterior margin 1.3–1.7 times as wide as narrowest width near base), elongate (length 2.3–2.6 as long as maximum width), and not meeting ventrally in anterior 0.3 (as in Fig. 69). Vein RS+M absent (as in Figs. 50, 55). Basal cell of forewing with 0–15 setae in apical 0.5 of cell, clearly less setose than 1st discal cell (as in Fig. 53). Subbasal cell of hind wing narrow: vein 1M 3.0 times as long as vein cu-a (as in Fig. 65).

Sculpture. Punctures on vertex, frons and mesoscutum about 10 μm in diameter (similar to diameter of ommatidia). Punctures 20–60 μm apart on vertex and frons, 30–60 μm apart on mesoscutum, 60–80 μm apart on mesopleuron except posteroventrally where often 10 μm apart, as on face and legs. Clypeus generally glabrous except for row of long setae along anterior margin. Notaulus not outlined in anterior 0.5 or outline suggested by wide impression (Fig. 41). Metasomal tergum 1 with about 6–8 longitudinal ridges, but these anastomosing in centre and forming a puncture-like sculpture (Fig. 67).

Frons and anterior portion of vertex very rarely with outlined isodiametric meshes of microsculpture (about 7 μm in diameter). Discal portion of mesoscutum in posterior half with microsculpture usually smooth or with a weak and restricted development of irregular transverse and convex ridges. Ventral 0.5 of mesopleuron smooth or with parallel ridges slanted downward anteriorly and more or less slanted horizontally posteriorly. Remaining body surface smooth.

MALE. Colour. Propodeum and posterior section of metathorax very light reddish brown.

Structure. Height of eye subequal to minimal distance between eyes: 0.89–1.0 times as long as minimum distance between inner eye margins. Otherwise, structure and sculpture as in female.

Geographical variation. Across most of its range except in the northeastern part of United States, the propodeum of females is as pale or almost as pale coloured as males. Many females are brown on the metanotum. From Virginia northward, the propodeum colour shifts from reddish brown to brown in females, and more males are brown on the

metanotum.

Taxonomic notes. Adults of *L. uniformis* occur in two sizes that are associated with host size (Day, 1990). Reared specimens from *Halticus bractatus* (Say) are smaller than those reared from *Lygus lineolaris* and *Adelphocoris lineolatus* (Goeze). The following measurements of *L. uniformis* females differ by more than 2 standard deviations between small and large hosts: maximum head width at level of eyes on average = 425 μm (1 SD = 9.8 μm) from *Halticus*, and 517 μm (1 SD=25.5 μm) from *Lygus* and *Adelphocoris*; maximum head width at level of genae on average = 432 μm (1 SD=9.9 μm) from *Halticus*, and 521 μm (1 SD=25.6 μm) for *Lygus* and *Adelphocoris*. The following measurements of *L. uniformis* males differ by slightly less than 1 standard deviation between small and large hosts: maximum head width at level of eyes on average = 400 μm (1 SD=20.3 μm) from *Halticus*, and 450 μm (1 SD=37.1 μm) for *Lygus* and *Adelphocoris*; maximum head width at level of genae on average = 403 μm and (1 SD=20.4 μm) from *Halticus*, and 466 μm (1 SD = 42.6 μm) from *Lygus* and *Adelphocoris*.

Adults of *L. uniformis* are most similar to those of *L. lygivorus*, and differ in the microsculpture development on the discal portion of the mesoscutum, the colour pattern on the propodeum in females, and the almost allopatric range (narrowly sympatric in southern Ontario). A summary of measurement differences between *L. lygivorus* and *L. uniformis* is given in Table 4.

Adults of *L. uniformis* differ from those of *L. australis* by the body colour pattern, and forewing venation. Because only one male and one female are known, the measurements in Table 1 are not discussed further.

Adults of *L. uniformis* differ from those of *L. simoni* by the forewing venation, notauli development, and the anterior mesoscutellar fovea proportions. A summary of measurement differences between *L. simoni* and *L. lygivorus* is given in Table 3.

Host and biological notes. Reared specimens have been recorded mainly from *Halticus bractatus*, but they have also been reared successfully from *Adelphocoris lineolatus*, *Lygus lineolaris*, *L. elisus* Van Duzee, *Trigonotylus caelestialium*, *T. tenuis* Reuter, and *Pseudatomoscelis seriatus* (Reuter). Adults occur from May until August. This is a bivoltine species with two generations a year.

Material examined and range. 287 (79♂, 116♀ and 102♂/♀) adults were studied. Of these, 208 were reared from Miridae and 78 were field collected. The species is known across the warm temperate regions of North America from southernmost Ontario to Mexico.

CANADA. ON: Foxboro (1♂); London (3♂, 10♀); Talbotville (1♂, 2♀). **USA. AZ:** Cochise Co., Huachuca Mtn. (1♀); Yuma (1♀; USNM). **CA:** Imperial Co., Calexico (12♂, 7♀; USNM); Imperial Co., Brawley (4♂, 4♀; USNM); Riverside Co. (2♂, 10♀; USNM); Riverside Co., San Jacinto (4♂, 4♀; USNM). **DE:** Newark (11♂, 13♀, 67; USDA). **KS:** Balwin (1♂; USNM); Garden City (1♂; USNM); Wellington (1♀; USNM). **LA:** Logansport (1♂; USNM). **MD:** Howard Co. (3♂; USNM); Montgomery Co., 4 mi S

Ashton (1♀; USNM); Beltsville (1♀; USNM); Cabin John (1♀; USNM); Funkstown (3♀; USNM); Glen Echo (1♀; USNM); Hagerstown (1♂; USNM); Patuxent (1♂; USNM). **MO:** Boone Co., Columbia (5♀; USNM). **MS:** St. Louis Co., St. Louis (1♀; USNM); Tunica Co., 3 mi N Tunica (2♂, 3♀; USNM). **NH:** Hillsboro Co., Milford (1♀; USDA). **NJ:** Moorestown (1♂, 4♀; USNM); Blairstown (21♂, 31♀, 35; USNM, USDA); Woodstown (1♂; USDA); Warren Co., Harmony Twp. (1♂; USDA). **NY:** Rensselaer Co., Coomer (1♂; USDA); Rensselaer Co., White Church (1♀;USDA); Tompkins Co., Ithaca (1♀); Washington Co. 43º10.362'N 73º30.025'W (2♂); Wayne Co. (2♂; USNM). **OH:** Lucas Co., Adams Twp. (2♀; USNM). **PA:** Carbon Co., Lake Harmony Lehigh Co., (1♂; USDA); Lynnville (1♂, 1♀;USDA); Walawana (1♀; USNM). **UT:** Karob (1♀; USNM). **MEXICO. TAM:** Tampico, Victoria Hwy (1♂; ITMM). "Flying over the country" (1♀; USNM).

Peristenus Foerster

Diagnosis: Head with medial carina between antennal socket and median ocellus (Fig. 79). Metasomal tergum 2 sharply folded above spiracle, separating tergum into medio- and laterotergites (the fold caused by break in the cuticle not only by a change in cuticle thickness) (Figs. 4–9, 77, 78). Hind wing subbasal cell large: vein 1M 0.9–1.7 times as long as vein cu-a (Fig. 66).

The following characters apply to specimens of almost all species. Metasomal tergum 1 with lateral margins meeting ventrally in basal 0.1–0.5 (Fig. 70). Fore wing with radial cell more than 0.5 times maximum width of stigma (Figs. 52, 57–63), and wing densely pubescent (Figs. 52, 54).

The occipital carina development mentioned in Shaw (1997) is variable and is not used further.

This is a large worldwide genus. All reared specimens are from Miridae.

***Peristenus digoneutis* group.** Adults show a wide range of colour patterns, but all have the occipital carina widely interrupted dorsally (this character may be hidden in some specimens with the head inclined upward) (Fig. 32). The three included species, *P. digoneutis*, *P. relictus* (Ruthe) and *P. rubricollis* (Thomson), were intentionally introduced and established for biological control of *Lygus* and *Adelphocoris* plant bugs.

Peristenus digoneutis Loan
(Figs. 6 habitus, 19, 25, 31, 32, 43, 45, 68, 77, 78, 79, 80, 81, 82, 84, 87, Table 5)

Peristenus digoneutis Loan, 1973: 273–274. Type locality: Poland, Dziekanow Lesny (near Warsaw). Holotype, male (Institute of Zoology, Polish Academy of Sciences, Warsaw), not seen.

Holotype reared from a nymph of *Lygus rugulipennis* Poppius, collected in 1969, and emerged in May 1970. Paratypes seen: 9 males and 4 females (CNCI and USNM).

Diagnosis. Mesoscutum densely punctuate, without occipital carina in upper third of head, metacoxa straw coloured, and flagellum with 17–19 flagellomeres in females, and 17–20 in males.

Description. FEMALE. Colour. Body colour variable. Typical specimens coloured as follows: head dark brown or black except for light reddish brown clypeus, face, and lower 0.3 of gena, and reddish brown along inner, upper and dorsal portion of outer margin of eye (Figs. 6, 19, 25, 84); mesosoma dark brown or black except for reddish brown or brown on posterodorsal corner of pronotum and anteroventral corner of mesepisternum (Fig. 45); metasoma brown, but paler at side and ventrally (Fig. 77). Rarely, body completely black, or body brown with head, prothorax and mesothorax light reddish brown. Legs, palpi and tarsomere 5 straw coloured (as in Fig. 11). Flagellum straw coloured at base becoming reddish brown in apical 0.3–0.6. Stigma brown and straw coloured in basal third (as in Fig. 60).

Structure. Flagellum with 17–19 flagellomeres (respectively 5%, 43% and 52% of 100 specimens) and flagellomeres enlarged in apical 0.5. Length of gena behind eye 0.9–1.1 times as long as length of eye. Height of eye 1.25–1.4 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal (0.94–0.96) to maximum head width at eye level. Occipital carina not developed in dorsal third or at most suggested by shallow transverse sculpture (Fig. 32). Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.0–2.9 times as wide as narrowest width near base), and elongate (medial length of tergum 1.4–1.8 times maximum width at posterior end) (Fig. 68). Radial cell length 0.8–1.1 as long as stigma length (as in Fig. 58). Forewing vein r lacking (as in Figs. 57, 59, 60) or vein rarely developed, and basal cell almost completely densely pubescent and about as densely pubescent as first discal cell.

Sculpture. Punctures on vertex, frons and mesoscutum about 7–15 μm in diameter (similar to diameter of ommatidia). Punctures 20–30 μm apart on vertex and 10–20 μm apart on frons, 15–30 μm apart on mesoscutum. Punctures on mesopleuron varying from almost completely smooth to very densely punctate. Clypeus generally glabrous except for row of long setae along anterior margin. Metasomal tergum 1 with about 10–12 longitudinal ridges, these commonly anastomosing on disc and forming a puncture-like sculpture (Fig. 68).

MALE. Colour. As in female, but body of males often paler.

Structure. Flagellum with 17 to 20 flagellomeres (respectively 1%, 35% 54% and 10% of 100 specimens) and flagellomeres narrow in apical half. Height of eye subequal (0.88–1.0) to minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Geographical variation. At the northern limit of its range (e.g., in southern Quebec and northern Germany) or in mountain regions (e.g., Austria), a few specimens with

complete black body have been found. In these regions, intermediate colour patterns are seen in many individuals.

Taxonomic notes. Adults of *P. digoneutis* have been confused with those of *P. rubricollis* (Thomson) (Loan 1973). Loan (1973) correctly segregated the two species on colour pattern and number of flagellomeres. In addition, the two species differ in the preferred mirid hosts and in their life cycle. A summary of measurement differences between *P. dignoneutis* and *P. rubricollis* is given in Table 5.

Adults of *P. digoneutis* differ from those of *P. relictus* in puncture development on the mesoscutum, face and leg colour, and the length of the radial cell. A summary of measurement differences between *P. digoneutis* and *P. relictus* is given in Table 5.

Host and biological notes. In Europe, *P. digoneutis* has been reared from several Stenodemini and Mirini species. The attack level is extremely low except for *Lygus* and *Adelphocoris* hosts (Haye *et al*. 2005). In North America, *P. digoneutis* has been reared mainly from nymphs of *Lygus lineolaris* and *Adelphocoris lineolatus* and only once from a nymph of *Leptopterna dolobrata* (Linnaeus). Adults have been recorded from May (late May in cold temperate regions) to September with peaks of abundance in early June and in late July (Loan and Bilewicz-Pawinska 1973). This is a bivoltine species.

Material examined and range. Over 6,800 adults were studied. Most specimens were left in cold storage. About 1,800 specimens were pinned and mounted, about 960 from Europe and 823 (339♂, 360♀ and 125♂/♀) from North America. We have included W. H. Day published records as "(WHD)" with no reference to the number of specimens (Day *et al*. 1998, 2000, 2003). We have seen many of these specimens and they were all correctly identified. Several attempts at introducing this species from Europe were made between 1979 and 1988. By 1984, it was certainly established at Warren Co., New Jersey. Day *et al.* (1990, 1998, 2000, 2003) recorded the history of its introduction into North America and its subsequent expansion. Based on specimens submitted by C. Pickett in 2003 this species was successfully established at two sites in California. In eastern North America, the species has been encountered within a rectangle formed by northern New Jersey, southern Quebec, Nova Scotia and southern Ontario. The northernmost record, Bois Francs, QC, is at the northern end of the sugar maple range at the southern fringes of the boreal ecozone.

CANADA. NS: near Berwick, 45º01.846'N 64º46.185'W (1♂). **ON:** London (6♂, 8♀); near Mountain, 45º02'02"N 75º27'10"W (2♂, 2♀); Ottawa (2♀). **QC:** near Bois Francs, 46º32'45"N 75º57'04"W (1♀); near Hemmingford, 45º02'41"N 73º31'54"W (20♂, 11♀); near Hemmingford, 45º00'56"N 73º32'11"W (57♂, 65♀); near Rivière Ouelle, 47º25.657'N 70º00.989'W (1♀); near Ste. Clotilde, 45º10'05"N 73º40'53"W (231♂, 230♀); near St. Cyrille-de-Wendover, 45º57.258'N 72º27.846'W (1♂). **USA. CA:** Sacramento Co., Sacramento (3♂, 3♀; CDA, CNCI); Santa Cruz Co., Harkins slough (1♀; CDFA). **CT:** Hartford Co., near Suffield (WHD); Lichtfield Co., near Bakers field (WHD). **DE:** New Castle Co., Newark (14 ♂/♀; USDA). **MA:** Franklin Co., near Deerfield (WHD); Hampden Co., near Agawam (WHD). **ME:** Kennebec Co., near E. Monmouth (WHD);

Oxford Co., near Fryeburg (WHD). **NH:** Belknap Co., near Belmont (WHD); Carroll Co., near E. Conway (WHD); Coos Co., near Twin Mountain (WHD); Grafton Co., near Orford (WHD); Hillsboro Co., near Milford (WHD); Merrimac Co., near Concord (WHD); Rockingham Co., near Epping (WHD); Strafford Co., near Madbury (WHD). **NJ:** Blairstown (2♂, 1♀, 76♂/♀; USDA); Branchville (1; USDA); Hamburg (3♂/♀; USDA); Newton (8♂, 8♀: USDA); Rancocas (9♂/♀; USDA); Squire Corner (1♂/♀; USDA); Vernon (1♂/♀; USDA); Woodstown (1♂, 3♂/♀; USDA); Gloucester Co., Aura (1♀; USDA); Morris Co., near Long Valley (WHD); Hunterdon Co., near Hampton (WHD); Mercer Co., near Pennington (WHD); Sussex Co., near Fredon (WHD); Warren Co., near Marksboro (WHD). **NY:** Albany Co., Albany (4♂, 3♀), Preston Hollow (WHD); Broome Co., near Itaska (WHD); Cataraugus Co., near Great Valley (WHD); Cayuga Co., near Scipio Center (WHD); Chenango Co., near Norwich (WHD); Clinton Co., near W. Chazy (WHD); Columbia Co., near Hudson (WHD); Cortland Co., near Marathon (WHD); Delaware Co., near Lake Placid (WHD); Dutchess Co., near Hibernia (WHD); Greene Co., near Coxsackie (WHD); Madisson Co., near Nelson (WHD); Oneida Co., near Paris station (WHD); Onondaga Co., near Pompey (WHD); Otsego Co., near Richfield Station (WHD); Rensselaer Co., 42º55.296'N 73º35.011'W (11♀), near Poestenkill (WHD); Saratoga Co., near Waterford (WHD); Schoharie Co., near N. Blenheim (WHD); Schuyler Co., near Burdett (WHD); Seneca Co., near Fayette (WHD); Steuben Co., near Bath (WHD); Sullivan Co., near Roscoe (WHD); Tioga Co., near Berkshire (WHD); Tompkins Co., Ithaca (1♀; CNCI), near Lansing (WHD); Washington Co., 43º10.362'N 73º30.025'W (1♀; CNCI); 42º21.221'N 73º32.365'W (3♂, 11♀), near Easton (WHD); Wyoming Co., near Silver Springs (WHD). **PA:** Bradford Co., near Terrytown (WHD); Carbon Co., near Beltzville (WHD); Columbia Co., near Benton (WHD); Luzerne Co., near Conyngham (WHD); Lycoming Co., near Calvert (WHD); Monroe Co., near Kresgville (WHD); Northampton Co., near Windgap (WHD); Northumberland Co., near Elysburg (WHD); Potter Co., near Brookland (WHD); Sullivan Co., near Dushore (WHD); Susquehanna Co., near Dundaff (WHD); Tioga Co., near Wellsboro (WHD); Wyoming Co., near Factoryville (WHD). **VT:** Bennington Co., near S. Schaftbury (WHD); Essex Co., near Lunebrug (WHD); Windham Co., near Vernon (WHD).

***Peristenus relictus* (Ruthe)**
(Figs. 8 habitus, 22, 44, 49, 57, Table 6)

Microctonus relictus Ruthe, 1856: 305. Type locality: Germany. Lectotype, female (BMNH), not seen, designated by Richards, 1967: 177, and labelled (based on Loan, 1974b): "Lectotype (British Museum (Nat. Hist.) lectotype label; B. M. Type Hym. 3C714; 59–101 Germany; 20; M. relictus Rut., Ruthe coll. 59–101; Microctonus relictus Ruthe 1856, ♀. Lectotype Richards 1966".
Leiophron relictus; Richards, 1967: 177.
Peristenus relictus; Loan, 1974b: 213.

Peristenus stygicus Loan, 1973: 272–273. Type locality: Poland, Dziekanow Lesny (near Warsaw). Holotype, female (Institute of Zoology, Polish Academy of Sciences, Warsaw), not seen. Paratypes seen: 9 males and 4 females (CNCI and USNM). Holotype reared from a nymph of *Lygus rugulipennis*, collected in 1967, and emerged in May 1969. Synonymy by Achterberg (2001: 378).

Diagnosis. Mesoscutum mostly impunctate and hind legs dark brown to black.

Description. FEMALE. Colour**.** Body black (Figs. 8, 22, 44, 49) occasionally with blackish red tinge on ventral surface of mesothorax or behind upper margin of eye. Leg colour variable. Typically: hind leg mainly dark brown with base of tibia reddish brown; mid leg with coxa, femur and mesotarsomere 5 brown, with tibia and tarsomeres 1–4 reddish brown; foreleg procoxa reddish brown with remainder of leg light reddish brown. In a few specimens legs either darker, with all coxae dark brown to black (Fig. 49), pro- and mesofemora and basal 0.5 of profemora dark brown, and tarsomere 5 of all legs brown, or paler with hind leg brown, and mid leg and forelegs light reddish brown. Scape, pedicel and flagellomeres 1, or 1 and 2 usually reddish brown, the following flagellomeres dark brown to black. Stigma dark brown and straw coloured in basal third.

Structure. Flagellum with 16–18 flagellomeres (respectively 8%, 74% and 18% of 100 specimens) and flagellomeres enlarged in apical 0.5. Length of gena behind eye 0.90–1.05 times as long as length of eye. Height of eye 1.2–1.3 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal (0.93–0.97) to maximum head width at eye level. Occipital carina not developed in dorsal 0.3. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 1.7–2.3 times as wide as narrowest width near base) and elongate (medial length of tergum 1.7–2.1 times maximum width at posterior end). Radial cell length 0.5–0.8 times as long as stigma width. Forewing vein r lacking, and basal half of basal cell sparsely pubescent, glabrous in spots and distinctly less pubescent than 1st discal cell.

Sculpture. Punctures on vertex from 10–15 μm to commonly 20–25 μm in diameter, frons and mesoscutum about 20–25 μm in diameter (a little smaller than diameter of ommatidia). Punctures 40–80 μm apart on vertex, 25–40 μm apart on frons, and 15–25 μm apart near antennal socket, 25–75 μm apart on anterior 0.3 of mesoscutum. Punctures on mesopleuron generally scattered or occasionally dense, forming a horizontal row and/or carina above mesocoxa. Clypeus generally glabrous except for row of long setae along anterior margin. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 17–19 flagellomeres (respectively 22%, 55% and 23% of 100 specimens) and flagellomeres narrow in apical 0.5. Height of eye 0.88–1.0 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. Adults of *P. relictus* differ from those of any known North

American species by the puncture development on the mesoscutum, and hind leg colour. A summary of measurement differences between *P. relictus* and *P. digoneutis* is given in Table 6.

Adults of *P. relictus* differ from those of *P. rubricollis* by puncture development on the posterior 0.7–0.8 of mesoscutum (Fig. 44), the face colour (Fig. 22), the spot development behind eye of females (Fig. 8), the head colour of males, and the leg colour (especially hind legs) (Figs. 8, 49). A summary of measurement differences between *P. relictus* and *P. rubricollis* is given in Table 6.

Host and biological notes. In Europe, adults of this species have been reared from nymphs of species from a wide variety of tribes and subfamilies of Miridae. Adults have been recorded from all species of *Lygus* studied. In North America, this species has been reared mainly from nymphs of *Lygus lineolaris* in the laboratory, and *Lygus shulli* Knight in the field in California. Adults occur from May to early September in Europe with peaks of abundance in early June and in late July. This is a bivoltine species.

Material examined and range. About 850 adults were studied. Of these, 565 were from Europe, 284 reared from laboratory colonies from Europe and North America and 31 reared (15♂, 16♀) from North America. There have been several attempts at establishing this species. C. H. Pickett proved its establishment in 2001 around Sacramento and in 2002 in Santa Cruz County. For the history of introduction into North America see Ball *et al*. (1999), Pickett *et al.* (1998, 2000, 2002). The species is known from three counties in California.

USA. CA: Monterey Co., Castroville (8♂, 8♀; CNCI, CDFA); Sacramento Co., Sacramento 38º35.607'N 121º29.519'W (4♂, 4♀; CNCI, CDFA); Santa Cruz Co., Harkins slough (4♂, 3♀; CNCI, CDFA).

Peristenus rubricollis (Thomson)
(Figs. 9 habitus, 20, 21, 23, 24, 29, 30, 46, Tables 7 and 8)

Euphorus rubricollis Thomson, 1891: 1749. Type locality: Sweden, Gualof. Lectotype, male (Zoological Institute, Lund, Sweden) not seen, designated by Loan (1974b) and labelled: "Glf. [= Gualof]; rubricollis (handwritten by Thomson).

Leiophron rubricollis; Shenefelt, 1969: 46.

Peristenus rubricollis; Loan and Bilewicz-Pawinska, 1973: 274.

Peristenus conradi Marsh, 1992: 484. Type locality: United States, Delaware, Newark. Holotype, female (USNM). Holotype reared from a nymph of *Adelphocoris lineolatus*, collected in May 27, 1988, and emerged in March 22, 1989. **NEW SYNONYM**.

Diagnosis. Mesoscutum densely punctate, without occipital carina in upper third of head, metacoxa light reddish brown to brown, and flagellum 21–24 flagellomeres in females and 20–24 in males.

Description. FEMALE. Colour. Body coloured as follows: head dark brown or black

except for light reddish brown clypeus and face (Fig. 20) and reddish brown spot behind eye in dorsal 0.3 (spot almost extended to occipital carina) (Figs. 23, 30); mesosoma dark brown or black (Fig. 46). Legs and palpi straw coloured except for brown tarsomere 5 and light reddish brown to dark brown metacoxa (Fig. 46). Flagellum straw coloured at base shifting to reddish brown in apical 0.3–0.6. Stigma brown except straw coloured in basal third (as in Figs. 57, 59, 60).

Structure. Flagellum with 21–24 flagellomeres (respectively 11%, 43%, 35% and 11% of 84 specimens) and flagellomeres enlarged in apical 0.5. Length of gena behind eye 0.90–1.05 times as long as length of eye. Height of eye 1.2–1.3 times as long as minimum distance between inner eye margins. Maximum width of head behind eyes subequal (0.93–0.97) to maximum head width at eye level. Occipital carina absent in dorsal third or at most suggested by transverse sculpture. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.0–2.3 times as wide as narrowest width near base) and elongate (medial length of tergum 1.6–1.9 times maximum width at posterior end). Radial cell 0.5–0.9 as long as stigma width. Forewing vein r lacking (vein RS at junction with vein r straight or angular), and basal cell almost completely densely pubescent and about as densely pubescent as 1st discal cell.

Sculpture. Punctures on vertex, frons and mesoscutum about 15–25 μm in diameter (similar to diameter of ommatidia). Punctures 40–80 μm apart on vertex and 15–25 μm apart on frons, 25–75 μm apart on mesoscutum. Punctures on mesopleuron densely punctate but smooth anteriorly. Clypeus glabrous or with few setae except for row of long setae along anterior margin. Metasomal tergum 1 with about 10–12 longitudinal ridges, these commonly anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. Body colour pattern distinctly paler than in female, with clypeus and face light reddish brown, and rest of head reddish brown except for black stripe from antennal sockets to occipital carina and on medial portion of occiput (Figs. 21, 24, 29). Prothorax and most of mesothorax reddish brown.

Structure. Flagellum with 20–24 flagellomeres (respectively 7%, 49%, 33%, 7% and 4% of 81 specimens) and flagellomeres narrow in apical 0.5. Height of eye 0.88–1.0 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. In North America, *P. conradi* was considered as specifically distinct from *P. rubricollis* because the North American population is parthenogenetic; only a few males are known. Are the two species specifically distinct?

Morphologically, all character states mentioned for *P. conradi* (e.g., generally darker colour pattern, forewing vein RS angular at junction with stigma, and notauli weakly indicated) fall within the range of variation of *P. rubricollis*, and statistical parameters are similar except that those of *P. conradi* show generally shorter linear measurements.

Biologically, both populations are univoltine on the first nymphal generation of *Adelphocoris* and *Lygus*, have a marked preference for *Adelphocoris* nymphs, and require

3–4 weeks (on average 23 days for *P. conradi*, and 30.8 days (SD 7.5 days based on 59 specimens) for *P. rubricollis* in southern Germany) to emerge after being warmed up to 20ºC. This is significantly longer than less than 2 weeks with typical univoltine *Peristenus* species associated with the first generation of *Lygus* nymphs.

However, the lack of structural differences is not proof enough to consider the two populations as conspecific.

In North America, W. H. Day (pers. com.) showed differences in number of days elapsed between diapause termination and adult emergence. Specimens of *P. conradi* and the European *P. rubricollis* emerged on average after 23 days from *Adelphocoris*. European *P. rubricollis* emerge after a markedly longer period when reared from *Lygus*. He concluded that the biology of *P. conradi* is different from that of the bisexual *P. rubricollis* as shown by the markedly greater number of days elapsed to emergence when *Lygus* nymphs are the hosts. Is the difference in emergence periods related to host size? Adults of *P. conradi* are quite clearly smaller than typical *P. rubricollis*. Perhaps larvae of *P. rubricollis* find it more stressful developing in smaller *Lygus* nymphs.

The flagellomere frequency distribution is also affected by host. Based on European specimens of *P. rubricollis*, the frequency distribution of the number of flagellomeres is highest at 22 in females and 21 in males for specimens reared from *Lygus* whereas this number is highest at 23 in females and 22 in males for specimens reared from *Adelphocoris* nymphs. In North America, almost all studied specimens of *P. conradi* were reared from *A. lineolatus*. Despite a large host, most North American females of this species have 22 flagellomeres.

What would happen if adults of *P. conradi* were exposed to males of *P. rubricollis*? Would the progeny simply reintegrate into the *P. rubricollis* gene pool? What type of progeny would unmated females of *P. rubricollis* produce in the absence of males? We consider that the *P. conradi – P. rubricollis* problem is not satisfactorily resolved. W. Day (pers. com.) tested for *Wolbachia*. There was no evidence of its presence, though it was found in *P. digoneutis*.

Day *et al.* (1998) discussed several examples of species with identical morphology that are bisexual in Europe and parthenogenetic in North America. The North American species were considered specifically distinct from their European population. There are also examples of other species that are bisexual in Europe, but parthenogenetic in North America and are considered conspecific (e.g., *Dolerus nitens* Zaddack (Hymenoptera: Tenthredinidae) (Goulet 1983) and *Eupelmus vesicularis* (Retzius) (Hymenoptera: Eupelmidae) (Gibson 1990)). At present, it is best to consider *P. conradi* as conspecific with *P. rubricollis*.

Adults of *P. rubricollis* have been confused with those of *P. digoneutis* Loan (Loan 1973). Loan (1973) segregated the two species on colour pattern and number of flagellomeres. In addition, adults of the two species differ in their preferred hosts (though both are associated with *Lygus*) and their life cycle. A summary of measurements differing

between *P. rubricollis* and *P. digoneutis* is given in Table 7 (for North American females) and Table 8 (for European males and females).

Adults of *P. rubricollis* differ from those of *P. relictus* by puncture development on the mesoscutum (as in Fig. 43), face colour (Figs. 20, 21), the spot development behind eye of females, and the head colour pattern of males, and the leg colour (Figs. 9, 46). A summary of measurement differences between *P. rubricollis* and *P. relictus* is given in Table 7 (for North American females) and Table 8 (for European males and females).

Host and biological notes. In North America and in Europe, *P. rubricollis* has been reared from species in two genera of Mirini, mainly nymphs of *Adelphocoris seticormis* (Fabricius) and *Adelphocoris* sp., and occasionally from those of *Lygus rugulipennis* and *Lygus* spp. In North America, this species has been reared from nymphs of *Adelphocoris lineolatus* and *Lygus lineolaris*. Adults occur from May to early July in North America (a few specimens were reared from nymphs of the second generation of *Adelphocoris* sp. in central Europe) with peak of abundance in early June. In North America, this is a univoltine species and in Europe it is almost completely univoltine. Loan and Bilewicz-Pawinska (1973) published the biology of this species.

Material examined and range. About 388 adults were studied including, 228 from Europe and 160 (2♂, 96♀, 62♂/♀) from North America. We have included W. H. Day published records as "(WHD)" with no reference to the number of specimens (Day *et al*. 1998, 2000). Most of these specimens were seen and they were all correctly identified. Several attempts at establishing this species were made between 1978 and 1990. By 1988, it was certainly established at Newark, Delaware. Day *et al*. (1992, 1998, 2000) summarized the history of introduction into North America and its subsequent expansion. The species has been encountered between northern Delaware and southern Quebec (Day *et al*. 2000; Broadbent *et al*. 1999).

CANADA. QC: near St. Constant (2♀). **USA. DE:** New Castle Co., Newark (2♂, 73♀, 51; CNCI, USNM, USDA). **NJ:** Blairstown (7♀, 1; USDA); Mt Holly (9♂, 8♂/♀; USDA); Rancocas (2♀, 2; USDA); Newton (1♀); Burlington Co., near Juliustown (WHD); Cumberland Co., Carmel (1♀; USDA); Gloucester Co., near Harrisonville (WHD); Middlesex Co., near Cranbury (WHD); Monmouth Co., near Marlboro (WHD); Salem Co., near Cohansey (WHD). **NY:** Dutchess Co., Hyde Park (WHD); Ulster Co., High Falls (1♀; USDA); Ulster Co., Wallkill (WHD).

***Peristenus pallipes* complex.** The following nine species of *Peristenus* on *Lygus* are native and part of a difficult species complex known from temperate and boreal regions of the Holarctic region. The complex is so diverse that most of its species are difficult to characterize as they could hardly be recognized on structures alone. Without detailed biological data from known hosts most of these species could not have been recognized.

Adults have a complete or almost complete occipital carina dorsally (Fig. 33), which distinguishes them from the three introduced species. They also are densely punctate on

the frons, and over all or most of the median lobes of the mesocutum. The flagellum is dark brown to black at least in its apical third, and it consists of 17 or more flagellomeres in females and 20 or more flagellomeres in males.

The nine species are divided into two groups based on puncture development on the frons, colour pattern of the metatibia, length of the flagellum, and minimum distance between eyes.

***Peristenus dayi* group.** This group consists of two species, *P. braunae* and *P. dayi*. Punctures are large and dense on the vertex between inner eye margin and lateral ocellus (Fig. 26). The metatibia is straw coloured or pale reddish brown and is at most darkened in apical 0.2–0.3, and metatarsomere 1 is straw coloured (Fig. 11). In females, the length of the flagellum relative to maximum width of head between the outer eye margins is above 2.78, and the height of the eye relative to minimum distance between the inner eye margins is below 1.23 in almost all specimens (Tables 9 and 10) (Fig. 17).

Peristenus braunae n. sp.
(Fig. 15, Table 9)

Type material. Type locality: Canada, Alberta, north of Twin Lakes. Holotype, female (CNCI), labelled: [White] "Canada: AB, N of Twin Lakes, 27.VI.2003, 639m 57º30.823'N 117º28.825'W Goulet, Carcamo & Otani"; [Red] "HOLOTYPE Peristenus braunae CNC No. *23474*" Condition of holotype: excellent. Allotype, male, with same data as holotype. Except for specimens from low elevation in coastal British Columbia, the remaining specimens, mentioned under "Material examined and range", are paratypes.

Origin of species name. This species is named in honour of Lorraine Braun who reared this species from *Lygus* and helped to clarify a difficult part of the *P. pallipes* complex.

Diagnosis. Clypeus black, punctures dense on head (between lateral ocellus and inner eye margin) and less dense on frons (surface smoother with shiny spaces between punctures), occurring in boreal region mainly after mid June.

Description. FEMALE. Colour. Head and mesosoma black, clypeus usually black, metasoma usually black, rarely brown. Legs straw coloured or light reddish brown (metacoxa commonly brown or black (as in Fig. 5), uncommonly straw coloured). Metatibia light reddish brown and apical half often gradually becoming reddish brown, thus concolorous or almost so (as in Fig. 11). Metatarsomeres 1–5 as dark as apex of metatibia; palpi, tegula and mandible (except apex), straw coloured. Scape to flagellomere 2 straw coloured, then after flagellomere 3–4 brown to dark brown. Stigma uniformly dark brown or with a paler spot in basal half.

Structure. Flagellum with 19–22 flagellomeres (respectively 14%, 51%, 31% and 4% of 106 specimens) and flagellomeres enlarged in apical 0.5 with at most 2 preapical

flagellomeres quadrate or subquadrate. Genal length behind eye 1.00–1.31 times as long as length of eye. Height of eye 1.06–1.17 times as long as minimum distance between inner eye margins (as in Fig. 17). Maximum width of head behind eyes subequal (0.95–0.99) to maximum head width at eye level. Occipital carina developed in dorsal third (as in Fig. 33). Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 1.8–2.4 times as wide as narrowest width near base) and elongate (medial length of tergum 1.63–2.00 times as long as maximum width at posterior end) (as in Fig. 68). Radial cell length 0.83–1.00 as long as stigma width (as in Figs. 58–63). Forewing with vein r usually developed and short (as in Figs. 61, 62) and basal cell (except extreme base) pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, and on frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex and 5–15 μm apart on frons (thus, in most specimens with shiny surface between punctures) and between lateral ocellus and inner eye margin (as in Fig. 26), 5–10 μm apart near antennal socket, 20–25 μm apart on mesoscutum. Punctures in front of median ocellus in most specimens coarsely and densely punctate. Punctures on mesopleuron dense and in most specimens coarsely punctate on anteroventral surface of mesepisternum in lateral view. Clypeus generally impunctate or mostly so over surface, or occasionally densely punctate. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. Generally as in female, but metacoxa usually brown, sometimes brown on outer surface and paler on inner and ventral or, rarely completely straw coloured.

Structure. Flagellum with 21–24 flagellomeres (respectively 29%, 54%, 14% and 3% of 56 specimens) and flagellomeres narrow in apical half. Height of eye 0.91–1.00 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Geographical variation. There are a few differences between specimens from western and eastern Canada. In the West, the mesocoxae are often reddish brown to black and the clypeus is almost always smooth or a little punctate. In the East, the mesocoxae are straw coloured to light reddish brown and the clypeus is normally punctate. In specimens from coastal British Columbia, the flagellomere frequency distribution is higher, with most specimens from coastal regions having 21 flagellomeres in females, 22 or 23 in males. The coastal British Columbia sample is small (19 female and 12 male flagella counted) so it is unclear if the population is a geographical variant of *P. braunae* or another cryptic species. Because of this character variation, specimens from coastal regions of the Pacific were excluded from the paratype series.

Taxonomic notes. Among the species of the *P. pallipes* complex associated with *Lygus*, *P. braunae* is nearest *P. dayi*. Adults of the two species differ on flagellomere frequency, mesocoxa and metacoxa colour in females, clypeus and mesepisternum puncture development, and flight period.

The nearest populations of *P. braunae* to those of *P. dayi* are 300 km apart. The populations of *P. braunae* nearest to those of *P. dayi* are not more similar than distant populations of both species. There is probably no gene flow. Thus, the boreal population of *P. braunae* is specifically distinct from the eastern temperate *P. dayi*. A summary of measurement differences between *P. braunae* and *P. dayi* is given in Table 9.

Host and biological notes. Adults of this species have been reared mainly from *Adelphocoris lineolatus* and rarely from *Lygus lineolaris*. Adults occur from early June to mid August with a peak of abundance from late June to early July. This is a univoltine species on nymphs of the first generation of *Lygus*.

Material examined and range. 167 (62♂, 105♀) adults were studied. Of these, 7 were reared from Miridae and 156 were field collected. The species is known from boreal regions of North America between the Northwest Territories and Alaska to southwestern British Columbia, south to montane regions of California and Utah and coastal regions of New Brunswick and Nova Scotia.

CANADA. NT: Aklavik (1♀); Norman Wells (1♀); Wrigley (1♀); **NS:** Cape Breton Highlands Nat. Park, Meat Cove (1♀); Sable Island (1♂); Yarmouth (1♂, 1♀). **NB:** Kouchibouguac Nat. Park (5♂, 3♀). **QC:** vic. Frelighsburg, 45º05'N 72º50'W (1♂); vic. La Corne, 48º24'19"N 78º00'12"W (1♂, 13♀) ; La Vérendrye Prov. Park, 47º36'57"N 77º33' 42"W (15♂, 8♀); Matagami, 49º45'08"N 77º37'14"W (5♂, 5♀). **MB:** Brandon (1♀). **SK:** E lbow (2♀); vic. Saskatoon, 52º09.1'N 106º34.9'W (1♂). **AB:** Banff (1♂); Beaverlodge, Mountain Trail (2♂, 3♀); Blairmore (1♀); Burmis (1♂, 1♀); Dunvagan (1♂, 1♀); Gilchrist Beach, Aden (1♀); N of Grande Cache, between 54º09'N 118º45'W and 54º34'N 118º42'W (1♂, 3♀); 1 km E Jasper Nat. Park, 53º14.138'N 117º49.418'W (1♂); vic. La Crete, 58º01.257'N 116º19.621'W (1♂); Lethbridge (3♂, 18♀); Lethbridge, 49º42.279'N 112º44.951'W (1♀); Long view, 50º24.335'N 114º31.028'W (2♀); Milk River, 49º08'N 110º48'W (1♀); Oyen (1♀); Saskatoon Mtn., 55º13.204'N 119º17.042'W (3♂, 4♀); Shaunessey (1♂); Tompcam's Landing, 57º59.034'N 117º06.291'W (1♀); vic. Twin Lake, 57º30.823'N 117º28.825'W (2♂, 4♀); Waterton Lakes Nat. Park, Cameron Lake (1♀); Waterton Lakes Nat. Park, 1300 m (4♀). **BC:** 15 km N Boston Bar, 49º58'39"N 121º29'49"W (4♂, 4♀); 20–25 km E Chilliwack Lake Rd. (1♀); Cowichan Lk. (1♀); Crownest (1♂, 1♀); Diamond Head trail near Squamish (1♀); Fort St. John (1♂); Harrison Bay (1♀); vic. Langley (4♀); vic. Lytton, 50º31'20"N 121º43'57"W (1♀); vic. Lytton, 50º14'38"N 121º34'35"W (1♀); Madden Lake, Oliver (2♀); Saltspring Is. Tuam Mtn. (1♂); Summit Lake, mi 392 Alaska Hwy. (1♀). **USA. AK:** Fairbanks (1♀). **CA:** Nevada Co., Sagehen Cr., 13 km W Truckee (1♂). **CO:** Doolittle Ranch (1♂, 2♀); Estes Park (3♂); 3 km S Meeker (2♂, 2♀). **UT:** Summit Co., Cobble Cr. (1♀).

***Peristenus dayi* n. sp.**
(Figs. 5 habitus, 11, 17, 26, Table 10)

Type material. Type locality: Canada, Ontario, Guelph. Holotype, female (CNCI), labelled: [White] "Canada, Ontario, Guelph Conc. 2, 20.VI.1998 ex: Adelphocoris lineolatus nymphs 4 & 5 [Emergence date] 27.III.1999, S. Lachance"; [Red] "HOLOTYPE Peristenus dayi CNC No. 23475" Condition of holotype: Perfect. Allotype male from the same locality but reared on June 16, 1999. Paratypes: all specimens mentioned under "Material examined and range".

Origin of species name. This species is named in honour of W. H. Day who helped clarify the biology and taxonomy of several species of *Leiophron* and *Peristenus* through rearing. This was the only species he studied that was unnamed.

Diagnosis. Clypeus black, punctures dense on head (especially between the lateral ocellus and the inner eye margin) and on frons (surface matt with few shiny spaces between punctures), occurring in temperate regions of eastern North America and before mid June.

Description. FEMALE. Colour. Head and mesosoma black; clypeus usually reddish black or dark brown, rarely black; metasoma usually black, rarely brown. Legs straw coloured (metacoxa almost always straw coloured or brown on dorsal surface). Metatibia usually light reddish brown and apical half occasionally reddish brown, thus almost always concolorous. Metatarsomeres 1–5, metatibia. Palpi; tegula and mandible, except apex, straw coloured. Scape to flagellomere 2 straw coloured, flagellomere 3 or 4 brown and dark brown from 5–9. Stigma uniformly dark brown or with a paler cloud in basal third.

Structure. Flagellum with 20–23 flagellomeres (respectively 13%, 48%, 37% and 2% of 60 specimens) and flagellomeres enlarged in apical half, with at most 2 preapical flagellomeres quadrate or subquadrate. Length of gena behind eye 0.87–1.14 times as long as length of eye. Height of eye 1.06–1.21 times as long as minimum distance between inner eye margins (Fig. 17). Maximum width of head behind eyes subequal (0.94–0.98) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 1.9–2.5 times as wide as narrowest width near base) and elongate (medial length of tergum 1.61–1.91 times maximum width at posterior end). Radial cell length 0.87–1.06 as long as stigma width (as in Figs. 58–63). Forewing vein r usually developed and short and basal cell (except extreme base) pubescent.

Sculpture. Punctures on vertex 5–10 μm in diameter, frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex and 5–15 μm apart on frons (in most specimens surface matt with generally shiny surface between punctures) and between lateral ocellus and inner eye margin) (Fig. 26), 5–10 μm apart near antennal socket, 20–25 μm apart on mesoscutum. Punctures in front of median ocellus in most specimens coarse and dense. Punctures on mesopleuron

dense and in most specimens finely punctate or smooth on anteroventral surface of mesepisternum in lateral view. Clypeus generally punctate over surface or occasionally almost impunctate. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. Generally as in female, but metacoxa usually brown, sometimes brown on outer surface and paler on inner and ventral, and rarely completely straw coloured.

Structure. Flagellum with 20–25 flagellomeres (respectively 1%, 1%, 19%, 62%, 10% and 1% of 32 specimens) and flagellomeres narrow in apical 0.5. Height of eye 0.91–1.10 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. Among the species of the *P. pallipes* complex associated with *Lygus* spp., *P. dayi* is nearest *P. braunae*. Adults of *P. braunae* differ in flagellomere frequency, mesocoxa and metacoxa colour in females, clypeus and mesepisternum puncture development, clypeus colour, and flight period.

The nearest populations of *P. dayi* and of *P. braunae* are 300 km apart. The populations of *P. dayi* nearest to those of *P. braunae* are not more similar than distant populations of both species. There is probably no gene flow between these species. Thus, *P. dayi* is specifically distinct from *P. braunae*. A summary of measurement differences between *P. dayi* and *P. braunae* is given in Table 10.

Host and biological notes. Adults of this species have almost always been reared from *Adelphocoris lineolatus*, very rarely from *Lygus lineolaris*. Adults occur from early May to mid June in eastern Ontario and southern Quebec with peak abundance in late May. This is a univoltine species on nymphs of first generation *Lygus* bugs. Loan (1965) described the biology of this species under *P. pallipes* associated with *Adelphocoris* sp.

Material examined and range. 231 (37♂, 103♀ and 91♂/♀) adults were studied. Of these, 23 were reared from Miridae and 208 were field collected. The species is known from temperate regions of eastern North America from southernmost Quebec and Ontario to Delaware.

CANADA. QC: vic. Cantley, 45º33'44"N 75º49'09"W (1♂, 2♀); vic. Dunham (1♀); vic. Frelighsburg, 45º05''N 72º50'W (1♂); vic. Hemmingford, 45º00'56"N 73º32'11"W (12♀); vic. Hemmingford, 45º02'41"N 73º31'54"W (4♀); Ste. Anne de Bellevue (1♂); vic. Ste. Clotilde, 45º10'05"N 73º40'53"W (3♂, 16♀). **ON:** Belleville (5♂, 7♀); Bells Corner (1♀); Constance Bay (1♂); vic. Fitzroy Harbour, 45º28'N 76º11'W (3♂, 20♀); Guelph, Stone Rd. (1♂, 9♀); Guelph, Concession 2 (2♂, 1♀); Kemptville (1♂); vic. Kinburn, 45º15'N 76º09'W (1♂); Marmora (1♀); Morepth (1♀); Ottawa (3♀); Ottawa, 45º23'16"N 75º43'06"W (1♂, 2♀); Ottawa, 45º23'00”N 75º42'30"W (3♀); 10 km W Richmond (1♂); Stittsville (1♂). **USA. DE:** Newark (6♂, 7♀, 48; CNCI, USDA). **NJ:** Blairstown (4♂, 5♀, 43, USDA); Salem Co., Cohensey (1♀). **NY:** Ithaca (3♀); Greene Co., Freehold (1♂, 3♀); Slaterville Springs (1♂); Ulster Co., Clintondale (1♂); High Falls (1♂); Wallkill (1♀).

***Peristenus mellipes* group**. This group consists of seven species. The punctures on the vertex are fine and scattered between the inner eye margin and lateral ocellus (Fig. 27). The metatibia is dark brown to black in apical 0.6–0.8 at least on dorsal surface (90% of specimens) and metatarsomere 1 is clearly darker than the following tarsomeres (95% of specimens) (Figs. 10, 12). In females, the length of the flagellum relative to the maximum width of the head between the outer eye margins is less than 2.73 in specimens of five species, and in most specimens of *P. carcamoi* and *P. mellipes* it is below 2.78, rarely as high as 2.87, the height of the eye relative to the minimum distance between inner eye margins is more than 1.23 in specimens of five species and in most specimens of *P. mellipes* and *P. pseudopallipes* is more than 1.23 and rarely as low as 1.21 (Tables 11 to 17) (Fig. 18).

The following seven species are similar and difficult to distinguish from one another. The descriptions are organized based on clypeus colour and then alphabetically to make species comparisons a little easier. Specimens of *P. carcamoi*, *P. mellipes*, *P. otaniae* and *P. pseudopallipes* have a reddish brown clypeus (Fig. 18) and almost always (about 99.5%) straw coloured metacoxae (Fig. 48). Specimens of *P. broadbenti*, *P. gillespiei* and *P. howardi* have a black clypeus that is almost always (about 99.5%) blackish brown in the apical half.

Peristenus carcamoi n. sp.
(Table 11)

Type material. Type locality: Canada, Alberta, Lethbridge. Holotype, female (CNCI), labelled: [White] “CANADA: AB, Lethbridge Victoria Church, alfalfa-weed mix, coll. 24.VII.2002 49º42.279'N 112º44.951'W C. Herle, Cage ID:3E”; [White] “ Lab emg. 13.VI.2003 Ex Lygus nymph”; [Red] “HOLOTYPE Peristenus carcamoi Goulet CNC No. 23476”. Condition of holotype: perfect. Allotype male, labelled as holotype but from “Cage ID: 3F”. Paratypes: all specimens from Lethbridge, Alberta.

Origin of species name. This species is named in honour of Hector Cárcamo who reared this and other species of *Peristenus* and *Leiophron* in southern Alberta. Hector was instrumental in actively supporting our sampling efforts which led to the discovery of many species of *Peristenus* and *Leiophron* in Alberta.

Diagnosis. Clypeus reddish brown, the most common frequency of flagellomeres, 20 in females and 22 in males, and specimens found in temperate regions of western North America.

Description. FEMALE. Colour. Head and mesosoma black; metasoma usually brown, rarely black or reddish brown. Legs generally straw coloured, metacoxa occasionally light reddish brown and exceptionally reddish brown. Basal 0.3–0.5 of metatibia usually straw coloured, or occasionally light reddish brown and apical 0.5–0.7 of metatibia and metatarsomere 1 clearly darker than basal 0.5 of metatibia. Metatarsomeres 2–5 less dark

than metatarsomere 1. Palps, tegula and mandible (except apex) straw coloured. Scape to flagellomere 2 straw coloured, then gradually darkening to reddish brown in middle to brown or dark brown in apical third. Stigma dark brown and straw coloured in basal 0.3.

Structure. Flagellum with 19–21 flagellomeres (respectively 32%, 50% and 18% of 44 specimens) and flagellomeres enlarged in apical half. At most, one preapical flagellomere subquadrate (none 57% and one 43%). Length of gena behind eye 0.88–1.19 times as long as length of eye. Height of eye 1.32–1.48 times as long as minimum distance between inner eye margins (as in Fig. 18). Maximum width of head behind eyes subequal (0.93–0.96) to maximum head width at eye level. Occipital carina developed in dorsal 0.3. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.2–2.4 times as wide as narrowest width near base) and elongate (medial length of tergum 1.5–1.8 times as long as maximum width at posterior end). Radial cell length 0.72–1.1 as long as stigma width (as in Figs. 58–63). Forewing vein r usually developed and short (as in Figs. 60, 61) and basal cell except extreme base pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex, 5–15 μm apart on frons to 5–10 μm apart near antennal socket, and 20–25 μm apart on mesoscutum. Punctures in front of median ocellus generally fine to moderate (none or few 37%, many small 58% and coarse 5% based on 40 specimens) and surrounding surface not densely punctate. Punctures on mesopleuron generally dense, occasionally scattered. Clypeus generally punctate over surface, rarely almost glabrous. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 21–24 flagellomeres (respectively 1%, 41%, 48% and 10% of 69 specimens) and flagellomeres narrow in apical half. Height of eye 1.03–1.13 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Geographical variation. None observed.

Taxonomic notes. Four species of the *P. pallipes* complex that are associated with *Lygus* have the clypeus mainly reddish brown and the metacoxa almost always straw coloured.

Adults of *P. carcamoi* are most similar to those of *P. otaniae* and differ in their geographic range, the flagellomere frequency, and puncture development in front of the median ocellus. A summary of measurement differences between *P. carcamoi* and *P. otaniae* is given in Table 11.

Adults of *P. carcamoi* and *P. mellipes* differ in number of subquadrate preapical flagellomeres in females, and their geographic range. A summary of measurement differences between *P. carcamoi* and *P. mellipes* is given in Table 11.

Adults of *P. carcamoi* differ from those *P. pseudopallipes* in their geographic range,

the number of subquadrate preapical flagellomeres in females, and their biology. A summary of measurement differences between *P. carcamoi* and *P. pseudopallipes* is given in Table 11.

Based on colour patterns of the clypeus, metacoxa and metatibia, and puncture development on the frons, adults of *P. carcamoi* resemble those of only one European species of the *P. pallipes* complex. This European species occurs during mid summer in nymphs of two species of *Stenodema* (Miridae: Stenodemini). No specimen of *P. carcamoi* was ever reared from Stenodemini nymphs. Therefore, *P. carcamoi* is a Nearctic species. The same comment would apply to *P. mellipes*, *P. otaniae* and *P. pseudopallipes*.

Host and biological notes. Adults of *P. carcamoi* have been reared from several *Lygus* species. Adults have been recorded from late May to late June with peak abundance in early June. This is a univoltine species on nymphs of the first generation of *Lygus*.

Material examined and range. 101 (52♂, 49♀) adults were studied. Of these, 59 were reared from Miridae and 25 were field collected. The species is known from southernmost Alberta to Harrison Lake in the Cascade Mountains in southern British Columbia.

CANADA. AB: Elkwater (1♂); Glenwood (2♂, 4♀); Lethbridge (3♂, 6♀); Lethbridge Research Centre (10♂, 10♀); Lethbridge, 49º42.279'N 112º44.951'W (23♂, 17♀); Lethbridge, Pavan Park 49º45.116'N 112º44.951'W (11♂, 8♀); Rolling Hills (2♀); Vauxall (1♂); Waklin (1♂). **BC:** Harrison Lake (2♀).

Peristenus mellipes (Cresson)
(Figs. 7 habitus, 12, 33, 37, 38, 48, 54, 66, 70, 71, 72, 73, 74, 75, 76, 83, 86, Table 12)

Euphorus mellipes Cresson, 1872: 227. Type locality: U.S.A., New Jersey. Holotype, male (ANSP), labelled: [White] "N. J."; [Red] "Type No. *1773.1*"; [White with red frame] "*Euphorus Microctonus mellipes Cress*". Condition: right and left flagellomeres beyond 15 (right flagellum glued on point), right protarsus, and left leg beyond metafemur missing.

Brachistes nocturnus Viereck, 1905: 279. Type locality: U.S.A., Kansas, Lawrence. Holotype male (SEMC), labelled: [White] "May" [White] "At night Lawrence, Ks. E. S. Tucker." [Red with black frame] "*Brachistes nocturnus Type Vier*". Condition: Head and Left fore leg missing. **NEW SYNONYMY**.

Peristenus pallipes; Muesebeck and Wakley, 1951:103, *nec pallipes* Curtis.

Peristenus pallipes; Loan 1974a: 837, *nec pallipes* Curtis.

Diagnosis. Clypeus pale, females with two to five subquadrate preapical flagellomeres, usually many fine punctures below median ocellus, and from temperate regions of eastern North America, in May or June.

Description. FEMALE. Colour. Head and mesosoma black; metasoma usually brown, rarely black or reddish brown. Legs generally straw coloured, metacoxa occasionally light reddish brown, exceptionally reddish brown. Base of metatibia usually straw coloured, occasionally light reddish brown. Apex of metatibia and metatarsomere 1 clearly darker

than basal half of metatibia. Metatarsomeres 2–5 paler than metatarsomere 1. Palpi, tegula and mandible (except apex) straw coloured. Scape to flagellomere 2 straw coloured, gradually darkening to reddish brown in middle to brown or dark brown in apical 0.3. Stigma dark brown and straw coloured in basal third.

Structure. Flagellum with 18–22 flagellomeres (respectively 1%, 6%, 44%, 44% and 5% of 234 specimens) and flagellomeres enlarged in apical 0.5. Many preapical flagellomeres subquadrate (three 18%, four 31%, five 27%, six 16% and more 8%). Length of gena behind eye 0.90–1.04 times as long as length of eye. Height of eye 1.27–1.41 times as long as minimum distance between inner eye margins (as in Fig. 18). Maximum width of head behind eyes subequal (0.94–0.98) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.0–2.5 times as wide as narrowest width near base) and elongate (medial length of tergum 1.6–1.9 times as long as maximum width at posterior end). Radial cell length 0.87–1.0 as long as stigma width (as in Figs. 58–63). Forewing vein r usually developed and short (as in Figs. 60, 61) and basal cell except extreme base pubescent (Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex, 5–15 μm apart on frons to 5–10 μm apart near antennal socket, and 20–25 μm apart on mesoscutum. Punctures in front of median ocellus generally fine to moderate (few or none 21%, many small 78%, and coarse 1% based on 100 specimens), surrounding surface beyond, dense. Punctures on mesopleuron generally dense, occasionally scattered. Clypeus generally punctate over surface, rarely almost glabrous. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 21–25 flagellomeres (respectively 1%, 22%, 42%, 29% and 6% of 119 specimens) and flagellomeres narrow in apical 0.5. Height of eye 0.90–1.17 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. For structural and biological differences between *P. mellipes* and *P. carcamoi*, see "Taxonomic notes" under *P. carcamoi*. A summary of measurement differences between *P. mellipes* and *P. carcamoi* is given in Table 12.

Adults of *P. mellipes* differ from those of *P. otaniae* in their geographic range, the frequency of subquadrate preapical flagellomeres in females, and in type of puncture development in front of the median ocellus. The geographically nearest samples of each species are not more similar than distant samples. Therefore, there is no evidence of gene flow between the two species. A summary of measurement differences between *P. mellipes* and *P. otaniae* is given in Table 12.

Adults of *P. mellipes* differ from those of *P. pseudopallipes* in type of life cycle, the

frequency of flagellomeres, and puncture development in front of the median ocellus. Despite almost identical geographic ranges, the population characteristics remain constant over the range of each species. A summary of measurement differences between *P. mellipes* and *P. pseudopallipes* is given in Table 12.

Muesebeck (1936) synonymized *P. mellipes* with the European *P. pallipes*. Muesebeck *et al.* (1951), Loan (1974a) and Marsh (1979) accepted this synonymy. Though the work on European species of *Peristenus*, is not published yet (done in collaboration with K. van Achterberg), no adults of the Nearctic species associated with the *P. pallipes* complex matches those (including types) of any European species of the complex. Moreover, many species of the complex are recorded from *Lygus* nymphs in North America whereas only one, *P. varisae* Varis & Achterberg (2001), is recorded from *Lygus* nymphs. *P. varisae* is an easily distinguished species. As discussed below, the oldest name for the *P. pallipes* of North American authors is *P. mellipes*.

The holotypes associated with *P. mellipes* were a challenge. The holotype of *P. mellipes* had incomplete antennae and no date of collection on the label. Both *P. mellipes* and *P. pseudopallipes* are recorded from New Jersey. The only decisive character state was the development of punctures in front of the median ocellus. The holotype was typical of specimens that attack the first nymphal generation. The male holotype of *B. nocturnus* was a greater challenge as there was no head left. The metacoxa of this old specimen is straw coloured, its metatibia is bleached but seems to be a little darker, and it was collected in May. This holotype is clearly similar to pale coloured species of the *P. pallipes* complex. A sample in May would eliminate *P. pseudopallipes*, and the range in eastern temperate North America would not support its association with *P. carcamoi* and *P. otaniae*, but would support an association with *P. mellipes*, the oldest name. Other studied structures of *B. nocturnus* are typical of *P. mellipes* males, hence the above synonymy.

Host and biological notes. Adults of this species have been reared commonly from *Lygus lineolaris* and rarely from *Adelphocoris lineolatus*. Adults occur from early May to early July, (in eastern Ontario and western Quebec, from the end of May to the start of July) with peak abundance between June 2 and 13. This is a univoltine species on nymphs of the first generation of *Lygus*. Loan (1965) described the biology of this species under *P. pallipes* associated with *Lygus lineolaris*. Lim *et al.* (1976) and our data confirm Loan's biological observations.

Material examined and range. 1161 (506♂, 595♀) adults were studied. Of these, 212 were reared from Miridae and 949 were field collected. An eastern North American species recorded from southern Canada to Georgia.

CANADA. NB: Kouchibouguac Nat. Park (2♂). **NS:** Cape Breton Highlands N. Park, 46º48'N 60º44'W (1♀); Cape Breton Highlands N. Park, 46º47'N 60º50'W (1♂); Cape Breton Highland Nat. park, Mackenzie Mtn. (1♂); vic. Cheticamp, 46º39.004'N 60º59.704'W (1♂); vic. Kentville, 45º05.075'N 64º35.402'W (1♂, 4♀); Kings Co., (1♀); vic. Lockhartville, 45º05.081'N 64º14.040'W (1♀); vic. Sheffield Mills, 45º08.165'N

64º29.489'W (1♂); Yarmouth (1♀). **QC:** vic. Bois-Francs, 46º32'N 75º57'W (40♂, 77♀); vic. Cantley, 45º34'N 75º49'W (24♂, 45♀); vic. Chelsea, 45º34'N 75º52'W (7♂, 4♀); Duchesnay (2♀); vic. Dunham (4♂, 1♀); Forestville (1♀); vic. Frelighsburg, 45º05'N 72º50'W (125♂, 36♀); Gatineau Nat. Park (1♂); Gracefield (3♂, 1♀); vic. Hemmingford 45º02'N 73º32'W (67♂, 65♀); vic. Hemmingford 45º01'N 73º32'W (26♂, 37♀); Hull (1♂, 1♀); Lac à la Tortue (1♂); Lanoraie (1♂, 2♀); Nominingue (2♂); Old Chelsea (3♂, 1♀); Sherrington (3♂, 2♀); Ste. Anne-de-Bellevue (1♀); vic. Ste. Clotilde 45º07'N 73º36'W (5♀); vic. Ste. Clotilde 45º10'N 73º41'W (114♂, 158♀); Wakefield (4♂); vic. Wakefield, 45º38'N 75º56'W (16♀). **ON:** Aberfoyle (1♂); Alfred (3♂); vic. Almonte, 45º15'N 76º09'W (2♂, 2♀); Ancaster (1♀); Belleville (5♂, 4♀); Cayuga (1♀); Chatham (1♀); vic. Fitzroy Harbour, 45º28'N 76º11'W (4♂, 3♀); Fuller (2♂); Grimsby (1♂, 1♀); Guelph (5♂, 18♀); Kanata, 45º20'N 75º56'W (1♀); Leamington (1♂); Listowel (1♂); vic. London, 43º01'N 81º12'W (9♂, 13♀); vic. London, 43º2.26'N 81º05.35'W (4♂, 6♀); Morepth (1♂); vic. Mountain, 45º02'N 75º27'W (5♂, 9♀); Ottawa (11♂, 17♀); Oxford Mills (1♀); Point Pelee (1♂); Port Ryerse (1♂); Simcoe (1♂); Shorthills Prov. Park, 43º06'N 79º16'W (1♂, 2♀); vic. Talbotville, 42º50'N 81º16'W (2♀); Thorold (1♀); vic. Vineland, 43º03'N 79º14'W (11♂, 9♀). **USA. DE:** Mt. Holly (5 ♂/♀; USDA); Newark (3♂, 1♀; 8 ♂/♀; CNCI, ESUW, USDA); **GA:** Brasstown bald, 4,800' (1♀); Forsyth (1♂); Rabun Co., Pine Mtn., 1,500' (1♂). **IL:** Union Co., Shawnee State For. (13♂). **KS:** Lawrence (1♀; SEMC). **MA:** Mt. Greylock, summit (1♀). **MD:** Laurel (2♂, 1♀); Patuxent wildlife refuge, vic. Bowie (1♂). **ME:** Sherman Mills (1♀). **MI:** Livonia (1♂; ESUW). **MO:** Williamsville (1♂). **MS:** Pontotoc Co., Pontotoc, 34º08'N 89º00'W (1♂/♀; USDA). **NC:** Great Smoky Mountain Nat. park, Clingman's Dome, 6,300' (1♀); Macon Co. (1♀; ESUW). **NJ:** Blairstown (10♂, 30♀; 51 ♂/♀; ESUW, USDA, USNM); Newton (1♂, 1♀); Woodstown (1 ♂/♀; USDA). **NY:** Albany (1♀); Argyle (1♂); Ithaca (10♂, 2♀); MacClean bog, vic. Ithaca (2♂); Slaterville Springs (2♂). **SC:** vic. Lexington, 34º02'N 81º17'W (1♂). **VA:** Louisa Co., 6 km S. Cockoo (5♂); Page Co., Shenadoah Nat. park, Compton Gap (3♂).

***Peristenus otaniae* n. sp.**
(Figs. 18, 39, Table 13)

Type material. Type locality: Canada, Alberta, Mountain Trail near Beaverlodge. Holotype, female (CNCI), labelled: [White] "CANADA, AB Beaverlodge, Mountain Trail 12.VIII.1999, emg. late VII.2000, J. Otani"; [White] "EX: Lygus spp. Det: J. Otani, 2000"; [Red] "HOLOTYPE Peristenus otaniae Goulet CNC No. 23477". Condition of holotype: perfect. Allotype male labelled as holotype. Paratypes: all specimens mentioned under "Material examined and range".

Origin of species name. This species is named in honour of Jennifer Otani who reared *P. otaniae* as well as other interesting species of *Peristenus* and *Leiophron* in northern Alberta.

Diagnosis. Clypeus reddish brown, range within boreal regions of North America, females generally with fewer than three subquadrate preapical flagellomeres and in both sexes generally with few punctures below median ocellus.

Description. FEMALE. Colour. Head and mesosoma black; metasoma usually brown, rarely black or reddish brown. Legs generally straw coloured, metacoxa occasionally light reddish brown and exceptionally reddish brown on dorsal surface. Base of metatibia usually straw coloured or light reddish brown. Apex of metatibia and metatarsomere 1 clearly darker than basal 0.5 of metatibia. Metatarsomeres 2–5 less dark than metatarsomere 1. Palpi, tegula and mandible (except apex) straw coloured. Scape to flagellomere 2 straw coloured, then gradually darkening to reddish brown in middle to brown or dark brown in apical 0.3. Stigma dark brown and straw coloured in basal third.

Structure. Flagellum with 18–20 flagellomeres (respectively 13%, 65% and 22% of 148 specimens) and flagellomeres enlarged in apical half. Few of the preapical flagellomeres subquadrate (none 35%, one 43%, two 19% and more 3%). Length of gena behind eye 0.80–1.09 times as long as length of eye. Height of eye 1.34–1.46 times as long as minimum distance between inner eye margins (Fig. 18). Maximum width of head behind eyes subequal (0.92–0.97) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.1–2.4 times as wide as narrowest width near base) and elongate (medial length of tergum 1.38–1.67 times maximum width at posterior end). Radial cell length 0.83–1.07 as long as stigma width (as in Figs. 58–63). Forewing vein r usually developed and short (as in Figs. 60, 61) and basal cell (except extreme base) pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex and 5–15 μm apart on frons to 5–10 μm apart near antennal socket, 20–25 μm apart on mesoscutum. Punctures in front of median ocellus in most specimens absent, few or fine and surrounding surface with punctures less dense (few or none 95%, many small 4% and coarse 1% based on 100 specimens). Punctures on mesopleuron generally dense, occasionally scattered. Clypeus generally punctate over surface, rarely almost impunctate. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 20–23 flagellomeres (respectively 6%, 27%, 54% and 11% of 98 specimens) and flagellomeres narrow in apical 0.5. Height of eye 1.00–1.14 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. Adults of *P. otaniae* and *P. mellipes* are similar. The two species differ in the frequency distribution of flagellomere number, in geographic ranges, in life zones occupied, in the proportion of subquadrate preapical flagellomeres in females, and

in type of puncture development in front of median ocellus. The nearest samples of each species are not more similar than distant samples. Therefore, there is no evidence of gene flow between the two species. A summary of measurement differences between *P. otaniae* and *P. mellipes* is given in Table 13.

Though the flight periods overlap widely between *P. otaniae* and *P. pseudopallipes*, the two species differ in life cycle, geographic range (allopatric), life zone occupied, in the proportion of subquadrate preapical flagellomeres in females, and in type of puncture development in front of median ocellus. A summary of measurement differences between *P. otaniae* and *P. pseudopallipes* is given in Table 13.

Host and biological notes. Adults of this species have been reared from various species of *Lygus* (65 specimens), *Lygus lineolaris* (5 specimens) and *Adelphocoris lineolatus* (6 specimens). Adults occur from early June to early August with peak abundance between late June and early July. This is a univoltine species. Females of this species parasitize nymphs of only the first generation even when an occasional second *Lygus* generation occurs at the southern end of its range. Loan and Craig (1976) described the biology of this species under *P. pallipes*. Braun *et al.* (2001) confirmed Loan's and Craig's data.

Material examined and range. 253 (97♂, 156♀) adults were studied. Of these, 76 were reared from Miridae and 165 were field collected. The species is known from the Rocky Mountains in south central British Columbia to Newfoundland. Most specimens and localities are in boreal regions of Canada and from the montane zone in the Rocky Mountains.

CANADA. NF: South Branch (2♀). **QC:** vic. La Corne 48º24'19"N 78º00'12"W (11♂, 38♀); La Verandrye Prov. Park 47º36'57"N 77º33'42"W (1♀); Matagami 49º45'08"N 77º37'14"W (3♂, 5♀). **MB:** Ninette (1♂); Riverton (1♂); 3 km N Stockton (1♀). **SK:** Brancepeth (1♂); vic. Saskatoon 52º09.1'N 106º34.9'W (9♂, 3♀); White Fox (10♂, 10♀). **AB:** vic. Bear Lake 55º12.863'N 118º58.743'W (1♀); Beaverlodge (7♂, 7♀); Mountain trail vic. Beaverlodge (21♂, 29♀); Dunvegan (3♀); Edmonton (5♀); Frank (1♀); Highway 667 (1♀); vic. La Crete 58º01.257'N 116º19.621'W (2♂, 4♀); Pincher (1♀); Saint Albert (1♀); Saskatoon Mountain 55º13.663'N 119º18.160'W (21♂, 30♀); Saskatoon Mountain 55º10.286'N 119º12.571'W (3♂); Spruce Grove (1♂). **BC:** Kishatinaw Riv. 56º14.448'N 120º30.082'W (3♀); Laird Hot Springs (1♀); Revelstoke (1♀). **USA. CO:** Estes Park (1♂, 1♀); 6 km SW Golden (2♂, 3♀); 3 km S Meeker (3♂, 3♀).

Peristenus pseudopallipes (Loan)
(Table 14)

Leiophron pseudopallipes Loan. Type locality: Canada, Ontario, Fuller, 44º24'N 77º25'W. Holotype, female (CNCI), labelled: [White] "*Fuller, Ont VIII 11.63 C. C. Loan*"; [White] "*Swept ex Solidago canadensis*; [White] "*Host: Liocoris lineolaris*"; [Red] "HOLOTYPE *Leiophron*

pseudopallipes Loan CNC No. *11587*". Condition of holotype: Left antenna above scape, right and left mid legs above trochanter, and right hind leg above trochanter missing. Allotype male from same locality, but reared on July 29, 1965.

Comments: The Holotype in CNCI is not labelled as the one Loan (1970) studied. The present holotype specimen matches very well his description and I consider it the official holotype specimen as no specimen with the published label information has been found in the collection. However, the allotype specimen was found and received an allotype label.

Diagnosis. Clypeus pale, in female flagellum with two to five subquadrate preapical flagellomeres, surface below median ocellus usually coarsely punctuate, and from temperate regions of eastern North America in July or later.

Description. FEMALE. Colour. Head and mesosoma black; metasoma usually brown rarely black or reddish brown. Legs generally straw coloured, metacoxa occasionally light reddish brown or exceptionally reddish brown on dorsal surface. Base of metatibia usually straw coloured, or light reddish brown. Apex of metatibia and metatarsomere 1 clearly darker than basal half of metatibia. Metatarsomeres 2–5 paler dark than metatarsomere 1. Palpi, tegula and mandible (except apex) straw coloured. Scape to flagellomere 2 straw coloured, then gradually darkening to reddish brown in middle to brown or dark brown in apical third. Stigma dark brown but straw coloured in basal third.

Structure. Flagellum with 17–21 flagellomeres (respectively 3%, 20%, 59%, 17% and 1% of 100 specimens) and flagellomeres enlarged in apical 0.5. Many of the preapical flagellomeres quadrate or subquadrate (none 0%, one 8%, two 15%, four 25%, five 26%, six 8% and more 3%). Length of gena behind eye 0.80–1.09 times as long as length of eye. Height of eye 1.34–1.46 times as long as minimum distance between inner eye margins (as in Fig. 18). Maximum width of head behind eyes subequal (0.92–0.97) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.1–2.4 times as wide as narrowest width near base) and elongate (medial length of tergum 1.38–1.67 times maximum width at posterior end). Radial cell length 0.83–1.07 as long as stigma width (as in Figs. 58–63). Forewing vein r usually developed and short (as in Figs. 60, 61) and basal cell (except extreme base) pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, and on frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex, 5–15 μm apart on frons to 5–10 μm apart near antennal socket, and 20–25 μm apart on mesoscutum. Punctures in front of median ocellus in most specimens coarse (few or none 8%, many small 19% and coarse 73% based on 100 specimens). Punctures on mesopleuron generally dense, occasionally scattered. Clypeus generally punctate over surface, rarely almost glabrous. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 20–24 flagellomeres (respectively 7%, 34%, 41%, 17% and 1% of 110 specimens) and flagellomeres narrow in apical 0.5. Height of eye 1.00–1.14 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. The specific status of *P. pseudopallipes* was clearly demonstrated by Loan (1970). This fine study is the clue to unravel the species complex within *P. mellipes* (Loan's *P. pallipes*). Reared series allow one to see through the wide variation seen in field collected specimens and resolve cryptic species. Loan (1970) recognized *P. pseudopallipes* from *P. mellipes* based on its biology.

Adults of *P. pseudopallipes* differ from those of *P. mellipes* in life cycle, in the frequency distribution of flagellomeres, and in type of puncture development in front of the median ocellus. A summary of measurement differences between *P. pseudopallipes* and *P. mellipes* is given in Table 14.

Though the flight periods overlap widely between *P. otaniae* and *P. pseudopallipes*, adults of the two species differ in life cycle, geographic range (allopatric), life zone occupied, in proportion of subquadrate preapical flagellomeres in females, and in type of puncture development in front of the median ocellus. A summary of measurement differences between *P. pseudopallipes* and *P. otaniae* is given in Table 14.

Adults of *P. pseudopallipes* differ from those of *P. carcamoi* in life cycle, in range (allopatric), in frequency distribution of flagellomere number, in proportion of subquadrate preapical flagellomeres in females, and in type of puncture development in front of the median ocellus. A summary of measurement differences between *P. carcamoi* and *P. pseudopallipes* is given in Table 14.

Host and biological notes. Adults of *P. pseudopallipes* have been reared from *Lygus lineolaris* and *L. vanduzeei* Knight (Loan 1980). Adults occur from mid July to mid September in eastern Ontario and southern Quebec with peak abundance between late July and early August. This is a univoltine species. Females of this species parasitize nymphs of only the second *Lygus* generation. Loan (1970) discovered the unusual biology of this species. Lim *et al*. (1976) confirmed Loan's data.

Material examined and range. 534 (300♂, 234♀) adults were studied. Of these, 106 were reared from Miridae and 427 were field collected. The species is known from temperate regions of eastern North America from southernmost Quebec and Ontario in the North to Georgia in the South.

CANADA. NB: Kouchibouguac Nat. Park (3♂, 5♀). **QC:** Cascapedia (1♀); Dunham (3♂, 5♀); 3 km N Frelighsburg 45º05'N 72º50'W (10♂, 6♀); Gatineau Park, 1 km S Ramsey Lake (2♀); vic. Hemmingford 45º00'56"N 73º32'11"W (4♂, 2♀); 4.5 km N Hemmingford 45º09'41"N 73º34'54"W (3♂, 4♀); Iberville (1♂, 1♀); Lac Brulé (1♀); Ladysmith (1♀); Mt. St. Hilaire (2♂, 1♀); 7 km NW Old Chelsea (1♂, 1♀); vic. Ste. Cyrile-de-Wendover, 45º57.258'N 72º27.846'W (1♀); vic. Ste. Clotilde 45º09'05"N 73º40'53"W (191♂, 115♀). **ON:** Ancaster (1♀); Brighton (1♂, 1♀); Finland (1♂); 3 km E

Fitzroy Harbour 45º28'N 76º11'W (1♂, 1♀); Fuller 44º24'N 77º25'W (28♂, 17♀); 10 km E Griffith (1♀); Guelph (18♂, 22♀); 6 km E Kinburn 45º23'N 76º08'W (1♀); London 43º01.77'N 81º12.33'W (1♂, 2♀); vic. London 43º02.76'N 81º05.58'W (2♀); Marmora (1♀); Middlesex Co., 43º02'7"N 81º05'58"W (2♂, 1♀); vic. Mountain 45º02'02"N 75º27'10"W (1♂, 1♀); Ottawa, Central Experimental Farm (5♂, 3♀); Shorthills Prov. Park 43º05.08'N 79º17.40'W (9♂, 12♀); Strathroy (1♀); vic. Talbotville 42º49.93'N 81º16.92'W (1♂, 1♀). **USA. CT:** E. Hartford (1♀). **DE:** Newark (10 ♂/♀: USDA). **GA:** Hiawasee (1♀). **NC:** Macon Co., Wayah Bald (1♂); Whiteface Cove near Highland (1♀). **NJ:** Blairstown (10♂/♀: USDA); Warren Co., Hilltop Berry (1♀); Woodstown (2♂/♀: USDA). **NY:** Ithaca (1♀); Lake Placid (2♀); Slaterville (1♀); Whiteface Mountain (1♀); Lake Placid (1♂). **OH:** Steubenville (1♂).

Peristenus broadbenti n. sp.
(Figs. 4 habitus, 10, 16, 47, 52a, 52b, 58, 61, 62, 63, 85, Table 15)

Type material. Type locality: Canada, Alberta, Lethbridge. Holotype, female (CNCI), labelled: [White] "Canada, Alberta, Lethbridge, Victoria Church, alfalfa-weed mix, Coll. 24.VII.2002 49º42.279'N 112º44.951'W C. Herle, Cage ID: 3D"; [White] "Lab. emg. 10.VI.2003–4.VII.2003 Ex. Lygus nymph"; [Red] "HOLOTYPE Peristenus broadbenti CNC No. 23478". Condition of holotype: Perfect. Allotype male from same locality and emergence date, but cage "ID: 11B". Paratypes: all specimens from above locality.

Origin of species name. This species is named in honour of Bruce Broadbent who worked for many years on *Lygus* endoparasitoids. He reared several species, which benefited markedly our species concept for southern Ontario. Because all species he worked on in Ontario are named, this species is dedicated to him as acknowledgement for his long support of systematic research of mirid parasitoids.

Diagnosis. Clypeus black or dark brown, Frons not densely punctate (especially between lateral ocellus and inner eye margin), forewing vein r generally developed and a univoltine life cycle associated with the second nymphal generation of *Lygus*.

Description. FEMALE. Colour. Head and mesosoma black; metasoma black. Legs generally straw coloured, metacoxa brown to black; basal 0.3–0.5 of metatibia usually straw coloured or occasionally light reddish brown, and apical 0.5–0.7 of metatibia, metatarsomere 1 clearly darker than basal half of metatibia, but metatarsomeres 2–5 less dark than metatarsomere 1. Palpi, tegula and mandible (except apex) straw coloured. Scape to flagellomere 2 straw coloured, threafter brown to dark brown. Stigma dark brown and straw coloured in basal 0.3. See habitus (Fig. 4).

Structure. Flagellum with 18–20 flagellomeres (respectively 3%, 59% and 35% of 32 specimens) and flagellomeres enlarged in apical 0.5. Few preapical flagellomeres subquadrate (none 60%, one 34% and two 6%). Length of gena behind eye 0.91–1.09 times as long as length of eye. Height of eye 1.30–1.42 times as long as minimum distance

between inner eye margins (as in Fig. 18). Maximum width of head behind eyes subequal (0.91–0.96) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.2–2.3 times as wide as narrowest width near base) and elongate (medial length of tergum 1.5–1.8 times maximum width at posterior end). Radial cell length 0.94–1.06 as long as stigma width (Figs. 58, 61–63). Forewing vein r usually developed (85% based on 50 specimens) and short (Figs. 58, 61–63) and basal cell of forewing (except extreme base) pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, on frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex (especially between lateral ocellus and inner eye margin), 5–15 μm apart on frons to 5–10 μm apart near antennal socket, and 20–25 μm apart on mesoscutum. Punctures on mesopleuron generally dense, occasionally scattered. Clypeus generally smooth, rarely punctate over disc. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 20–23 flagellomeres (respectively 7%, 45%, 42% and 5% of 40 specimens) and flagellomeres narrow in apical 0.5. Height of eye 1.00–1.11 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. Among the species of the *P. pallipes* complex with a black or dark brown clypeus, *P. broadbenti* is nearest to *P. gillespiei*. Almost no structural differences were found between the two species. However, adults of the species differ in their life cycle and their almost allopatric range (narrowly sympatric in the Cascade Mountains). Though the data on reared specimens is limited, the Cascades samples from the Harrison Lake support the lack of gene flow between the two species. The emergence data from this locality are consistant with the typical *P. gillespiei* early emergence and the typical *P. broadbenti* late emergence. A summary of measurement differences between *P. broadbenti* and *P. gillespiei* is given in Table 15.

Adults of *P. broadbenti* differ from those of *P. howardi* in the development of forewing vein r, the presence of males, and a univoltine life cycle. A summary of measurement differences between *P. broadbenti* and *P. howardi* is given in Table 15.

Adults of *P. broadbenti* could easily be confused with those of *P. braunae* a darkly coloured species. They are easily distinguished from those of *P. braunae* by the colour of the clypeus and metatibia, by the puncture density on the vertex especially between the lateral ocellus and the inner eye margin, by the the ratio of eye height to minimal distance between eye inner margins, and the ratio of length of flagellum to maximum width of head between outer eye margins.

Host and biological notes. Adults of *P. broadbenti* have been reared from various species of *Lygus*. Adults occur from late June till late August with peak abundance

probably in mid July. This is a univoltine species. Females of this species parasitize nymphs of only the second generation of *Lygus*.

Material examined and range. 116 (36♂, 80♀) adults were studied. Of these, 42 were reared from Miridae hosts and 74 were field collected. The species is known from temperate regions where two full *Lygus* generations occur from southwestern Alberta and southern British Columbia south to Nevada and Wyoming.

CANADA. AB: Eisenhower jct. Banff Nat. Park (1♀); Johnston Canyon, vic. Banff (3♀); Hardstead (1♀); Hendrickson (1♀); Lethbridge (7♂, 9♀); Lethbridge, 49º42.279'N 112º44.951'W (22♂, 16♀); Lethbridge, Pavan Park, 49º45.294'N 112º50.525'W (1♂, 6♀); Rolling Hills (2♂, 6♀); Rosdal (1♀); Waklin (1♂, 2♀); Waterton Lakes Nat. Park, 1300 m (1♂, 6♀). **BC:** Diamond Head Trail, vic. Squamish, 1000 m (5♀); Hatzic Lake (3♀); Harrison Lake (1♀); Harrison Mills (1♀); MacGillivray Creek, vic. Chilliwack (1♀); Prince Rupert (1♀); Robson (1♂); Terrace (2♀); Summerland (1♀); West Harrison Rd., 49º16'26"N 121º52'41"W (2♀). **USA. MT:** Beaverhead Co., Clark Canyon Dam Rd. (1♀; ESUW). **NV:** 19 km SW Wells, 2700 m (1♀). **OR:** Lincoln Co., 13 km E Eddyville (6♀). **WA:** Lewis Co., Meskill, 1.6 km W Hwy. 6 (2♀); Pacific Co., Idwaco, 28 km N Hwy 101 (1♀). **WY:** Albany Co., Medecine Bow Nat. For., 0.8 km NE Lincoln Monument (1♀; ESUW); Albany Co., Medecine Bow Nat. For., 1.6 km N Lincoln Monument (1♀; E SUW); Albany Co., Medecine Bow Nat. For., 0.6 km S Lincoln Monument (1♀; ESUW); Albany Co., Pole Mtn. (1♀; ESUW); Battle Lake Rd., Sierra Madre Range (1♀; ESUW).

Peristenus gillespiei n. sp.
(Table 16)

Type material. Type locality: Canada, British Columbia, West Harrison Road. Holotype, female (CNCI), labelled: [White] “Canada, BC West Harrison road 49º16'26"N 121º52'41"W 20.VI.2001, emg. 19.V.2002 D. Gillespie, clover”; [White] “Ex Lygus shulli Knight Code: WHR20VI01Ls19V02”; [Red] “HOLOTYPE Peristenus gillespiei CNC No. 23479”. Condition of holotype: excellent. Allotype male from Canada, BC, Silver & Skagit Rd., 22.VI.2000 49º14'N 121º23'W to 49º08'N 121º16'W, 450–600 ms. Paratypes: all specimens reared from the following localities in Canada, BC: West Harrison road; 20–25 km SE Chilliwack Lake road; Hemlock Valley ski hill; Mount Cheam; 30 km S Skagit Valley road.

Origin of species name. This species is named in honour of David Gillespie who worked for many years on *Lygus* endoparasitoids. He reared several species, which benefited markedly our species concept along the Pacific coast of Canada. Moreover, Dave was instrumental in actively supporting our sampling efforts, which led to the discovery of new species of *Peristenus* and *Leiophron* in western British Columbia.

Diagnosis. Clypeus black or dark brown, frons not densely punctate (especially between lateral ocellus and inner eye margin), forewing vein r generally developed, and a

univoltine life cycle associated with first generation of *Lygus* nymphs.

Description. FEMALE. Colour. Head and mesosoma black; metasoma black. Legs generally straw coloured, metacoxa brown to black; basal 0.3–0.5 of metatibia usually straw coloured or occasionally light reddish brown, and apical 0.5–0.7 of metatibia, and metatarsomere 1 clearly darker than base of metatibia, but metatarsomeres 2–5 less dark than metatarsomere 1. Palpi, tegula and mandible (except apex) straw coloured. Scape to flagellomere 2 straw coloured, thereafter brown to dark brown. Stigma dark brown but straw coloured in basal third.

Structure. Flagellum with 18–20 flagellomeres (respectively 12%, 53% and 35% of 17 specimens) and flagellomeres enlarged in apical 0.5. Few of the preapical flagellomeres subquadrate (none 35%, one 50%, two 9% and three 6%). Length of gena behind eye 0.80–1.00 times as long as length of eye. Height of eye 1.36–1.46 times as long as minimum distance between inner eye margins (as in Fig. 18). Maximum width of head behind eyes subequal (0.92–0.96) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.2–2.5 times as wide as narrowest width near base) and elongate (medial length of tergum 1.5–1.8 times maximum width at posterior end). Radial cell length 0.83–1.06 as long as stigma width (as in Figs. 58–63). Forewing vein r of forewing in most specimens clearly developed (95% based on 100 specimens) and short (as in Figs. 60, 61) and basal cell of forewing (except extreme base) pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, on frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex (especially between lateral ocellus and inner eye margin), 5–15 μm apart on frons to 5–10 μm apart near antennal socket, and 20–25 μm apart on mesoscutum. Punctures on mesopleuron generally dense occasionally scattered. Clypeus generally smooth, rarely punctate all over. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Colour. As in female.

Structure. Flagellum with 21–23 flagellomeres and flagellomeres narrow in apical 0.5. Height of eye 1.00–1.14 times as long as minimum distance between inner eye margins. Otherwise structure and sculpture as in female.

Taxonomic notes. Among the species of the *P. pallipes* complex with a black or dark brown clypeus, *P. gillespiei* is nearest *P. broadbenti*. Almost no structural differences were found between the two species. However, adults of the two species differ in their life cycle and their almost allopatric range (narrowly sympatric in the Cascade Mountains). A summary of measurement differences between *P. gillespiei* and *P. broadbenti* is given in Table 16.

Adults of *P. gillespiei* differ from those of *P. howardi* in the development of the forewing vein r, the common presence of males, and the univoltine life cycle. A summary of measurement differences between *P. gillespiei* and *P. howardi* is given in Table 16.

Adults of *P. gillespiei* could easily be confused with those of *P. braunae* a darkly coloured species. They are easily distinguished from those of *P. braunae* by the colour of the clypeus and metatibia, by the puncture density on the vertex especially between the lateral ocellus and the inner eye margin, by the the ratio of eye height to minimal distance between eye inner margins, and the ratio of length of flagellum to maximum width of head between outer eye margins.

Host and biological notes. Adults of this species have been reared from various species of *Lygus*. Adults occur from early May to late June, with peak abundance probably in early June but late July at higher elevations (e.g., subalpine meadows). This is a univoltine species. Females of this species parasitize nymphs of only the first nymphal generation of *Lygus*.

Material examined and range. 53 (13♂, 40♀) adults were studied. Of these, 20 were reared from Miridae and 33 were field collected. The species is known from the Cascades and Coastal ranges to the lowlands from British Columbia to California.
CANADA. BC: Boston Bar, 15 km N, 49º58'39"N 121º52'41"W (6♀); Mount Cheam (1♀); vic. Chilliwack, 49º07'32"N 122º06'10"W (3♀); Chilliwack Lake Rd., 49º06'N 121º36'W, 800 m (3♂, 4♀); Chilliwack Lake Rd., 20–25 km SE (2♀); Delta, 49º04.996'N 123º00.949'W (1♀); Gagnon Rd., 10 km W Terrace (5♀); Harrison Bay (3♀); Hemlock ski hill, 49º22.846'N 121º56.111'W, 700 m (4♂, 5♀); vic. Hope, 49º22'47"N 121º31'22"W (1♂); Kleana Cr., 21 km E Terrace (1♂); Silver and Skagit Rd., between 49º14'N 121º23'W and 49º08'N 121º16'W, 450–600 m (2♂, 1♀); Skagit Valley Rd., 30 km S, 49º08'43"N 121º17'36"W (1♂); Terrace, 29 km SW (1♀); Terrace, 51 km SW (1♀); West Harrison Rd., 49º16'26"N 121º52'41"W (7 ♀). **USA. CA:** Monterey Co., Big Creek Station, 1450 m (1♂).

Peristenus howardi Shaw
(Figs. 59, 60, Table 17)

Peristenus howardi Shaw, 1999: 371. Type locality: USA: Idaho, Canyon Co., Parma. Holotype, female (ESWU), not seen, labelled: "Idaho, Canyon County, Parma, 4 August 1997, C. R. Baird, host: *L. hesperus* Knight nymph swept in alfalfa, emerged 3 September 1997.

Diagnosis. Clypeus black or dark brown, not densely punctate (especially between lateral ocellus and inner eye margin), forewing vein r generally absent, and a multivoltine life cycle associated with all generations of *Lygus*.

Description. FEMALE. Colour. Head, mesosoma and metasoma black. Legs generally straw coloured, metacoxa brown to black; basal 0.3–0.5 of metatibia usually straw coloured or occasionally light reddish brown, and apical 0.5–0.7 of metatibia, and metatarsomere 1 clearly darker than basal 0.3–0.5 of metatibia, but metatarsomeres 2–5 less dark than metatarsomere 1. Palpi, tegula and mandible (except apex) straw coloured.

Scape to flagellomere 2 straw coloured, thereafter brown to dark brown. Stigma dark brown and straw coloured in basal 0.3.

Structure. Flagellum with 18–20 flagellomeres (respectively 12%, 73% and 12% of 17 specimens) and flagellomeres enlarged in apical 0.5. Few of the preapical flagellomeres subquadrate (none 3%, one 15%, two 9%, three 29% and four 44% of 34 specimens). Length of gena behind eye 0.91–1.09 times as long as length of eye. Height of eye 1.34–1.52 times as long as minimum distance between inner eye margins (as in Fig. 18). Maximum width of head behind eyes subequal (0.93–0.97) to maximum head width at eye level. Occipital carina developed in dorsal third. Metasomal tergum 1 with lateral edges clearly convergent (posterior margin 2.1–2.4 times as wide as narrowest width near base) and elongate (medial length of tergum 1.5–1.7 times maximum width at posterior end). Radial cell length 0.94–1.13 as long as stigma width (as in Figs. 58–63). Forewing vein r in most specimens not developed (78% based on 100 specimens) and short (Fig. 59, 60), and basal cell of forewing (except extreme base) pubescent (as in Fig. 54).

Sculpture. Punctures on vertex 5–10 μm in diameter, on frons and mesoscutum about 10–15 μm in diameter (a little larger than diameter of ommatidia). Punctures 20–25 μm apart on vertex (especially between lateral ocellus and inner eye margin), 5–15 μm apart on frons to 5–10 μm apart near antennal socket, and 20–25 μm apart on mesoscutum. Punctures on mesopleuron generally dense, occasionally scattered. Clypeus generally smooth, rarely punctate all over. Metasomal tergum 1 with about 10–12 longitudinal ridges, these often anastomosing on disc and forming a puncture-like sculpture.

MALE. Unknown.

Taxonomic notes. The holotype was not seen, but several specimens reared in a laboratory colony in Delaware originating from the type locality have been studied. The lack of r vein in the forewing, discovered by Shaw (Day *et al*. 1999), applies to the holotype. The character is not seen in all specimens of this species studied and it also shows up frequently in adults of closely related species. Nevertheless, evidence discussed below supports its specific status.

Adults of *P. howardi* are most similar to those of *P. broadbenti*. Almost no structural differences were found between *P. howardi* and *P. broadbenti*. Adults of *P. howardi* differ from those of *P. broadbenti* in the development forewing vein r, the lack of males, and a multivoltine life cycle. A summary of measurement differences between *P. broadbenti* and *P. howardi* is given in Table 17.

Almost no structural differences were found between *P. howardi* and *P. gillespiei*. Adults of *P. howardi* differ from those of *P. gillespiei* in the development of the forewing vein “r”, males unknown, and the multivoltine life cycle. A summary of measurement differences between *P. howardi* and *P. gillespiei* is given in Table 17.

Adults of *P. howardi* could easily be confused with those of *P. braunae* a darkly coloured species. They are easily distinguished from those of *P. braunae* by the colour of the clypeus and metatibia, by the puncture density on the vertex especially between the

lateral ocellus and the inner eye margin, by the the ratio of eye height to minimal distance between eye inner margins, and the ratio of length of flagellum to maximum width of head between outer eye margins.

Host and biological notes. Adults of *P. howardi* have been reared from field-collected *Lygus hesperus* and in the laboratory on *L. lineolaris* (Day *et al*. 1999). Adults occur from early May to late September with peaks of abundance probably in mid June, late July, and early September. This is a multivoltine species. Females of this species parasitize nymphs of all generations of *Lygus*.

Material examined and range. 56 (56♀) adults were studied. All were reared from Miridae. The species is known from the northern portions of the Great Basin in Idaho and Washington.

USA. DE: Newark, Laboratory colony from ID, Canyon Co., Parma (52♀; CNCI, USDA, USNM). **ID:** Canyon Co., Parma (5♀, not seen; ESUW). **WA:** Benton Co., EWSU Exp. Station N of Prosser (4♀; ESWU, CNCI).

Concluding remarks on the *Leiophron* and *Peristenus* associated with *Lygus*

Sixteen species (4 *Leiophron* and 12 *Peristenus*) are recognized as parasitizing *Lygus* in North America, including 3 species intentionally introduced from Europe. Eight new species are described and *P. mellipes* (Cresson) is removed from synonomy. The number of species may still increase significantly in future studies because the endoparasitoid fauna of *Lygus* nymphs remains poorly understood in the southern half of the United States.

Resolution of the *P. pallipes* complex was possible because of the extensive collections of reared material and associated biological information from biological control research conducted during the last 15 years. Loan (1970) showed in his work on *P. pseudopallipes* that biological information was valuable to understanding differences between cryptic species. Of the nine North American species in the *P. pallipes* complex associated with *Lygus* spp. six are newly described and one is removed from synonymy. Only *P. pseudopallipes* and *P. howardi* were previously recognized. None of the European species in the *P. pallipes* complex are recorded from North America.

There is a marked difference in species composition between the temperate faunas east and west of the prairies. In each region, seven have been recorded. Of the five species of each region none are shared. However, the most unexpected change was seen in the boreal regions (including cool maritime and montane zones). The species in boreal regions are less diverse (3 native species) and, except for *L. lygivorus*, none is shared with either of the temperate eastern and western regions. Though we have almost nothing from the prairie region in the United States, it seems that the prairie region is a barrier for numerous insects from the eastern and western temperate regions. The barrier from the temperate to the boreal regions is not obvious as the range of many species of insects can extend over part

of temperate and boreal regions. In this situation, the barrier is likely the change from two full generations of various *Lygus* species to one or mainly one generation per year.

Parasitoid biology and its impact on *Lygus*

Biology. Of the euphorine endoparasitoid complex associated with *Lygus* species in North America (Table 18) all but one of the species, *P. howardi*, have been reared from *Lygus lineolaris. Lygus lineolaris*, the most widely distributed *Lygus* species in North America, was recorded from over 300 host plants and has 1–5 annual generations (Schwartz & Foottit 1998). Because *L. lineolaris* is found in a wide variety of habitats it is available to a greater number of parasitoid species.

All four species of *Leiophron* recorded on *Lygus* are native. Three of the species have been reared from *Lygus lineolaris* only and have eastern distributions. The fourth species *L. uniformis*, is widespread in the continental United States and is known to parasitize seven species including *Lygus lineolaris*, although its major host is the potato leafhopper, *Halticus bractatus,* which is common throughout the range of *L. uniformis*. All of the *Leiophron* species treated here are bivoltine and each attacks first and second generation *Lygus lineolaris*.

Of the 12 species of *Peristenus* treated, 3 are introduced and 9 are native. The native North American *Peristenus* spp. appear to have regional distributions (Table 18). Northern boreal or montane species include *P. braunae* and *P. otaniae*, both of which are univoltine. *Peristenus otaniae* and *P. braunae* parasitize the first generation of *Lygus lineolaris.* The main host of *P. braunae* is *Adelphocoris lineolatus*. Western temperate species include *P. broadbenti, P. carcamoi, P. gillespiei*, and *P. howardi*. Of these, *P. howardi* is multivoltine and *P. carcamoi, P. gillespiei* and *P. broadbenti* are univoltine. *Peristenus gillespiei* and *P. carcamoi* parasitize the first generation of *Lygus* whereas *P. broadbenti* parasitizes the second generation. The eastern species are all univoltine. *Peristenus dayi* and *P. mellipes* parasitize the first generation of *Lygus* whereas *P. pseudopallipes* parasitizes the second generation. The main host for *P. dayi* is *Adelphocoris lineolatus*, a multivoltine species, whereas *P. mellipes* primarily parasitizes first generation and *P. pseudopallipes* parasitizes second generation *L. lineolaris*.

Three Palaearctic *Peristenus* spp. have been successfully introduced to North America. *Peristenus digoneutis* was the first to be established and its spread in eastern North America is well documented (Day *et al.* 1990, 1996, 1998, 2000). More recently it has been established in California (Pickett *et al*. 2003, 2005). In Europe, *P. digoneutis* has been reared from 11 hosts, of which *Lygus rugulipennis*, *L. pratensis* (L.), *L. maritimus* Wagner and *Adelphocoris lineolatus* are parasitized at significant levels (i.e. >5%) (Haye *et al*. 2005). In eastern North America, *P. digoneutis* primarily parasitizes *Lygus lineolaris*, which is an ecological counterpart to *L. rugulipennis*, and occasionally the introduced

species *Trigonotylus caelestialium* and *Leptopterna dolobrata* (Day 1999). A second species, *P. rubricollis*, was introduced accidentally into northeastern USA (Day *et al*. 1992 [as *P. conradi*]). This species mainly parasitizes *Adelphocoris lineolatus* but also sometimes *Lygus lineolaris* (Day 1999). The third introduced species, *P. relictus*, is recently established in California (Pickett *et al*. 2001, 2005 [as *P. stygicus*]). In Europe, *P. relictus* has been reared from 16 hosts, of which *Lygus rugulipennis*, *L. pratensis*, *L. maritimus*, *Trigonotylus caelestialium*, *Plagiognathus chrysanthemi* (Wolff) and *Adelphocoris lineolatus* are the primary hosts (Haye *et al*. 2006). In North America, *P. relictus* has so far been reared from mixed populations of field-collected *Lygus hesperus* and the introduced European *Closterotomus norvegicus* (Gmelin) (Pickett *et al*. 2003, 2005).

Impact on *Lygus*. To better resolve host-parasitoid dynamics, populations of plant bugs and associated parasitoids were monitored weekly during 2000–2002 in an alfalfa (Ste. Clotilde) and a hay (Hemmingford) field in southern Quebec. These sites were also sampled once in June of 1998 and 1999. Only *Lygus lineolaris* adults were collected from the sites, thus all *Lygus* nymphs collected were assigned to this species. The euphorine parasitoid complex associated with *Lygus lineolaris* from these sites consisted of six species (Table 18). Of these, *P. dayi* and *P. rubricollis* mainly attack *Adelphocoris lineolatus*, and only rarely use *Lygus lineolaris* as a host. Both parasitoid species are univoltine and are present during the first *Lygus* generation when their multivoltine primary host (i.e., *Adelphocoris lineolatus*) occurs. The remaining four species parasitize mainly *Lygus lineolaris*. Two species, *P. mellipes* and *P. pseudopallipes*, are univoltine and each species attacks the first *Lygus* generation and the second *Lygus* generation respectively. Two species, *Leiophron lygivorus* and the introduced *P. digoneutis*, are bivoltine and each attacks both *Lygus* generations.

Females of *Leiophron* and *Peristenus* oviposit in the haemocoel of second and third instar nymphs (Loan 1980); thus adult parasitoids should fly during those periods when suitable host stages are present. In southern Quebec, *Lygus lineolaris* completes two annual generations and nymphs are present from late May to late June (first generation) and late July to late August (second generation) although in some years depending on climatic factors the generations may be slightly earlier or later. Data from the 2002 southern Quebec sampling demonstrates the relationships clearly. *Lygus lineolaris* had discrete spring and summer generations, and the greatest numbers of 1–3 instar nymphs were present from about June 4 – July 4 and July 24 – September 7 (Fig. 90). Incidence of adult euphorine parasitoids showed that maximum numbers of *P. mellipes* (Fig. 88b) are most closely synchronized with the increase in numbers of first generation *Lygus lineolaris*, and those of *P. pseudopallipes* with the second *Lygus lineolaris* generation (Fig. 88c), whereas those of *P. digoneutis* (Fig. 88d) with both first and second generation *Lygus lineolaris*. The initial adult flight period of *Leiophron lygivorus* extended over 8 weeks

without a distinct peak for first generation *Lygus lineolaris*. A second flight period began during the second *Lygus lineolaris* generation, and was well synchronized with the onset of increasing numbers of second instar of *L. lineolaris* (Fig. 88a). In 2002, the peak abundance of *P. pseudopallipes* occurred 2 weeks later than expected (Fig. 88c) and was dominated by males. This is abnormal based on observation in previous years (1994 to 1997, and 1999 to 2001 at various sites). In 2002, the site had been cut before the August 13 sample. Adults especially males may have migrated to an adjacent small uncut alfalfa parcel. In previous years, peaks of abundance of *P. pseudopallipes* were at the end of July at the peak of abundance of second and third instar nymphs of *Lygus lineolaris*. In contrast, the numbers of adult *P. dayi* collected peaked about 2 weeks before the numbers of second instar *Lygus lineolaris* nymphs increased (Fig. 88e), supporting the hypothesis above that *L. lineolaris* is a secondary host for *P. dayi*.

Collections of *P. mellipes*, *P. pseudopallipes* and *P. digoneutis* showed a classic 1:1 female to male sex ratio when peak adult numbers were found (Figs. 89a, 89b, 89c). This peak also coincides with the peak of abundance of first and second instar nymphs of *Lygus lineolaris*. During this peak, third instar nymphs of *L. lineolaris* are also present, but in low numbers. The sex ratio is male biased before this peak when few first instar nymphs are recorded, and female biased after this peak following the increase in second and third instar host nymphs. An exception to this was *P. pseudopallipes* in 2002, though not in previous years, where fewer females than males were collected during the week of August 13 (Fig. 89c). This discrepancy again may possibly have resulted because the field was recently cut.

The discovery of *P. digoneutis* in southern Quebec in 1997 (Broadbent *et al*. 1999) provided an opportunity to monitor its establishment. Samples collected each year during peak abundance periods (Day *et al*. 1990) showed that the proportion of *P. digoneutis* relative to *L. lygivorus*, *P. dayi*, *P. mellipes*, and *P. pseudopallipes* increased from <1% in 1998 to 62% in 2002 (Fig. 91). Overall numbers of *Lygus lineolaris* declined from 2000–2002 suggesting that *P. digoneutis* had an impact on its population. However, the average numbers of fourth and fifth instar nymphs collected from first and second generations showed no consistent trends (Table 19). In the Hemmingford site hay field, the numbers of *Lygus lineolaris* were similar in 2000 and 2002 but much lower in 2001. The numbers of second generation *L. lineolaris* in the hay field showed a general decline whereas in the alfalfa there was an increase in numbers of *L. lineolaris* (almost 2 fold) in each successive year. Overall, populations of *L. lineolaris* were higher in the alfalfa than in the hay field habitat. Parasitism levels also showed no consistent trends. In the hay field, parasitism levels of first generation *L. lineolaris* declined whereas those of the second generation increased slightly from 2000 to 2001, and then almost doubled in 2002. In the alfalfa field, parasitism levels remained about the same in each year whereas second generation levels of *L. lineolaris* markedly declined. These results might suggest that *P. digoneutis* was more successful in unmanaged habitats (hay) than in managed habitats

(alfalfa). Day (1996) reported a 40–50% increase of parasitism and a 75% decrease in *L. lineolaris* numbers in New Jersey after release of *P. digoneutis*. However, these dramatic changes became evident only 10 years after initial and repeated introductions of *P. digoneutis*. Therefore, evidence of significant impact of *P. digoneutis* parasitism on *L. lineolaris* populations in southern Quebec may not occur for several years. The absence of a significant impact on *L. lineolaris* populations in southern Quebec suggests that *P. digoneutis* has only recently become established and is in an 'expansion' phase where it is extending its range from the original release sites in the northeastern United States. It is likely to continue spreading throughout eastern Canada. Its numbers are still increasing.

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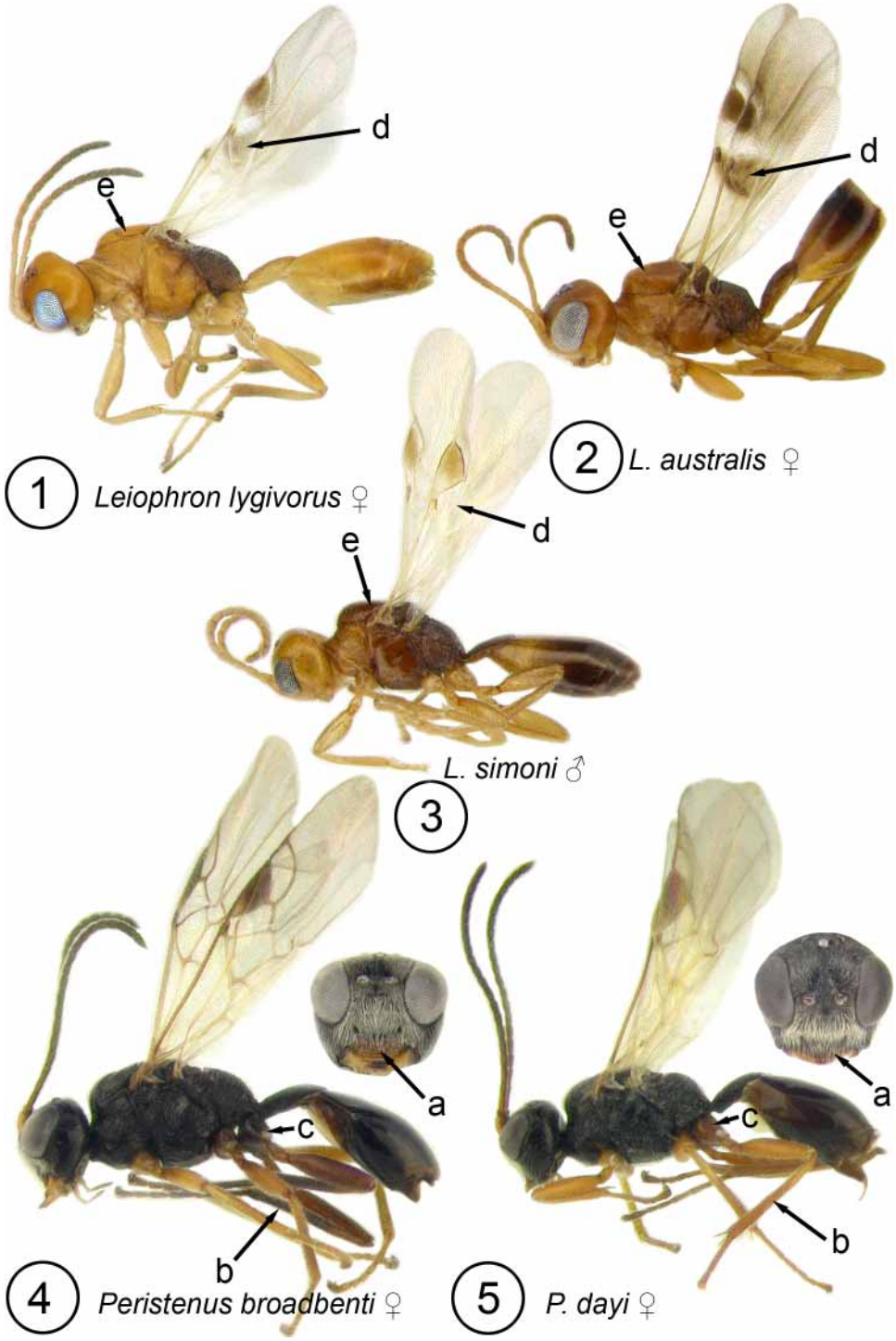
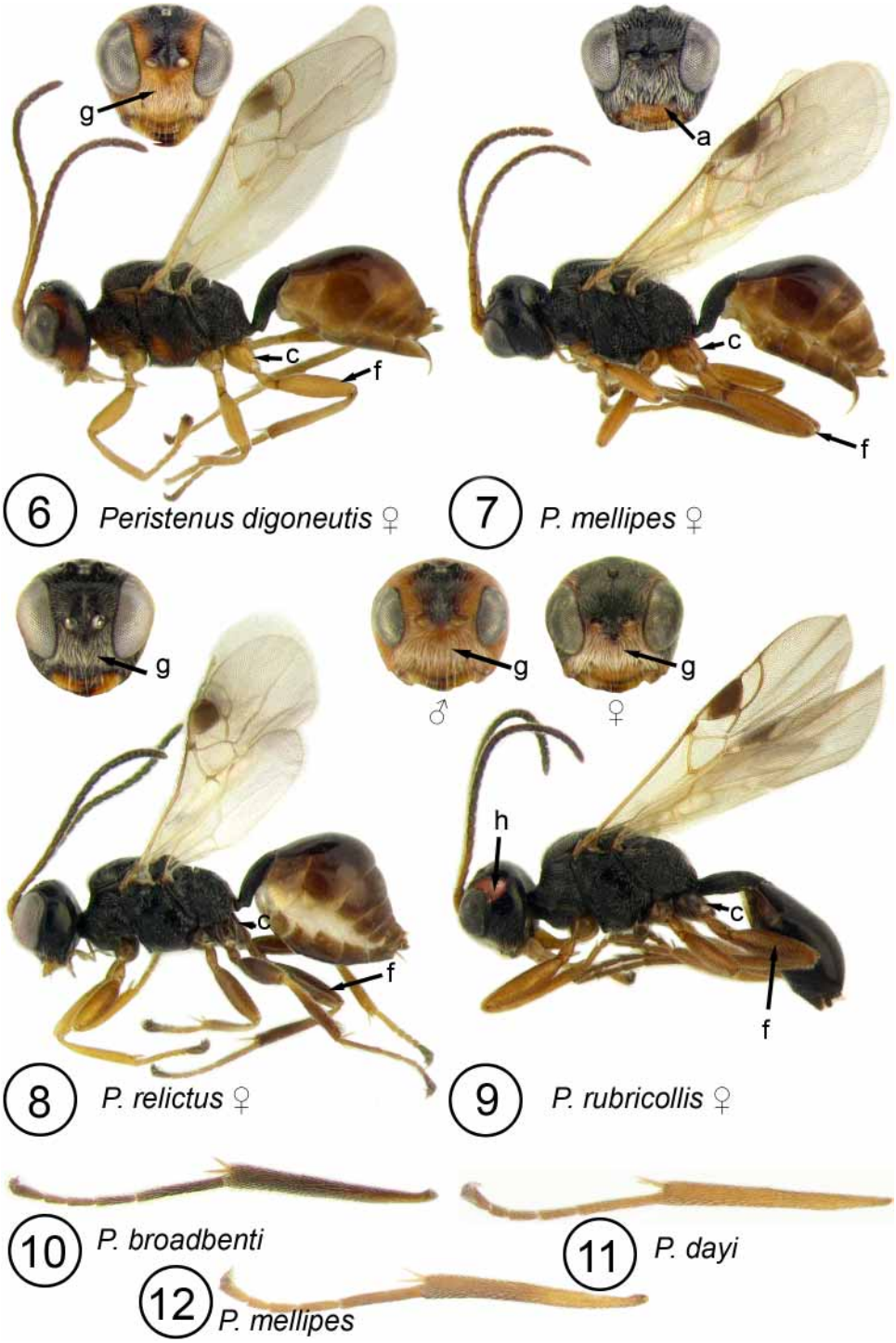
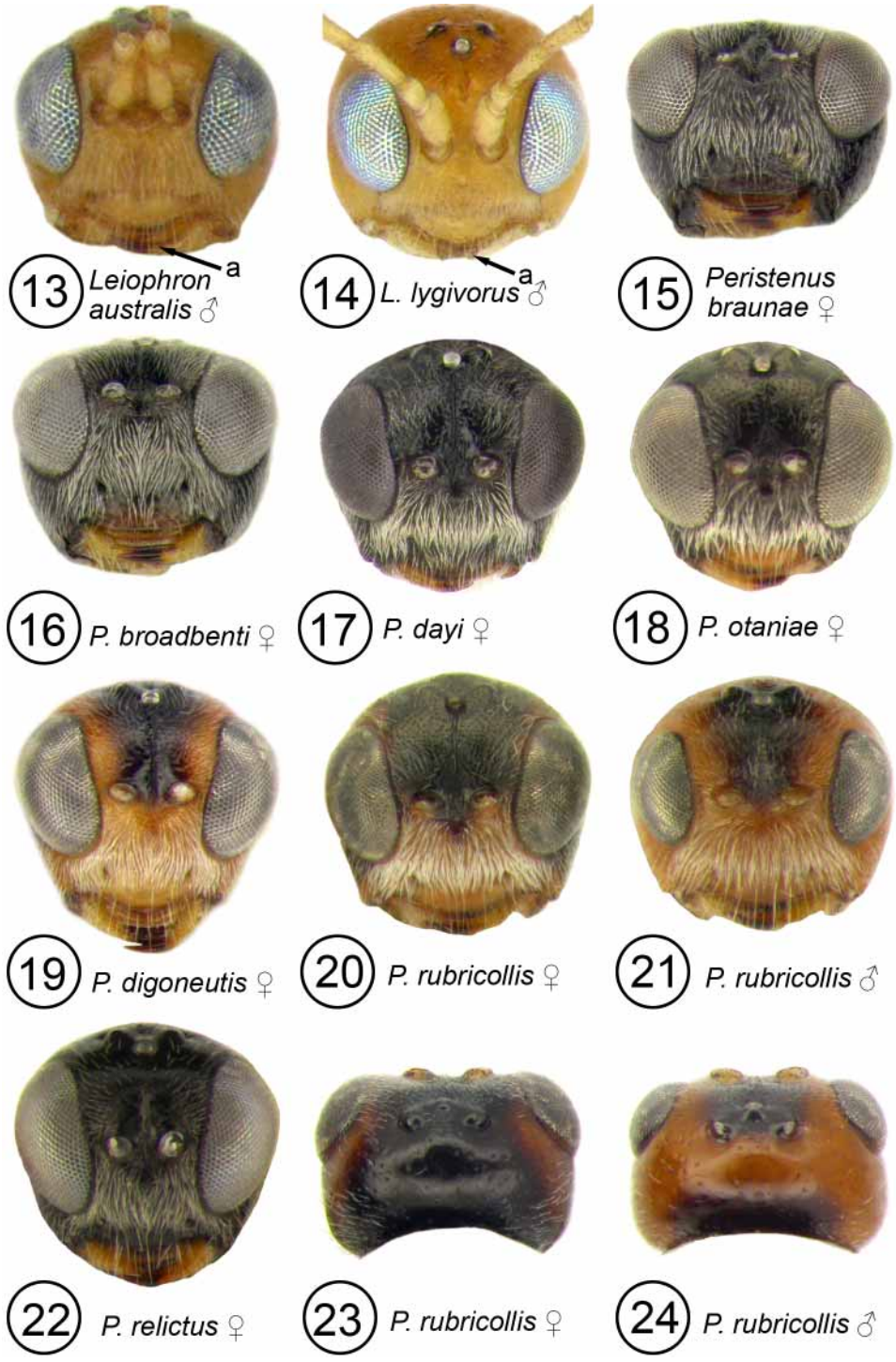


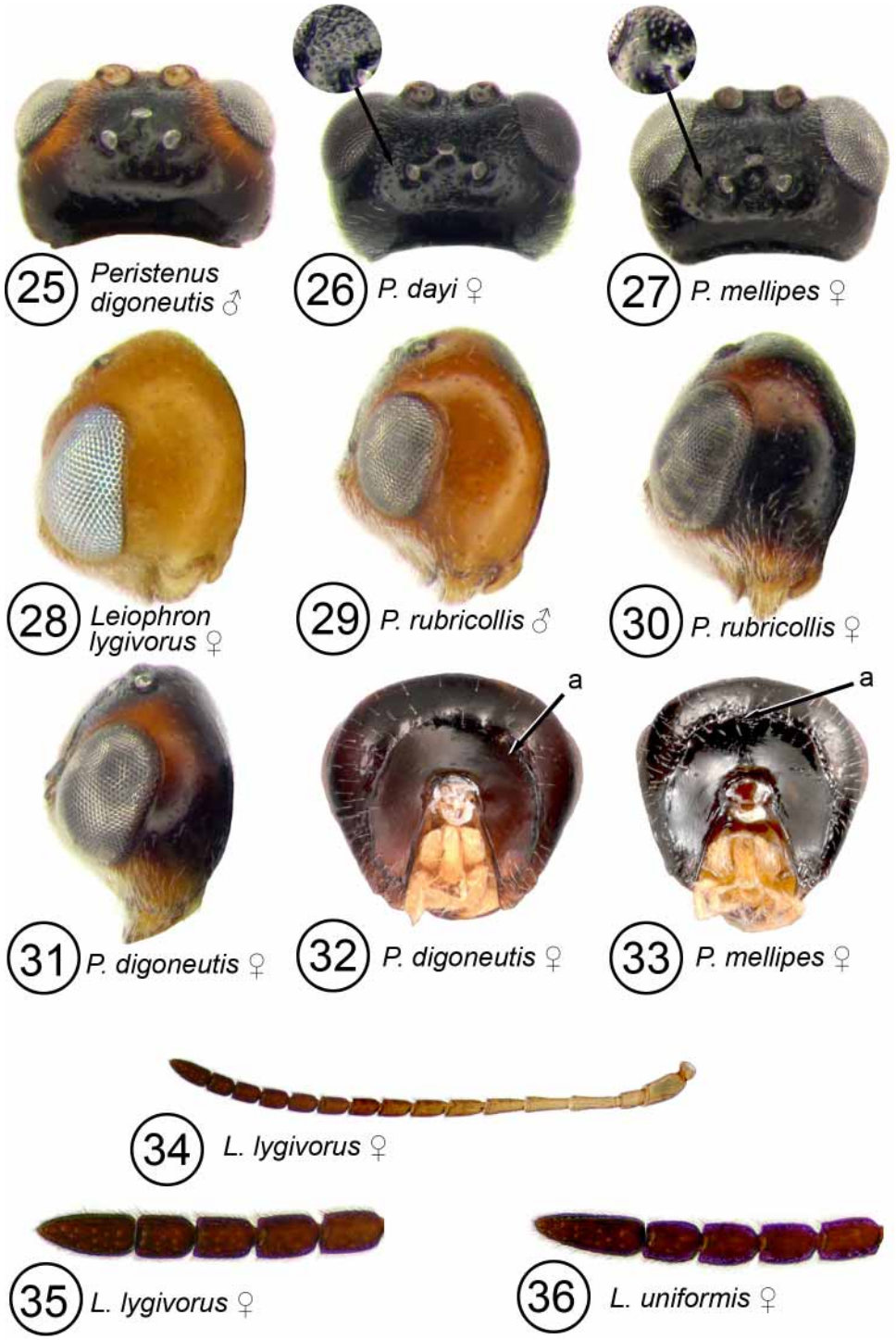
FIGURES 1–5. Habitus with frontal view of head. Codes: “a” clypeal colour; “b” metatibial colour; “c” metacoxal colour; “d” forewing colour; “e” mesoscutal colour.



FIGURES 6–12. 6–9. Habitus with frontal view of head. Codes: "a" clypeal colour; "c" metacoxal colour; "f" metafemoral colour; "g" facial colour; "h" genal spot. **10–12**. Lateral view of metatibia.



FIGURES 13–24. **13–22**. Frontal view of head. Code : "a" ventral edge of clypeus. **23–24**. Dorsal view of head.



FIGURES 25–36. **25–27**. Dorsal view of head with insert to show sculpture. **28–31**. Lateral view of head. **32–33.** Posteroir view of head. Code: "a" dorsal end of occipital carina. **34.** lateral view of antenna. **35–36.** Last five flagellomeres in lateral view.

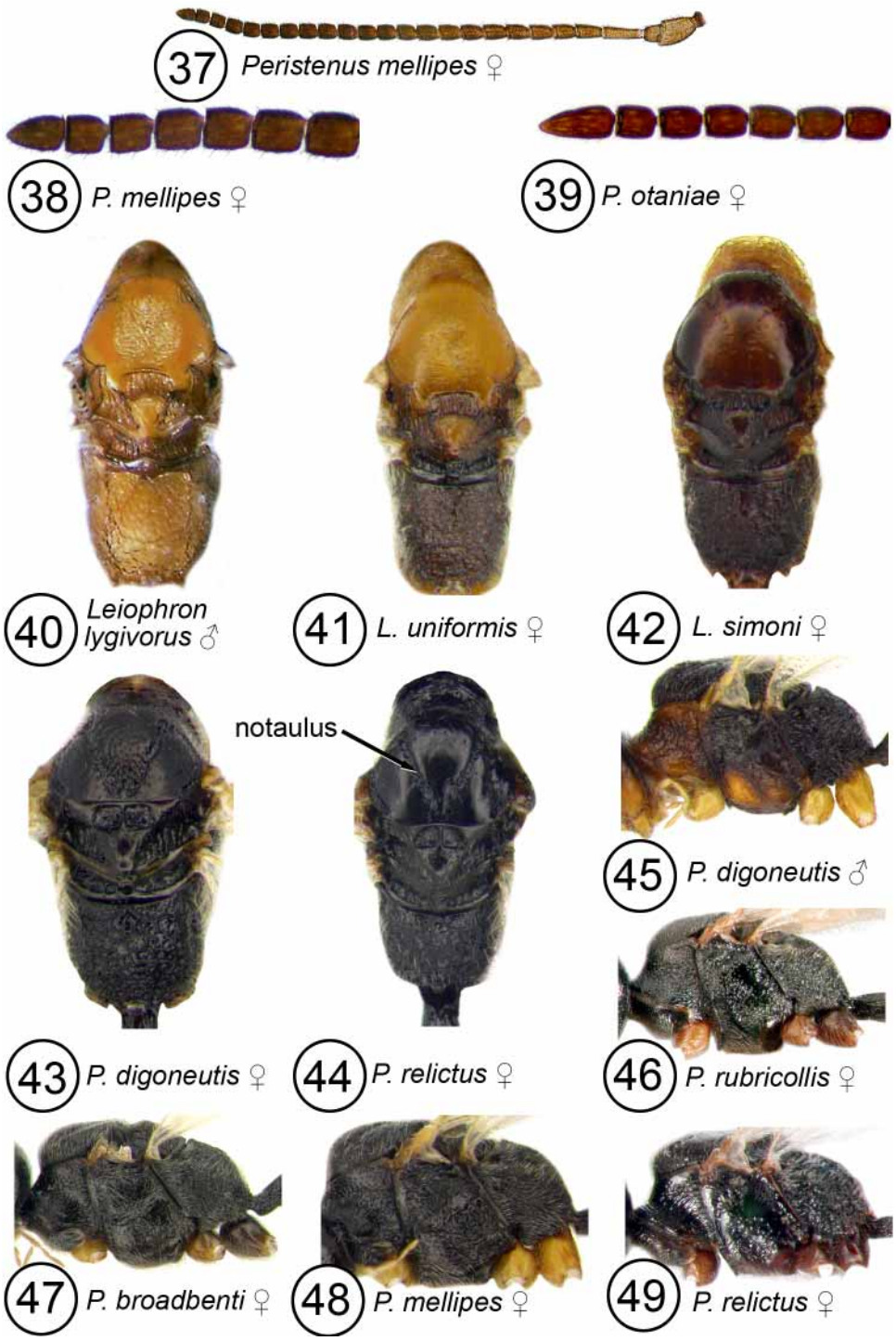
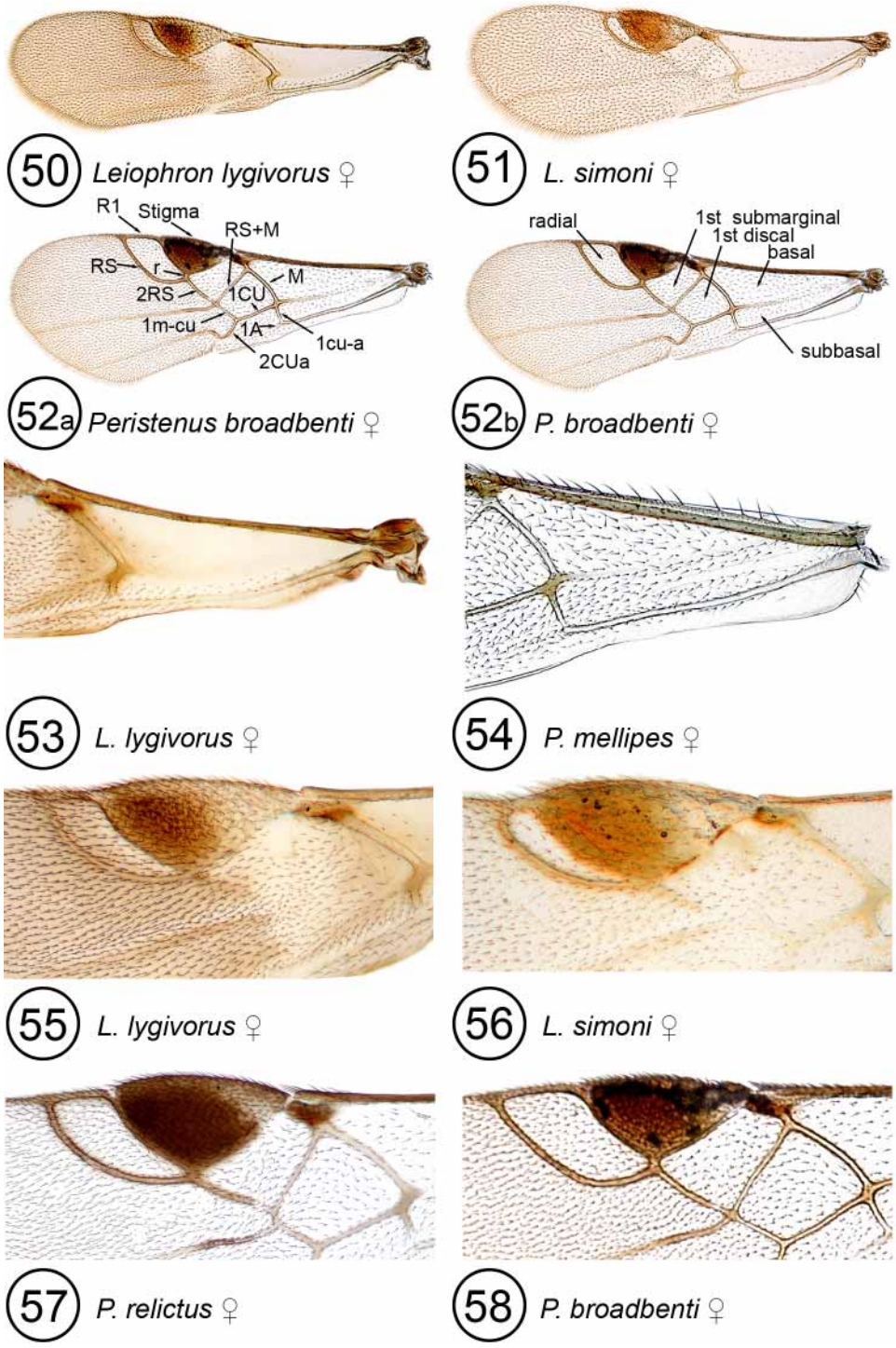
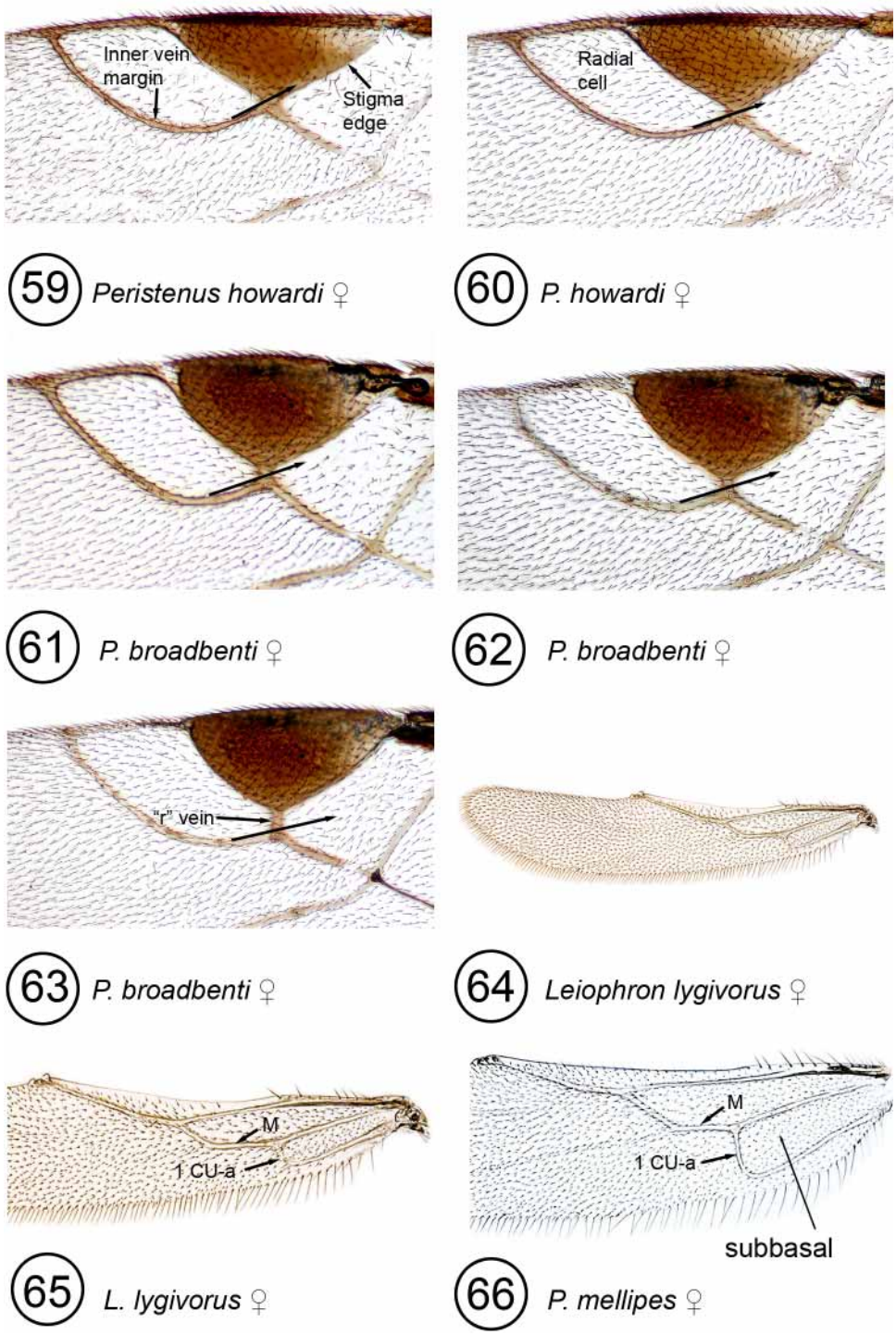


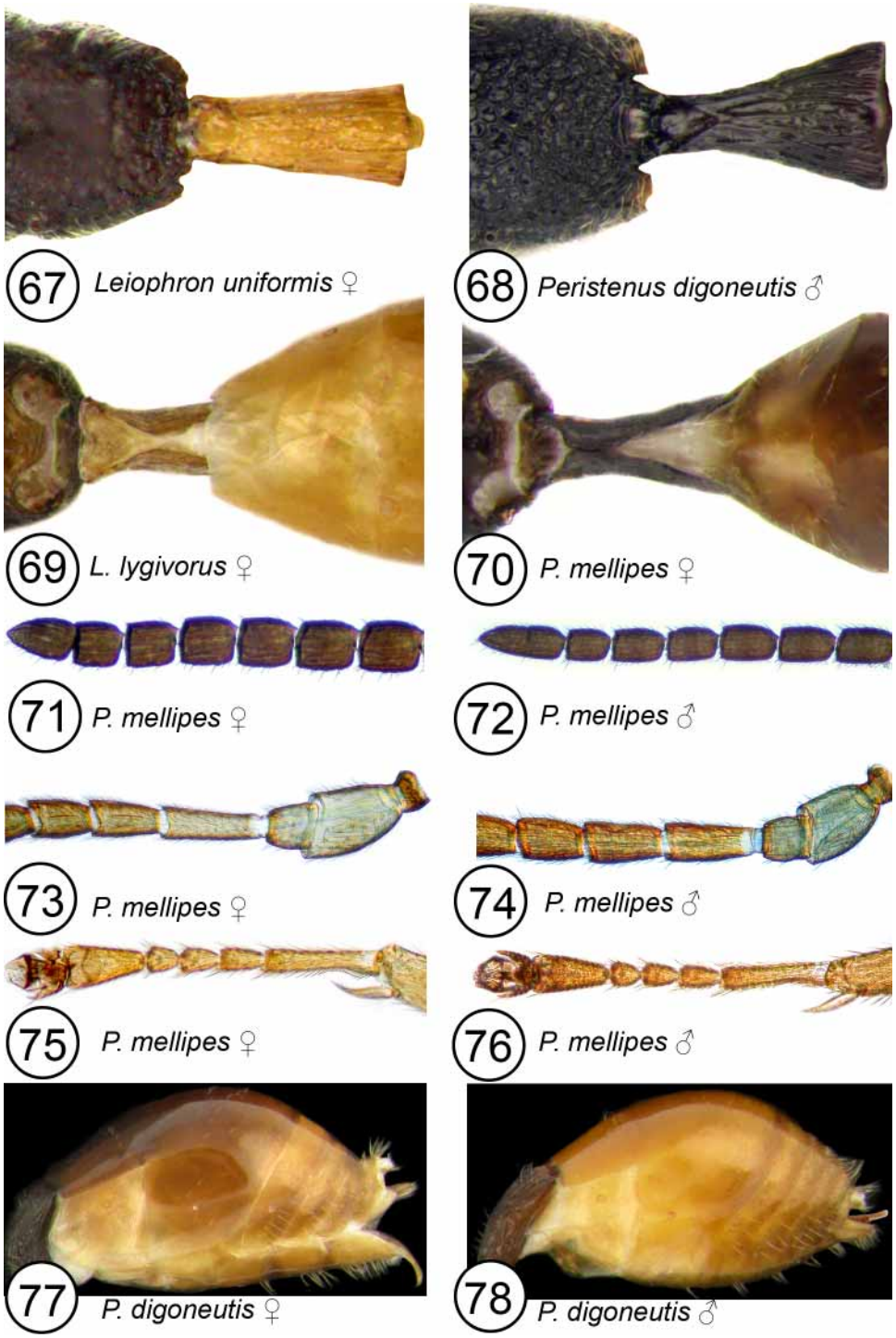
FIGURE 37–49. 37. Lateral view of antenna. **38–39**. Last six flagellomeres in lateral view. **40–44**. Dorsal view of mesosoma. **45–49.** Lateral view of mesosoma.



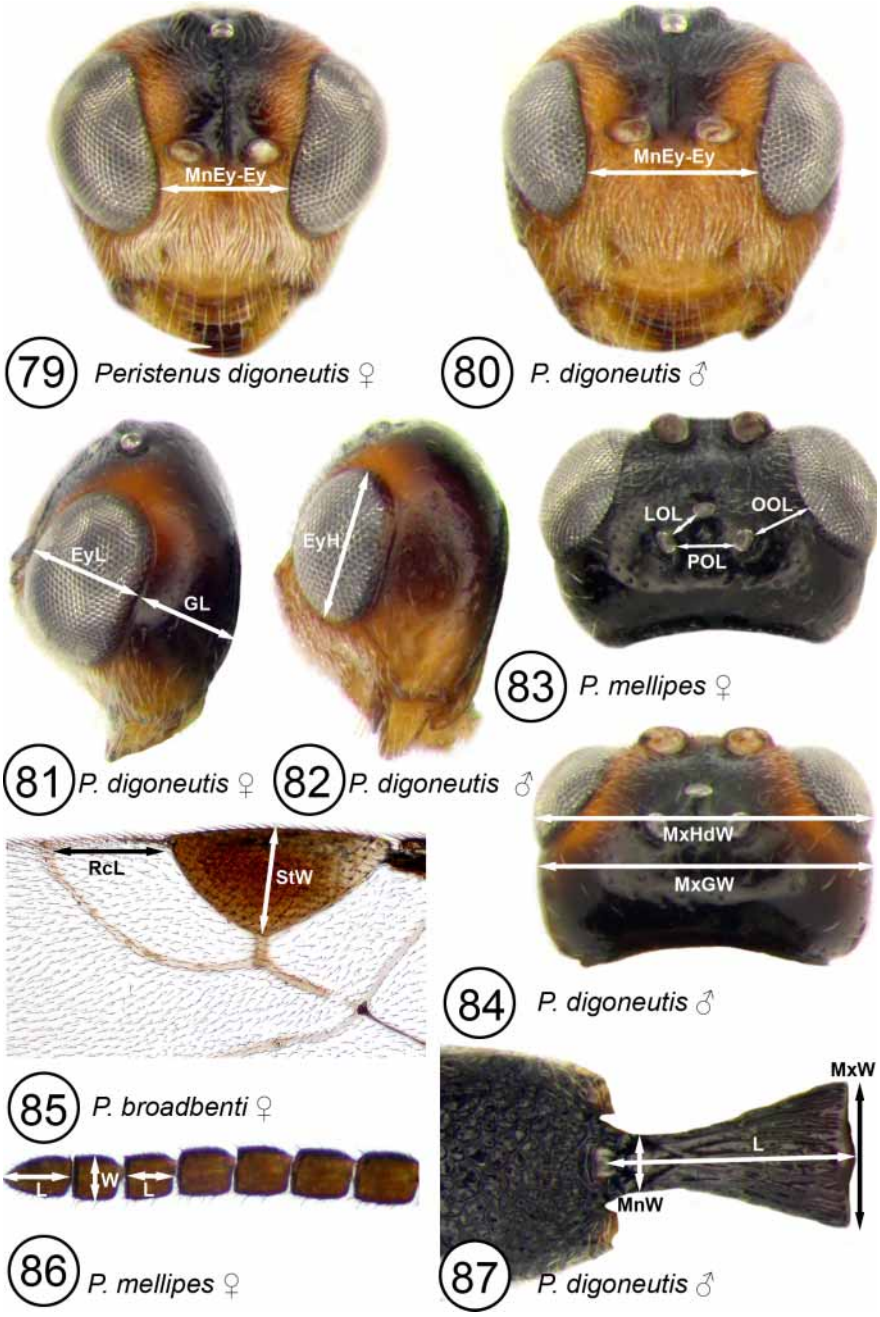
FIGURES 50–58. **50–52**. Forewing. **53–54.** Basal and subbasal cells of forewing. **55–58**. Radial cell and stigma of forewing.



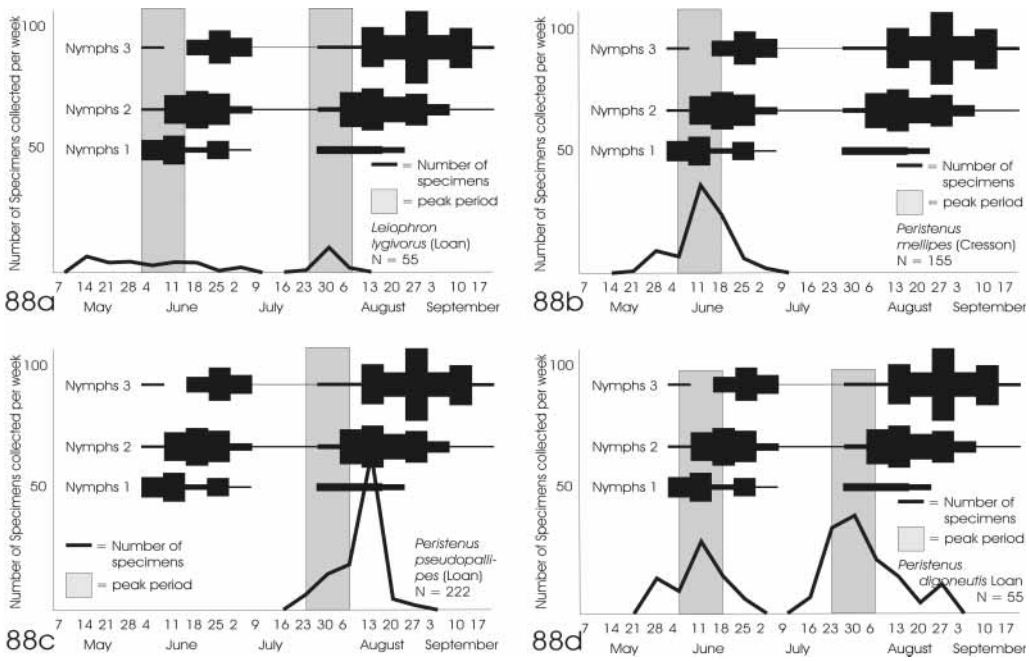
FIGURES 59–66. **59–63**. Radial cell and stigma of forewing. **64.** Hind wing. **65–66.** Basal and subbasal cells of hind wing.



FIGURES 67–78. 67–68. Dorsal view of metasomal tergum 1. **69–70.** Ventral view of metasomal segment 1. **71–72.** Lateral view of seven last flagellomeres. **73–74.** Lateral view of first three flagellomeres. **75–76**. Dorsal view of protarsus. **77–78.** Lateral view of metasoma.



FIGURES 79–87. 79–80. Frontal view of head (MnEy-Ey = minimum eye distance). **81–82.** Lateral view of head (GL = genal length, EyL = eye length, EyH = eye height). **83–84.** Dorsal view of head (LOL lateral ocelli length, POL posterior ocelli length, OOL ocellar ocular length, MxHdW = maximum head width, MxGW = maximum genal width). **85.** Radial cell and stigma of forewing (RcL = radial cell length, StW = stigma width). **86.** Lateral view of seven last flagellomeres (L= length, W = width). **87.** Dorsal view of metasomal tergum 1 (L = length, MxW = maximum width, MnW = minimum width).



FIGURES 88a–88d. Weekly number of *Lygus lineolaris* (Palisot) nymphs of instars 1–3 and of euphorine adult parasitoids collected in alfalfa and hay fields in southern Quebec in 2002: a) *Leiophron lygivorus* (Loan); b) *Peristenus mellipes* (Cresson); c) *Peristenus pseudopallipes* (Loan); d) *Peristenus digoneutis* Loan. Vertical gray bars represent the 2 week peak flight of adult parasitoids.

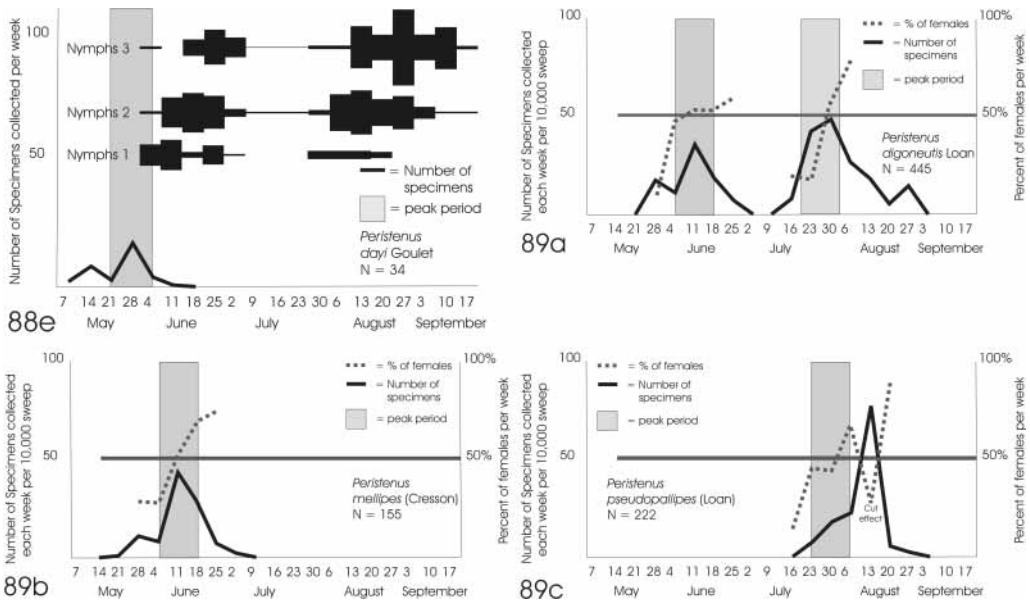


FIGURE 88e & 89. 88e. Weekly number of *Lygus lineolaris* (Palisot) nymphs of instars 1–3 and of euphorine adult parasitoids collected in alfalfa and hay fields in southern Quebec in 2002: *Peristenus dayi* Goulet. **89.** Number of adult *Peristenus* spp. and proportion of females collected per week in alfalfa and hay fields in southern Quebec in 2002: a) *Peristenus digoneutis* Loan; b) *Peristenus mellipes* (Cresson); c) *Peristenus pseudopallipes* (Loan). Vertical bars represent the 2 week peak flight of adult wasps; horizontal bar represents the 1:1 (♀:♂) sex ratio.

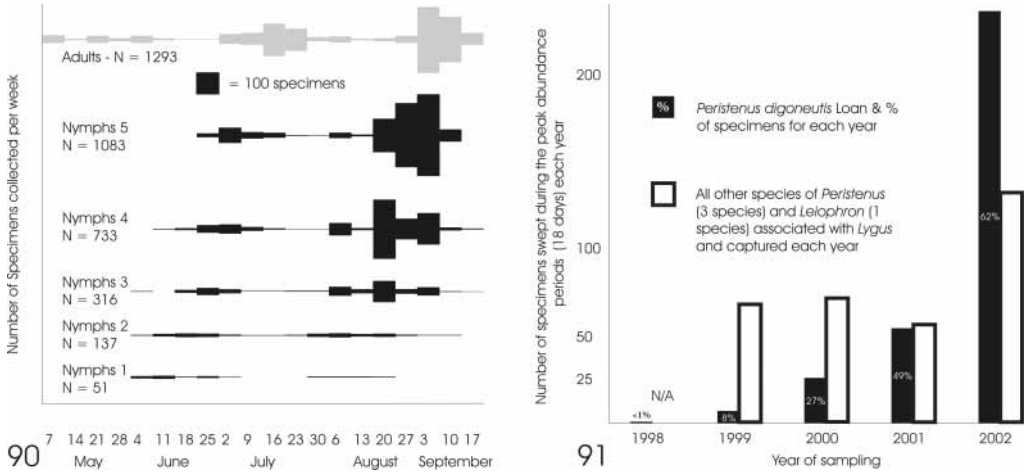


FIGURE 90–91. 90. Proportion of each stage of *Lygus lineolaris* (Palisot) present in alfalfa and hay fields in southern Quebec in 2002. **91.** Proportion of *Peristenus digoneutis* Loan versus other euphorine parasitoids collected during peak adult abundance periods in alfalfa and hay fields in southern Quebec 1998–2002.

TABLE 1. Measurements and ratios from 1 female and 1 male of *Leiophron australis* Goulet from Newark, DE, and Greene Co., NY.

Leiophron australis Goulet																
		Flagellomere measurements														
Sex		Flagellomere Length: Fl # (L)														
	Stats	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
F		110	100	90	80	70	70	70	60	60	60	60	60				
M		90	85	80	75	60	50	50	55	50	50	50	50	50			
M&F																	

		Flagellomere Length						13/14	Length	Flagellomere Width: Fl # (W)							
	Stats	17	18	19	20	21	22	Last	Fl (L)	1	Mid	-6	-5	-4	-3	-2	-1
F								120	1010	40	50	-	-	50	50	50	50
M								95	890	30	45	-	-	40	40	40	40
M&F																	

		Flagellomere Ratios: Fl # (L/W)								Fl (L)/	Metasomal tergum 1			Forewing	
	Stats	1	Mid	-6	-5	-4	-3	-2	-1	MxHdW	L	Mx W	Mn W	RcL	StW
F		2.75	1.40	1.20	1.20	1.20	1.20	1.20	1.20	1.94	340.0	120.0	90.0	90	178
M		3.00	1.22	1.40	1.10	1.25	1.25	1.25	1.25	2.07	310.0	120.0	85.0	80	160
M&F															

Sex		*Leiophron australis* Goulet								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F		510	520	175	312.5	200	175	70	90	110
M		420	430	187	225	162.5	150	50	80	90
M&F										

		Head Ratios						Tergum 1 Ratios		Forewing Ratio
	Stats	MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/MnW	RcL/StW
F		0.98	1.79	1.14	1.29	1.57	1.22	2.83	1.35	0.51
M		0.98	1.20	1.08	1.60	1.80	1.12	2.58	1.36	0/50
M&F										

TABLE 2. Measurements and ratios from 10 females and 10 males of *Leiophron lygivorus* (Loan) from Guelph, ON.

		***Leiophron lygivorus* (Loan)**															
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	121.8	116.8	103.0	89.1	73.7	71.7	68.3	69.8	69.3	67.8	61.9	59.9				
	SD	10.5	9.1	8.3	10.4	5.9	4.8	2.1	2.8	2.3	3.3	3.5	2.8				
M	**Mean**	118.3[1]	113.8[1]	99.0[2]	86.6	74.2	71.8	69.3	68.8	65.3	64.3	61.4	59.4	57.4	53.9		
	SD	10.0	8.4	0.0	6.3	4.0	6.7	4.7	5.4	5.1	4.7	5.8	6.6	4.8	4.6		
M&F	**Mean**	120.0	115.3	101.0	87.9	74.0	71.8	68.8	69.3	67.3	66.1	61.6	59.6				
	SD	10.1	8.7	6.1	8.5	4.9	5.7	3.6	4.2	4.4	4.3	4.7	4.9				
		Flagellomere Length						**13/15**	**Length**			**Flagellomere Width: Fl # (W)**					
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**							124.2	1097.4	37.6	49.0	-	-	49.5	49.5	49.5	49.5
	SD							13.8	58.1	2.6	1.6			0.0	0.0	0.0	0.0
M	**Mean**							101.5	1159.8	40.6[1]	48.5	-	-	49.0	48.5[1]	48.5	48.0[2]
	SD							17.3	74.0	2.1	3.9			1.6	2.1	2.1	3.3
M&F	**Mean**							112.9	1128.6	39.1	48.8	-	-	49.5	49.3	49.0	49.0
	SD							18.2	72.2	2.7	2.9			1.6	1.1	1.5	1.5
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**			
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**		
F	**Mean**	3.25	1.40	-	-	1.40[1]	1.37[2]	1.25	1.21[2]	2.03	396.2	165.0	103.7	83.2	168.0		
	SD	0.39	0.07			0.05	0.07	0.07	0.06	0.099	18.7	9.9	10.3	7.5	11.9		
M	**Mean**	2.93	1.43	-	-	1.27	1.22	1.20	1.16	2.16	387.5[2]	183.7[1]	123.7[1]	68.7	158.0		
	SD	0.25	0.10			0.134	0.134	0.111	0.118	0.086	21.2	11.9	4.0	10.6	13.2		
M&F	**Mean**	3.09	1.41	-	-	1.33	130	1.22	1.19	2.09	391.9	174.4	113.7	76.0	163.0		
	SD	0.36	0.09			0.119	0.127	0.94	0.092	0.114	20.0	14.3	12.8	11.6	13.3		

[1] differs by 1.00 to 1.49 SD from *L. uniformis* . [2] differs by 1.50 to 1.99 SD from *L. uniformis.*

Sex		*Leiophron lygivorus* (Loan)								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	539.6	542.0	202.9	301.0[1]	227.7	169.3	62.4	103.9	115.8
	SD	17.6	23.0	8.4	11.6	18.7	13.6	4.8	5.2	8.2
M	**Mean**	559.3[1]	536.6[1]	243.5[1]	262.8[2]	235.6[1]	152.5[1]	66.3	103.5	121.8[1]
	SD	26.9	24.2	8.3	14.1	15.4	6.9	4.2	5.9	11.5
M&F	**Mean**	549.4	539.3	223.2	281.9	231.6	160.9	64.3	103.7	118.8
	SD	24.4	23.1	22.4	23.2	17.1	13.6	4.8	5.4	10.2
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	1.00	1.48	1.36	1.67	1.87	1.12	2.41[1]	1.60	0.50
	SD	0.015	0.067	0.184	0.132	0.215	0.078	0.128	0.167	0.062
M	**Mean**	1.04	1.08[1]	1.55	1.57	1.84	1.18	2.11	1.49	0.44
	SD	0.015	0.058	0.122	0.135	0.157	0.144	0.126	0.095	0.062
M&F	**Mean**	1.02	1.28	1.45	1.62	1.85	1.15	2.26	1.54	0.47
	SD	0.030	0.216	0.181	0.142	0.184	0.118	0.195	0.145	0.069

[1] differs by 1.00 to 1.49 SD from *L. uniformis.* [2] differs by 1.50 to 1.99 SD from *L. uniformis.*

TABLE 3. Measurements and ratios from 10 females and 10 males of *Leiophron simoni* Goulet from Iberville, QC and Dunham, QC.

Leiophron simoni Goulet																	
								Flagellomere measurements									
Sex								Flagellomere Length: Fl # (L)									
	Stats	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
F	Mean	77.2[3,6]	78.7[3,5]	73.7[3,4]	72.3[1]	60.4[1,4]	62.4	56.9[3,4]	59.9[1]	58.4[2]	57.9[1]	55.4	54.9				
	SD	7.8	2.4	4.9	5.3	5.1	4.8	3.5	5.4	4.5	3.3	5.6	4.3				
M	Mean	69.7[3,4]	74.2[3,6]	67.8[3,4]	68.8[1]	60.4[2]	62.4	59.4[1]	62.4	57.9	57.9	56.4	53.5	52.5			
	SD	7.5	2.1	5.7	5.9	5.1	6.7	4.7	4.8	3.3	4.7	3.5	3.1	2.6			
M&F	Mean	73.5	76.5	70.8	70.5	60.4	62.4	58.2	61.1	58.2	57.9	55.9	54.2	52.5			
	SD	8.4	2.2	6.0	5.8	5.0	5.7	4.2	5.1	3.9	4.0	4.6	3.8	2.6			

		Flagellomere Length						13/14	Length	Flagellomere Width: Fl # (W)							
	Stats	17	18	19	20	21	22	Last	Fl (L)	1	Mid	-6	-5	-4	-3	-2	-1
F	Mean							103.0	871.2[1,4]	31.2[1]	39.6[1]	-	-	58.3[3,5]	58.3[1,4]	56.1[3,4]	55.0
	SD							15.6	60.0	2.4	3.3			4.8	3.3	5.5	4.6
M	Mean							93.6	896.9[3]	30.7[3]	38.6[1]	-	-	57.9[3]	56.4[2]	53.5[1]	52.5[1]
	SD							14.8	58.1	2.1	3.9			4.7	3.5	3.1	2.6
M&F	Mean							98.3	884.1	30.9	39.1	-	-	58.1	57.3	54.7	53.7
	SD							15.6	59.0	2.2	3.6			4.6	3.4	4.5	3.8

		Flagellomere Ratios: Fl # (L/W)								Fl (L)/	Metasomal Tergum 1			Forewing	
	Stats	1	Mid	-6	-5	-4	-3	-2	-1	MxHdW	L	MxW	MnW	RcL	StW
F	Mean	2.49[1,4]	1.44	-	-	1.39	1.36[4]	1.30	1.25[4]	1.85[1,4]	307.5[1]	171.2	97.5	50.0[3,4]	160.0
	SD	0.28	0.08			0.08	0.08	0.12	0.10	0.06	30.7	13.2	10.3	6.6	17.2
M	Mean	2.27[2,5]	1.54	-	-	1.54[1,4]	1.49[1]	1.41[2]	1.44[1]	1.99	296.5[2]	152.5	93.7[3]	46.9[1]	151.2
	SD	0.17	0.17			0.13	0.11	0.14	0.12	0.11	26.4	12.9	5.9	5.3	4.0
M&F	Mean	2.38	1.50	-	-	1.47	1.43	1.36	1.35	1.92	301.9	162.0	96.0	48.7	155.6
	SD	0.25	0.14			0.13	0.12	0.14	0.15	0.11	28.5	16.0	8.4	6.6	13.0

[1] differs by 1.00 to 1.49 SD from *L. lygivorus.* [2] differs by 1.50 to 1.99 SD from *L. lygivorus.* [3] differs by 2.00 or more SD from *L. lygivorus.* [4] differs by 1.00 to 1.49 SD from *L. uniformis.* [5] differs by 1.50 to 1.99 SD from *L. uniformis.* [6] differs by 2.00 or more SD from *L. uniformis.*

Sex		*Leiophron simoni* Goulet								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F	Mean	470.2[1]	492.0	173.2[1]	278.2	183.1[1,4]	155.4	62.9	99.5	99.5[1,4]
	SD	28.1	40.0	10.7	19.5	15.7	11.5	5.7	7.2	6.8
M	Mean	450.4[3]	447.0[3]	209.9[2]	316.8[2]	183.1[3]	126.7[1]	61.9	95.0	95.0[2]
	SD	20.5	20.2	9.1	9.8	8.4	10.2	4.2	4.5	5.1
M&F	Mean	460.3	469.5	191.6	247.5	183.1	141.1	62.4	97.3	97.3
	SD	26.0	35.7	21.1	34.9	12.2	18.1	4.9	6.3	6.3
		Head Ratios						Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/Mn W	RcL/StW
F	Mean	0.96[1,4]	1.61[4]	1.18[4]	1.59	1.59[4]	1.00	1.80[3,4]	1.76[4]	0.31[1,5]
	SD	0.02	0.07	0.11	0.08	0.13	0.06	0.12	0.10	0.03
M	Mean	1.01[1]	1.03[4]	1.46	1.54	1.54	1.00	1.95[1]	1.63	0.31[1,4]
	SD	0.02	0.04	0.16	0.12	0.09	0.07	0.22	0.10	0.03
M&F	Mean	0.98	1.32	1.32	1.56	1.56	1.00	1.87	1.70	0.31
	SD	0.03	0.30	0.19	0.10	0.11	0.06	0.19	0.12	0.04

[1] differs by 1.00 to 1.49 SD from *L. lygivorus*. [2] differs by 1.50 to 1.99 SD from *L. lygivorus*. [3] differs by 2.00 or more SD from *L. lygivorus*. [4] differs by 1.00 to 1.49 SD from *L. uniformis*. [5] differs by 1.50 to 1.99 SD from *L. uniformis*. [6] differs by 2.00 or more SD from *L. uniformis*.

TABLE 4. Measurements and ratios 10 females and 10 males of from *Leiophron uniformis* (Gahan) from London, ON, Talbotville, ON, Newark, DE, Moorestown, NJ, Blairstown, NJ, Rensselaer Co., NY, Lynnville, NY, Lake Harmony, PA and Milford, NH.

***Leiophron uniformis* (Gahan)**																	
Flagellomere measurements																	
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	112.9	103.0	91.6	81.7	69.8	68.3	66.3	66.3	64.8	61.9	56.9	56.4	51.9			
	SD	8.3	6.9	9.1	5.3	1.6	2.1	3.5	4.2	4.3	2.6	2.6	3.5	3.5			
M	**Mean**	94.0[1]	94.6[1]	84.1[2]	79.7	68.3	66.3	64.3	61.9	58.9	57.2	55.0	52.8	50.0	49.5		
	SD	12.6	6.8	8.4	8.2	5.1	5.8	4.7	6.3	4.9	5.0	6.3	6.5	4.6	0.0		
M&F	**Mean**	103.5	98.8	87.9	80.7	69.1	67.3	65.3	64.1	61.9	59.7	56.0	54.7	50.4			
	SD	14.2	7.9	9.3	6.8	3.8	4.4	4.1	5.5	5.4	4.5	4.7	5.3	4.3			
		Flagellomere Length						**14-15**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**							112.9	1021.2	35.6	46.0	-	-	48.5	49.0	49.0	48.5
	SD							23.9	49.2	3.9	4.1			2.1	1.6	1.6	2.1
M	**Mean**							95.7	988.9	34.2[1]	42.6	-	-	43.6	42.3[1]	41.8	41.2[2]
	SD							24.2	99.7	4.3	5.3			5.6	5.0	4.4	3.5
M&F	**Mean**							104.7	1055.9	34.9	44.3	-	-	46.0	46.3	45.9	45.3
	SD							25.0	76.9	4.1	4.9			4.8	4.9	4.9	4.7
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**				**Forewing**		
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**		**RcL**	**StW**	
F	**Mean**	3.19	1.45	-	-	1.26	1.16[2]	1.16	1.11[2]	1.96	347.5	164.2	109.7		78.2	155.5	
	SD	0.30	0.13			0.06	0.05	0.05	0.01	0.045	34.3	13.3	12.7		13.5	17.2	
M	**Mean**	2.77	1.52	-	-	1.30	1.26	1.21	1.25	1.98	303.7[2]	151.2[1]	98.0[1]		62.5	142.5	
	SD	0.36	0.14			0.112	0.121	0.051	0.00	0.698	32.8	16.1	16.4		11.8	9.4	
M&F	**Mean**	2.98	1.49	-	-	1.28	1.21	1.19	1.18	1.97	325.6	157.7	103.9		70.4	149.0	
	SD	0.38	0.13			0.087	0.104	0.057	0.084	0.482	39.6	15.8	15.5		14.7	15.0	

[1] differs by 1.00 to 1.49 SD from *L. uniformis.* [2] differs by 1.50 to 1.99 SD from *L. uniformis.*

Sex		*Leiophron uniformis* (Gahan)								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	516.8	520.7	191.1	272.2[1]	220.8	146.5	63.4	99.5	116.8
	SD	24.5	25.6	11.5	14.8	14.8	5.1	5.1	7.5	6.3
M	**Mean**	466.3[1]	449.5[1]	216.8[1]	204.9[2]	199.0[1]	129.7[1]	61.9	96.0	98.0[1]
	SD	42.6	37.1	13.6	16.2	18.9	15.1	4.2	6.7	8.7
M&F	**Mean**	491.5	485.1	203.9	238.6	209.9	138.1	62.6	97.8	107.4
	SD	42.9	48.0	18.0	38.0	20.0	15.2	4.6	7.2	12.1
				Head Ratios				Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.99	1.43	1.51	1.57	1.85	1.18	2.12[1]	1.50	0.51
	SD	0.016	0.071	0.137	0.080	0.117	0.083	0.112	0.095	0.094
M	**Mean**	1.04	0.94[1]	1.54	1.56	1.59	1.02	2.02	1.57	0.44
	SD	0.024	0.036	0.145	0.143	0.156	0.088	0.256	0.236	0.076
M&F	**Mean**	1.01	1.19	1.52	1.57	1.72	1.10	2.07	1.54	0.47
	SD	0.030	0.253	0.138	0.113	0.190	0.115	0.198	0.179	0.091

[1] differs by 1.00 to 1.49 SD from *L. uniformis.* [2] differs by 1.50 to 1.99 SD from *L. uniformis.*

TABLE 5. Measurements and ratios from 10 females and 10 males of *Peristenus digoneutis* Loan from Ste. Clotilde, QC.

		***Peristenus digoneutis* Loan**															
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	168.3[1,4]	115.3[4]	97.5[5]	96.0[3]	93.6	93.1	88.6	89.1	84.6	83.7	80.2[3]	78.7	76.2	75.7	71.8	69.8
	SD	10.4	4.7	2.4	4.2	4.3	4.5	2.8	5.7	4.3	4.9	2.1	4.9	3.5	3.3	2.6	4.9
M	**Mean**	129.7	113.4	103.5	104.4	103.9	102.0	99.5	100.0	97.5	97.5	94.5	94.5	90.1	88.1	84.6	81.7
	SD	7.3	8.9	6.4	6.4	5.7	5.8	5.4	3.9	4.7	3.3	4.3	4.9	5.1	4.5	3.7	4.2
M&F	**Mean**	149.0	114.3	100.5	100.2	98.8	97.5	94.0	94.5	91.1	90.6	87.4	86.6	83.2	81.9	78.2	75.7
	SD	21.7	7.0	5.6	6.8	7.2	6.8	7.0	7.3	7.9	8.2	8.1	9.4	8.3	7.4	7.3	7.5
		Flagellomere Length						**19/19**	**Length**			**Flagellomere Width: Fl # (W)**					
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	66.3	62.9					112.4	1703.8[3]	46.5	54.9	56.4	58.9	58.9	59.9	60.9	58.9
	SD	2.6	2.4					16.8	52.7	3.5	2.8	2.6	4.3	4.9	2.8	2.4	1.6
M	**Mean**	76.7	70.8					109.4	1841.9	48.5	51.5	49.5	49.0	48.5	48.0	47.0	45.0
	SD	4.8	7.0					22.3	94.7	3.1	3.5	4.7	3.7	3.1	2.4	4.2	3.7
M&F	**Mean**	71.5	66.8					110.9	1772.8	47.5	53.2	53.0	54.0	53.7	54.0	54.0	52.0
	SD	6.5	6.5					19.3	102.9	3.4	3.5	5.1	6.4	6.7	6.6	7.9	7.6
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**		**Metasomal tergum 1**				**Forewing**	
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**		**L**	**MxW**	**MnW**		**RcL**	**StW**
F	**Mean**	3.64[1,3]	1.53	1.35[2]	1.29[1]	1.22[1]	1.17	1.09	1.07	2.48[3]		461.2	295.2	115.5		210.5[4]	216.2
	SD	0.404	0.103	0.081	0.117	0.093	0.091	0.048	0.036	0.069		43.1	39.8	12.3		23.1	20.5
M	**Mean**	2.68	1.90[1]	1.83[1]	1.81[1]	1.75[2]	1.70[1]	1.64	1.58	2.99		422.5[1]	263.7	109.2		190.5[2,5]	210.5
	SD	0.209	0.101	0.123	0.150	0.098	0.07	0.165	0.159	0.052		25.5	24.6	15.2		10.9	15.5
M&F	**Mean**	3.16	1.71	1.59	1.55	1.47	1.43	1.37	1.32	2.74		441.9	279.5	112.4		200.5	213.4
	SD	0.583	0.216	0.264	0.294	0.283	0.286	0.307	0.284	0.270		39.8	36.0	13.8		20.3	17.9

[1] differs by 1.00 to 1.49 SD from *P. rubricollis.* [2] differs by 1.50 to 1.99 SD from *P. rubricollis.* [3] differs by 1.00 to 1.49 SD from *P. relictus.* [4] differs by 1.50 to 1.99 SD from *P. relictus.* [5] differs by 2.00 to 2.99 SD from *P. relictus*

Sex		*Peristenus digoneutis* Loan								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F	Mean	653.4	687.0	270.3	360.4	227.7	228.7	74.7[1]	120.8	133.6
	SD	20.9	22.0	6.7	14.9	11.4	17.1	4.9	7.8	13.4
M	Mean	604.9[2]	615.3[1]	311.8[1]	292.0	219.8[2]	181.2	62.4[1]	113.8[2]	122.8
	SD	34.4	32.7	18.2	12.6	18.6	12.4	8.1	11.4	11.6
M&F	Mean	629.1	651.2	291.1	326.2	223.7	204.9	68.6	117.3	128.2
	SD	37.2	45.7	25.2	37.5	15.5	28.4	9.1	10.2	13.4
		Head Ratios						Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/MnW	RcL/StW
F	Mean	0.95	1.33	1.00	1.62	1.80	1.11[3]	1.57[3]	2.55[2,4]	0.97[2,5]
	SD	0.010	0.061	0.105	0.133	0.230	0.110	0.117	0.141	0.057
M	Mean	0.98[1]	0.93[3]	1.22	1.84	1.99	1.08[1]	1.61	2.44[3]	0.91[1,4]
	SD	0.019	0.036	0.114	0.184	0.250	0.086	0.097	0.262	0.080
M&F	Mean	0.97	1.14	1.11	1.73	1.89	1.10	1.59	2.50	0.94
	SD	0.022	0.213	0.153	0.192	0.254	0.097	0.106	0.213	0.075

[1] differs by 1.00 to 1.49 SD from *P. rubricollis.* [2] differs by 1.50 to 1.99 SD from *P. rubricollis.* [3] differs by 1.00 to 1.49 SD from *P. relictus.* [4] differs by 1.50 to 1.99 SD from *P. relictus.* [5] differs by 2.00 to 2.99 SD from *P. relictus.*

TABLE 6. Measurements and ratios from 10 females and 10 males of *Peristenus relictus* (Ruthe) from Germany, Schleswig-Holtein, Luetjenbrode (laboratory colony used for introduction into California).

Peristenus relictus (Ruthe)																	
Flagellomere measurements																	
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	135.1[2]	129.7[2]	111.9[3]	108.9[1]	95.5	95.5	86.1	85.1	80.2	78.2	73.3[1]	73.3	70.3	68.3	64.3[4]	62.4[4]
	SD	7.0	3.9	4.2	7.7	6.2	4.7	3.5	4.5	5.6	3.9	4.5	4.5	4.5	4.5	5.2	3.5
M	**Mean**	119.8	116.8	106.9	107.4	103.5	103.9	99.0	98.0	95.0	95.5	89.1	90.1	83.7	84.1	80.2	79.2
	SD	9.8	7.5	8.5	6.6	5.4	8.4	4.7	6.5	6.1	7.8	7.7	6.9	6.4	7.7	6.5	6.6
M&F	**Mean**	127.5	123.3	109.4	108.2	99.5	99.7	92.6	91.6	87.6	86.9	81.2	81.7	77.0	76.2	72.3	70.8
	SD	11.5	8.8	7.0	7.1	7.0	7.9	7.7	8.6	9.5	10.7	10.2	10.3	8.7	10.2	10.0	10.0
		Flagellomere Length						**17/18**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**							139.6	1557.8[1,6]	48.0	54.4	56.4	57.9	58.9	58.9	57.4	56.9
	SD							24.5	81.4	2.4	3.3	3.5	3.3	2.8	2.8	2.6	3.5
M	**Mean**	71.3						127.2	1756.2[4]	47.5[4]	49.5[4]	49.0	48.0	48.5[4]	48.0	47.0	45.0
	SD	6.3						26.4	130.8	2.6	2.3	2.8	2.4	3.1	2.4	3.5	3.6
M&F	**Mean**							133.4	1654.3	47.8	52.0	-	-	-	-	-	-
	SD							25.6	145.1	2.4	3.8	-	-	-	-	-	-
		Flagellomere Ratios: Fl # (L/W)								**F (L)/**	**Metasomal tergum 1**				**Forewing**		
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**		**RcL**	**StW**	
F	**Mean**	2.82[1]	1.48	1.30	1.27	1.20	1.16	1.12	1.10	2.35[1,6]	432.5[6]	242.5[6]	121.7		146.2[2,4]	212.5[4]	
	SD	0.189	0.111	0.084	0.083	0.093	0.077	0.075	0.056	0.056	44.6	25.1	17.3		18.7	17.7	
M	**Mean**	2.53	1.93	1.85	1.75	1.74	1.67	1.69	1.59	2.85	400.0	228.7[4]	114.2		132.5[3]	205.0	
	SD	0.222	0.178	0.200	0.177	0.178	0.122	0.205	0.140	0.140	27.0	18.7	13.0		16.9	21.4	
M&F	**Mean**	2.67	2.67	1.57	1.51	1.47	1.42	1.41	1.34	2.59	416.2	235.6	118.0		139.4	208.7	
	SD	0.251	0.251	0.317	0.281	0.311	0.280	0.330	2.72	0.272	39.5	22.7	15.4		18.7	19.5	

[1] differs by 1.00 to 1.49 SD from *P. digoneutis.* [2] differs by 1.50 to 1.99 SD from *P. digoneutis.* [3] differs by 2.00 to 2.99 SD from *P. digoneutis.* [4] differs by 1.00 to 1.49 SD from *P. rubricollis.* [5] differs by 1.50 to 1.99 SD from *P. rubricollis.* [6] differs by 2.00 to 2.99 SD from *P. rubricollis.*

Sex		*Peristenus relictus* (Ruthe)								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	629.6[4]	663.3[4]	264.3[5]	370.3	212.8[5]	226.7	77.2	129.7[5]	113.8[5]
	SD	22.0	29.9	12.4	26.1	7.0	11.9	4.2	5.6	8.4
M	**Mean**	619.7[4]	616.8[4]	352.4	289.1	209.9[6]	185.1	73.3	121.8[4]	135.6
	SD	38.5	34.6	25.6	16.7	15.3	10.5	6.9	11.5	16.2
M&F	**Mean**	624.7	640.0	308.4	329.7	211.4	205.9	75.2	125.7	124.7
	SD	31.0	39.5	49.3	49.3	11.7	24.0	5.9	9.7	16.8
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.95	1.40[5]	0.94	1.68	1.48[4]	0.88[1,5]	1.79[1]	2.01[2]	0.69[3]
	SD	0.014	0.061	0.057	0.082	0.113	0.077	0.078	0.204	0.065
M	**Mean**	1.00	0.82[1,4]	1.13[5]	1.67	1.85	1.12	1.75	2.01[1]	0.65[2]
	SD	0.007	0.038	0.067	0.157	0.190	0.152	0.120	0.158	0.065
M&F	**Mean**	0.98	1.11	1.04	1.68	1.67	1.00	1.77	2.01	0.67
	SD	0.030	0.301	0.116	0.122	0.246	0.170	0.100	0.177	0.067

[1] differs by 1.00 to 1.49 SD from *P. digoneutis.* [2] differs by 1.50 to 1.99 SD from *P. digoneutis.* [3] differs by 2.00 to 2.99 SD from *P. digoneutis.* [4] differs by 1.00 to 1.49 SD from *P. rubricollis.* [5] differs by 1.50 to 1.99 SD from *P. rubricollis.* [6] differs by 2.00 to 2.99 SD from *P. rubricollis.*

TABLE 7. Measurements and ratios from 10 females of the North American form of *Peristenus rubricollis* (Thomson) (= *P. conradi* auct.) from St. Constant, QC, Newark, DE, Newton, NJ, Mt. Holly, NJ, Carmel, NJ and High Falls, NY.

***Peristenus rubricollis* (Thomson)**																
		Flagellomere measurements														
Sex		**Flagellomere Length: Fl # (L)**														
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	142.5	117.8	103.0	95.5	92.6	90.1	84.7	84.1	80.7	79.2	75.7	74.2	71.8	70.8	67.8[4]	67.3[4]
	SD	12.6	7.3	5.1	5.7	6.2	3.9	4.9	4.7	3.3	4.0	3.3	4.7	4.2	2.4	4.7	4.8
M	**Mean**																
	SD																
M&F	**Mean**																
	SD																

		Flagellomere Length						**22**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	66.3	63.3[1]	61.9	60.9	57.9		111.9	1819.6[2,6]	49.5	54.4	57.9	60.9	59.9	59.9	58.4	56.9
	SD	4.2	4.5	3.5	4.1	3.3		18.1	97.6	2.3	5.2	4.7	4.1	4.3	4.3	3.1	3.5
M	**Mean**																
	SD																
M&F	**Mean**																
	SD																

		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**	
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**
F	**Mean**	2.86	1.40	1.16	1.09	1.06	1.03	1.04	1.02	2.57[6]	461.9[2,6]	263.1[6]	121.6[2]	182.5[4]	234.2[4]
	SD	0.181	0.116	0.031	0.045	0.069	0.045	0.045	0.039	0.042	35.0	13.1	6.1	17.8	10.6
M	**Mean**														
	SD														
M&F	**Mean**														
	SD														

[1] differs by 1.00 to 1.49 SD from *P. digoneutis.* [2] differs by 1.50 to 1.99 SD from *P. digoneutis.* [3] differs by 2.00 to 2.99 SD from *P. digoneutis.* [4] differs by 1.00 to 1.49 SD from *P. relictus.* [5] differs by 1.50 to 1.99 SD from *P. relictus.* [6] differs by 2.00 to 2.99 SD from *P. relictus.*

Sex		*Peristenus rubricollis* (Thomson)								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F	Mean	673.2[4]	707.8[4]	286.1[2,5]	358.4	240.6[5]	244.5	61.9	118.8[2,5]	124.7[5]
	SD	27.2	34.4	10.9	16.0	11.5	16.2	4.2	10.4	11.6
M	Mean									
	SD									
M&F	Mean									
	SD									

		Head Ratios						Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/MnW	RcL/StW
F	Mean	0.95	1.25[1,5]	0.98	1.92[2,5]	2.02[4]	1.05	1.75	2.16	0.77[2]
	SD	0.013	0.037	0.048	0.198	0.237	0.072	0.090	0.0.74	0.062
M	Mean									
	SD									
M&F	Mean									
	SD									

[1] differs by 1.00 to 1.49 SD from *P. digoneutis.* [2] differs by 1.50 to 1.99 SD from *P. digoneutis.* [3] differs by 2.00 to 2.99 SD from *P. digoneutis.* [4] differs by 1.00 to 1.49 SD from *P. relictus.* [5] differs by 1.50 to 1.99 SD from *P. relictus.* [6] differs by 2.00 to 2.99 SD from *P. relictus.*

TABLE 8. Measurements and ratios from 10 females and 10 males of the European *Peristenus rubricollis* (Thomson) from Hugelheim, Nuenburg and Steinstadt along the Rhine valley, Germany.

***Peristenus rubricollis* (Thomson)**																	
Flagellomere measurements																	
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	152.5	123.7	104.4	100.0	95.0	93.1	88.6	87.6	83.7	83.2	78.7	78.7	76.2	74.7	73.7	72.8
	SD	11.1	9.0	4.9	4.5	5.6	5.1	4.3	5.2	3.7	4.5	2.8	3.6	4.2	3.7	3.7	5.2
M	**Mean**	128.7	117.3	105.9	103.0	99.5	100.0	95.5	95.5	91.5	92.6	89.6	90.1	87.6	85.6	83.2	81.2
	SD	8.1	9.0	6.7	6.1	7.2	5.1	6.6	6.6	4.8	4.7	5.9	5.6	4.1	5.2	3.9	4.2
M&F	**Mean**	140.6	120.5	105.2	103.0	97.3	96.6	92.1	91.6	87.6	87.9	84.1	84.4	81.9	80.2	78.5	77.0
	SD	15.4	9.4	6.7	6.1	6.7	6.1	6.5	7.1	5.8	6.6	7.2	7.4	7.1	7.1	6.1	6.3
		Flagellomere Length						**22/22**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	69.3	69.3	67.3	65.3	62.9		132.7	1933.4	50.5	57.4	61.9	60.9	60.9	60.9	60.9	60.4
	SD	4.7	3.3	3.5	3.9	3.3		18.2	84.1	2.1	4.2	5.3	4.1	4.7	4.7	2.4	3.1
M	**Mean**	79.2	75.7	72.8	71.8	66.3		117.8	2030.5[3]	53.5[3]	55.9[3]	54.0	54.0	52.5	51.0	51.5	50.0
	SD	3.3	4.7	4.1	3.5	3.5		20.6	109.6	2.1	3.3	4.9	4.9	2.6	4.1	3.5	3.6
M&F	**Mean**	74.2	72.5	70.0	68.6	64.6		125.2	1982.0	52.0	56.7	57.9	57.4	56.7	55.9	56.2	55.2
	SD	6.4	5.1	4.6	4.9	3.8		20.4	107.3	2.5	3.8	6.4	5.7	5.7	6.6	5.6	6.3
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**					**Forewing**	
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**			**RcL**	**StW**
F	**Mean**	3.02	1.37	1.18	1.14	1.14	1.11	1.07	1.04	2.61	563.7	337.5	143.7			186.2	245.0
	SD	0.223	0.068	0.123	0.104	0.064	0.093	0.047	0.88	0.071	16.1	18.6	8.8			19.9	8.7
M	**Mean**	2.41	1.61[1]	1.52[1]	1.48[1]	1.44[2,3]	1.44[1]	1.40	1.33	2.95	478.7[1,3]	296.2[3]	129.2			148.0[1]	212.5
	SD	0.164	0.169	0.174	0.172	0.101	0.160	0.118	0.116	0.067	30.6	27.0	10.5			15.5	11.8
M&F	**Mean**	2.72	1.49	1.35	1.31	1.29	1.27	1.24	1.19	2.78	521.5	316.9	136.5			167.1	228.7
	SD	0.367	0.173	0.226	0.222	0.176	0.210	0.189	0.179	0.185	49.7	31.0	12.0			26.2	19.5

[1] differs by 1.00 to 1.49 SD from *P. digoneutis.* [2] differs by 1.50 to 1.99 SD from *P. digoneutis.* [3] differs by 1.00 to 1.49 SD from *P. digoneutis.* [4] differs by 1.50 to 1.99 SD from *P. relictus.* [5] differs by 2.00 to 2.99 SD from *P. relictus.*

Sex		*Peristenus rubricollis* (Thomson)								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F	Mean	700.9	740.5	305.9	369.3	256.4	250.5	76.2	152.5	147.5
	SD	37.6	38.7	11.9	23.8	19.5	12.4	4.9	8.3	11.9
M	Mean	705.9[2,3]	688.0[1,3]	349.5[1]	315.8	274.2[2,5]	200.0	78.2[1]	149.5[2,3]	138.6
	SD	30.2	26.1	12.4	11.8	15.5	9.1	5.6	9.0	8.1
M&F	Mean	703.4	714.3	327.7	342.5	265.3	225.2	77.2	151.0	143.1
	SD	33.3	41.9	25.3	33.0	19.4	28.0	5.2	8.6	10.9
		Head Ratios						Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/MnW	RcL/StW
F	Mean	0.95	1.21	1.02	2.00	1.95	0.97	1.67	2.36	0.76
	SD	0.014	0.065	0.056	0.107	0.251	0.118	0.088	0.189	0.79
M	Mean	1.03[1]	0.90[3]	1.37[4]	1.92	1.78	0.92[1]	1.62	2.29	0.70[1]
	SD	0.015	0.0.19	0.0.082	0.109	0.123	0.060	0.114	0.125	0.092
M&F	Mean	0.99	1.06	1.20	1.96	1.86	0.95	1.65	2.32	0.73
	SD	0.043	0.163	0.192	0.114	0.211	0.096	0.103	0.159	0.089

[1] differs by 1.00 to 1.49 SD from *P. digoneutis*. [2] differs by 1.50 to 1.99 SD from *P. digoneutis*. [3] differs by 1.00 to 1.49 SD from *P. digoneutis*. [4] differs by 1.50 to 1.99 SD from *P. relictus*. [5] differs by 2.00 to 2.99 SD from *P. relictus*.

TABLE 9. Measurements and ratios recorded from 10 females and 10 males of *Peristenus braunae* Goulet, from La Corne, QC.

		***Peristenus braunae* Goulet**															
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	172.3	131.2	108.9	110.9	104.9	103.0	98.0	96.0	89.6	91.1	88.1	86.6	82.2	81.2	78.2	76.2
	SD	9.6	4.8	1.8	4.8	4.6	4.5	2.1	4.2	1.6	4.2	6.5	4.2	4.2	4.8	3.9	4.2
M	**Mean**	153.9[1]	133.6	117.8	119.8	117.8	115.8	112.4	111.9	106.4	108.9	104.4	105.4	100.0	101.0	97.5	96.5
	SD	10.8	7.4	8.3	9.8	9.6	7.8	8.1	5.8	6.3	7.7	6.4	7.0	6.1	6.7	5.2	3.5
M&F	**Mean**	163.1	132.4	113.4	115.3	111.4	109.4	105.2	103.9	98.0	100.0	96.3	96.0	91.1	91.1	87.9	86.4
	SD	13.7	6.2	7.3	9.8	9.8	9.1	9.3	9.5	9.7	10.9	10.5	11.2	10.5	11.6	10.9	11.1
		Flagellomere Length						**20/22**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	73.8	72.8	67.3				126.7	1938.9	48.5	54.4	59.9	59.9	59.9	59.9	59.9	59.4
	SD	5.4	4.7	4.8				25.0	82.1	2.1	4.0	2.8	3.6	3.6	3.6	3.6	4.0
M	**Mean**	93.6	91.6	89.1	85.1	76.7		144.5[1]	2383.9	61.9	58.4	55.4	54.9	53.0	52.0	51.0	49.5
	SD	4.9	5.3	4.0	4.5	4.2		19.3	126.5	5.3	3.9	3.9	3.6	4.1	3.5	3.3	2.3
M&F	**Mean**	83.7	82.2	78.2				135.6	2161.4	55.2							
	SD	11.3	10.8	12.0				23.6	252.1	7.9							
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**			
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**		
F	**Mean**	3.56	1.62	1.36	1.31	1.28	1.23	1.22	1.14	2.91	478.7	273.7	134.2	196.2	208.7		
	SD	0.295	0.147	0.088	0.093	0.111	0.107	0.078	0.076	0.059	33.9	23.9	14.2	11.8	14.5		
M	**Mean**	2.49	1.80	1.75	1.71	1.74	1.72	1.67	1.55	3.71	433.7	240.0	128.0	216.2	217.5		
	SD	0.143	0.186	0.160	0.151	0.135	0.137	0.119	0.116	0.147	31.8	21.1	14.4	10.3	10.5		
M&F	**Mean**	3.02	1.71	1.55	1.51	1.51	1.48	1.45	1.34	3.31	456.2	256.9	131.1	206.2	213.1		
	SD	0.591	0.186	0.240	0.239	0.264	0.276	0.254	0.235	0.425	39.4	27.9	14.3	14.9	13.1		

[1] differs by 1.00 to 1.49 SD from *P. dayi.*

Sex		*Peristenus braunae* Goulet								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	650.4	667.3	301.0	337.6	239.6	208.9	75.2	139.6	125.7
	SD	27.2	28.5	10.6	8.7	10.2	12.7	5.1	9.8	4.8
M	**Mean**	634.6	642.5	320.8	310.9	224.7	198.0	74.2	139.6	115.8
	SD	22.1	21.6	11.6	8.3	6.7	10.4	5.2	7.3	11.5
M&F	**Mean**	642.5	654.9	310.9	324.2	232.2	203.4	74.7	139.6	120.8
	SD	25.5	27.7	14.9	16.0	11.3	12.6	5.1	8.4	10.0
				Head Ratios				Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.97	1.12	1.15	1.86	1.68	0.90	1.76	2.05	0.94
	SD	0.012	0.034	0.095	0.124	0.112	0.074	0.131	0.169	0.053
M	**Mean**	0.99	0.97	1.14	1.89	1.57	0.83	1.81	1.89	1.00
	SD	0.014	0.032	0.063	0.125	0.181	0.075	0.137	0.205	0.057
M&F	**Mean**	0.98	1.05	1.14	1.87	1.62	0.87	1.78	1.97	0.97
	SD	0.014	0.085	0.079	0.122	0.157	0.082	0.134	0.200	0.060

[1] differs by 1.00 to 1.49 SD from *P. dayi.*

TABLE 10. Measurements and ratios recorded from 10 females and 10 males of *Peristenus dayi* Goulet from Ste. Clotilde, QC, Hemmingford, QC and Fitzroy Harbour, ON.

***Peristenus dayi* Goulet**																	
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	164.3	129.7	112.7	113.4	108.4	102.5	96.5	97.5	92.1	90.6	87.1	86.1	82.2	83.2	79.2	77.7
	SD	9.8	5.6	8.7	5.9	7.2	7.0	6.3	3.3	4.8	2.4	5.3	4.8	4.8	3.9	4.7	4.7
M	**Mean**	133.6[1]	122.3	109.9	110.4	106.9	106.4	104.9	102.0	99.5	99	98.0	99	96.0	94.0	91.1	89.1
	SD	9.6	9.1	8.3	7.4	6.6	5.8	7.7	5.3	5.9	5.2	5.1	6.2	5.2	5.2	4.2	5.2
M&F	**Mean**	149.0	126.0	111.4	111.9	107.6	104.4	100.7	99.7	95.8	94.8	92.6	92.6	89.1	88.6	85.1	83.4
	SD	18.4	8.2	8.4	6.7	6.8	6.6	6.6	4.9	6.5	5.9	7.5	8.5	8.8	7.2	7.4	7.5
		Flagellomere Length						**21/23**	**Length**			**Flagellomere Width: Fl # (W)**					
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	74.7	73.3	70.3	65.3			140.6	2027.5	50.0	54.9	58.4	58.4	57.4	57.4	56.4	54.9
	SD	4.9	4.5	5.6	6.1			21.8	103.3	2.8	3.6	2.1	2.1	2.6	2.6	3.5	4.3
M	**Mean**	86.6	84.6	83.2	78.7	73.3	65.8	100.0[1]	2234.4	55.9	54.9	51.5	51.0	49.0	48.5	47.0	45.5
	SD	4.2	4.3	5.1	4.9	4.5	4.7	20.0	112.8	3.3	4.9	4.2	4.1	1.6	2.1	2.6	2.1
M&F	**Mean**	80.7	79.0	76.7	72.0			120.3	2131.0	53.0							
	SD	7.5	7.3	8.4	8.7			29.1	149.5	4.3							
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**			
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**		
F	**Mean**	3.29	1.59	1.36	1.33	1.30	1.28	1.25	1.19	3.03	497.5	290.0	137.5	213.7	217.5		
	SD	0.182	0.088	0.094	0.101	0.073	0.068	0.095	0.107	0.118	27.5	19.4	10.8	21.6	12.1		
M	**Mean**	2.39	1.81	1.69	1.67	1.70	1.63	1.56	1.45	3.61	461.2	255.0	120.7	190.0	208.7		
	SD	0.185	0.113	0.148	0.121	0.123	0.128	0.094	0.117	0.124	17.1	14.7	5.9	21.1	11.9		
M&F	**Mean**	2.84	1.70	1.52	1.50	1.50	1.45	1.40	1.32	3.32	479.4	272.5	129.1	201.9	213.1		
	SD	0.494	0.150	0.209	0.203	0.226	0.205	0.185	0.171	0.316	29.0	24.5	12.1	24.1	12.5		

[1] differs by 1.00 to 1.49 SD from *P. braunae.*

Sex		*Peristenus dayi* Goulet								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	639.5	668.2	301.9	348.5	221.8	223.7	68.3	131.7	119.8
	SD	19.9	24.8	12.6	13.0	14.2	15.6	3.1	4.8	9.8
M	**Mean**	600.9	619.7	313.9	302.9	215.8	191.1	66.3	127.7	113.8
	SD	25.1	23.9	15.3	10.6	22.8	13.2	6.7	8.7	9.6
M&F	**Mean**	620.2	644.0	307.9	325.7	218.8	207.4	67.3	129.7	116.8
	SD	29.7	34.4	14.9	26.1	18.7	21.9	5.2	7.1	1.0
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.96	1.15	1.00	1.93	1.76	0.91	1.72	2.12	0.98
	SD	0.012	0.040	0.117	0.107	0.166	0.084	0.121	0.165	0.056
M	**Mean**	0.97	0.97	1.13	1.93	1.73	0.89	1.81	2.11	0.91
	SD	0.011	0.060	0.116	0.143	0.170	0.074	0.112	0.131	0.103
M&F	**Mean**	0.96	1.06	1.06	1.93	1.74	0.90	1.77	2.12	0.95
	SD	0.013	0.108	0.133	0.123	0.164	0.077	0.123	0.145	0.088

[1] differs by 1.00 to 1.49 SD from *P. braunae*.

TABLE 11. Measurements and ratios recorded from 8 females and 8 males of *Peristenus carcamoi* Goulet from Lethbridge, AB.

Peristenus carcamoi Goulet																	
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	155.3	116.9	102.7	105.2	99.0	96.5	92.8	92.8	87.9	86.6	82.3	82.9	78.6	81.1	78.0	77.3
	SD	7.5	4.5	3.5	4.4	5.9	5.3	5.8	4.4	2.3	4.6	4.5	4.4	3.2	2.6	3.5	3.7
M	**Mean**	142.9	126.2	110.8	115.1[4]	113.2[4]	112.6[4]	108.9[5]	110.8	105.8	108.9[4]	102.7	104.6	99.6	99.0	97.1	94.7[4]
	SD	6.7	5.3	2.6	4.4	4.9	4.4	2.5	4.5	3.7	4.6	4.4	5.6	3.2	2.6	3.7	3.2
M&F	**Mean**	149.1	121.6	106.7	110.1	106.1	104.6	100.9	101.8	96.8	97.8	92.5	93.7	89.1	90.0	87.6	86.0
	SD	9.4	6.7	5.1	6.6	9.0	9.5	9.2	10.2	9.7	12.3	11.4	12.2	11.3	9.6	10.5	9.5
		Flagellomere Length						**20/23**	**Length**		**10/12**	**Flagellomere Width: Fl # (W)**					
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	73.6	71.8	68.7				134.9	1864.9	49.5	52.0	57.5	58.2	57.5	57.5	58.2	56.9
	SD	4.1	3.7	4.9				26.4	73.7	0.0	2.6	3.7	2.3	2.6	2.6	2.3	3.7
M	**Mean**	91.6	92.8[4]	90.3[4]	87.2[5]	84.8[5]	74.2	105.2	2379.1[5]	57.5	55.7	56.9	55.1	53.8	53.2	50.1	47.6
	SD	3.7	3.5	4.4	3.7	4.1	7.5	17.5	72.5	3.7	4.4	3.7	4.9	4.1	3.5	1.8	2.6
M&F	**Mean**	82.6	82.3	79.5				120.0	2122.0	53.5							
	SD	10.0	11.4	12.1				26.5	274.8	4.9							
			10/12	**Flagellomere Ratios: Fl # (L/W)**						**Fl (L)/**	**Metasomal tergum 1**				**Forewing**		
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**		**RcL**	**StW**	
F	**Mean**	3.14	1.67	1.41	1.34	1.35	1.28	1.23[2]	1.21[2]	2.68	503.1[1]	309.4	137.2		201.6	214.1	
	SD	0.151	0.125	0.125	0.090	0.072	0.081	0.062	0.044	0.098	14.6	17.4	9.1		19.4	12.4	
M	**Mean**	2.49	1.88	1.61	1.70	1.68	1.64	1.69	1.56	3.66[4]	473.4	290.6	132.2		204.7	210.9	
	SD	0.167	0.145	0.114	0.149	0.116	0.099	0.120	0.088	0.123	15.6	14.6	8.2		21.1	8.0	
M&F	**Mean**	2.81	1.78	1.51	1.52	1.51	1.46	1.46	1.38	3.17	488.3	300.0	134.7		203.1	212.5	
	SD	0.367	0.171	0.155	0.218	0.198	0.207	0.254	0.192	0.515	21.1	18.3	8.7		19.6	10.2	

[1] differs by 1.00 to 1.49 SD from *P. otaniae.* [2] differs by 1.00 to 1.49 SD from *P. mellipes.* [3] differs by 1.50 to 1.99 SD from *P. mellipes.* [4] differs by 1.00 to 1.49 SD from *P. pseudopallipes.* [5] differs by 1.50 to 1.99 SD from *P. pseudopallipes.* [6] differs by 3.00 to 3.99 SD from *P. pseudopallipes.*

Sex		*Peristenus carcamoi* Goulet								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	653.4[1]	695.5[1,2]	269.8	377.4	230.2	224.0	80.4[1,3,6]	142.3[1,2]	112.6
	SD	9.2	11.5	7.0	14.4	11.5	13.9	3.5	7.4	9.1
M	**Mean**	621.2	650.9	298.2	321.7	217.8	196.8	73.0[4]	131.2	116.3[4]
	SD	15.7	17.3	11.1	14.0	7.5	6.3	5.1	7.0	7.0
M&F	**Mean**	6.37.3	673.2	284.0	349.6	224.0	210.4	76.7	136.7	114.5
	SD	20.7	27.1	17.2	31.9	11.4	17.5	5.7	9.0	8.1
				Head Ratios				Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.94	1.40	1.03	1.77[5]	1.40[2,5]	0.80	1.63	2.26	0.95
	SD	0.009	0.056	0.102	0.126	0.082	0.097	0.095	0.093	0.112
M	**Mean**	0.95	1.08	1.11	1.80	1.60	0.89	1.63	2.20	0.97
	SD	0.014	0.045	0.053	0.115	0.121	0.067	0.079	0.107	0.106
M&F	**Mean**	0.95	1.24	1.07	1.79	1.50	0.84	1.63	2.23	0.96
	SD	0.014	0.172	0.087	0.118	0.143	0.094	0.084	0.101	0.106

[1] differs by 1.00 to 1.49 SD from *P. otaniae.* [2] differs by 1.00 to 1.49 SD from *P. mellipes.* [3] differs by 1.50 to 1.99 SD from *P. mellipes.* [4] differs by 1.00 to 1.49 SD from *P. pseudopallipes.* [5] differs by 1.50 to 1.99 SD from *P. pseudopallipes.* [6] differs by 3.00 to 3.99 SD from *P. pseudopallipes.*

TABLE 12. Measurements and ratios from recorded 10 females and 10 males of *Peristenus mellipes* (Cresson) from Ste. Clotilde, QC.

***Peristenus mellipes* (Cresson)**																	
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	149.0	111.9	94.0	96.0	89.1	91.6	84.6	87.6	80.7	81.2	76.7	78.7	73.8	75.2	71.8	72.3
	SD	12.9	9.7	7.7	6.7	7.7	5.3	4.3	7.0	6.2	4.2	5.3	4.3	3.7	3.9	4.2	3.5
M	**Mean**	141.6	129.7	110.9	112.4	111.4	110.4	106.9	105.9	103.9	103.9	101.5	101.5	98.0	97.5	95.0	94.0
	SD	8.5	5.1	5.3	5.7	5.8	3.3	5.3	4.2	4.7	4.7	4.1	2.6	5.1	4.7	3.9	4.0
M&F	**Mean**	145.3	120.8	102.4	104.2	100.2	101.0	95.8	96.8	92.3	92.6	88.6	90.1	85.9	86.4	83.4	83.2
	SD	11.3	11.8	10.8	10.3	13.2	10.6	12.4	10.9	13.1	12.5	13.0	12.2	13.2	12.2	12.6	11.8
		Flagellomere Length						**20/23**	**Length**			**Flagellomere Width: Fl # (W)**					
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	68.8	66.3	62.4	-	-	-	122.8	1734.5	47.0	54.0	57.9	58.4[3]	57.9	59.4[3]	59.9[1,4]	58.9[1,3]
	SD	3.7	4.2	2.6	-	-	-	17.0	96.0	4.2	4.3	4.1	3.1	3.3	2.3	2.8	4.3
M	**Mean**	88.1	86.6	85.1	82.2	79.2	72.3	121.3	2338.4[5]	57.4	57.9	56.9	54.4	53.0	51.5	51.5	49.5
	SD	3.1	4.2	5.6	4.2	5.2	5.3	15.3	84.1	3.5	4.1	3.5	3.3	4.1	3.5	4.2	2.3
M&F	**Mean**	78.5	76.5	73.8	-	-	-	122.0	2036.4	52.2	-	-	-	-	-	-	-
	SD	10.4	11.2	12.4	-	-	-	15.8	322.0	6.5	-	-	-	-	-	-	-
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**				**Forewing**		
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**		**RcL**	**StW**	
F	**Mean**	3.17	1.51	1.30	1.23	1.25	1.16	1.11	1.06	2.68[5]	478.7	273.7[5]	122.0[3]		200.0	211.2	
	SD	0.158	0.074	0.088	0.063	0.086	0.048	0.055	0.064	0.83	32.3	24.6	9.2		16.7	15.0	
M	**Mean**	2.47	1.76	1.55	1.60	1.62	1.60	1.55	1.46	3.66[5]	481.2	278.0	124.2[5]		202.7	216.2[5]	
	SD	0.215	0.137	0.106	0.122	0.193	0.136	0.154	0.125	0.110	20.6	15.6	4.4		20.2	10.3	
M&F	**Mean**	2.82	1.63	1.43	1.41	1.44	1.38	1.33	1.26	3.14	480.0	275.9	123.1		201.4	213.7	
	SD	0.403	0.168	0.159	0.210	0.239	0.248	0.252	0.227	0.507	26.4	20.2	7.1		18.1	12.8	

[1] differs by 1.00 to 1.49 SD from *P. carcamoi.* [2] differs by 2.00 to 2.99 SD from *P. carcamoi.* [3] differs by 1.00 to 1.49 SD from *P. otaniae.* [4] differs by 1.50 to 1.99 SD from *P. otaniae.* [5] differs by 1.00 to 1.49 SD from *P. pseudopallipes.*

Sex		*Peristenus mellipes* (Cresson)								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	618.7	646.5[1]	264.3	343.5	212.8	214.8	58.4[2,3]	117.3[1]	108.9
	SD	27.7	36.5	14.0	21.4	12.6	10.5	7.3	10.4	8.1
M	**Mean**	618.7	641.5	306.9	319.8	218.8	201.0	62.9	122.8	110.0
	SD	16.3	15.3	9.3	14.8	9.8	11.5	5.7	6.9	11.9
M&F	**Mean**	618.7	644.0	285.6	331.6	215.8	207.9	60.6	120.0	109.4
	SD	22.1	27.3	24.7	21.7	11.4	12.8	6.9	9.1	10.0
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.96	1.30[3]	0.99	2.02[1]	1.89	0.93	1.75[3]	2.25	0.95
	SD	0.017	0.048	0.043	0.190	0.257	0.106	0.077	0.140	0.044
M	**Mean**	0.96	1.04	1.09	1.96	1.77	0.90	1.73	2.24[5]	0.94
	SD	0.012	0.066	0.100	0.125	0.284	0.116	0.082	0.95	0.081
M&F	**Mean**	0.96	1.17	1.04	1.99	1.83	0.92	1.74	2.24	0.94
	SD	0.015	0.143	0.091	0.159	0.270	0.110	0.078	0.117	0.063

[1] differs by 1.00 to 1.49 SD from *P. carcamoi.* [2] differs by 2.00 to 2.99 SD from *P. carcamoi.* [3] differs by 1.00 to 1.49 SD from *P. otaniae.* [4] differs by 1.50 to 1.99 SD from *P. otaniae.* [5] differs by 1.00 to 1.49 SD from *P. pseudopallipes.*

TABLE 13. Measurements and ratios recorded from 10 females and 10 males of *Peristenus otaniae* Goulet from Beaverlodge, AB.

***Peristenus otaniae* Goulet**																	
								Flagellomere measurements									
Sex								**Flagellomere Length: Fl # (L)**									
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	150.5	112.9	98.5	99.5	96.0	96.0	90.1	93.1	86.6	86.1	82.2	81.7	77.7	80.2	73.8	73.3
	SD	8.5	6.1	2.8	4.3	4.8	4.2	6.9	5.1	5.8	5.8	4.8	3.5	6.2	3.9	4.9	5.1
M	**Mean**	135.6	127.2	110.9	111.9	110.4	109.9	106.4	108.9	102.5	104.9	100.0	102.5	98.5	97.5	95.0	94.5
	SD	11.0	8.4	8.8	6.7	8.4	6.9	6.3	8.7	6.6	5.6	6.5	5.7	6.8	6.2	5.1	5.4
M&F	**Mean**	143.1	120.0	104.7	105.7	103.2	103.0	98.3	101.0	94.5	95.5	91.1	92.1	88.1	88.9	84.4	83.9
	SD	12.2	10.3	9.0	8.4	9.9	9.0	10.6	10.7	10.1	11.1	10.7	11.6	12.4	10.2	12.0	12.1
				Flagellomere Length				**19/22**	**Length**				**Flagellomere Width: Fl # (W)**				
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	72.3	68.3					123.7	1742.4	48.5	50.1	57.9	56.9	56.4	57.4	57.4	57.4
	SD	4.2	3.9					15.7	79.4	2.1	4.1	3.3	2.6	3.5	2.6	2.6	2.6
M	**Mean**	92.1	88.6	87.6	82.7	76.7		122.3	2266.6	57.9	57.9	55.4	55.4	52.5	53.0	52.5	50.0
	SD	4.8	4.3	4.7	4.7	4.8		17.1	128.4	3.3	4.1	3.1	3.9	3.5	4.1	3.5	3.7
M&F	**Mean**	82.2	78.5					123.0	2004.5	53.2							
	SD	11.1	11.2					16.0	288.3	5.5							
				Flagellomere Ratios: Fl # (L/W)						**Fl (L)/**	**Metasomal tergum 1**				**Forewing**	
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**		**RcL**	**StW**	
F	**Mean**	3.10	1.70	1.34	1.41[1]	1.31	1.28[1]	1.26[2]	1.19[1]	2.65[4]	462.5[3]	299.2	133.2		210.0	210.0	
	SD	0.143	0.129	0.093	0.105	0.099	0.66	0.037	0.055	0.043	21.2	22.5	9.6		12.9	11.5	
M	**Mean**	2.34	1.78	1.71	1.67	1.69	1.66	1.58	1.54	3.62[4]	431.2	261.2	126.0		195.0	215.0	
	SD	0.154	0.174	0.162	0.116	0.086	0.124	0.117	0.084	0.105	40.1	31.4	12.6		19.7	11.5	
M&F	**Mean**	2.72	1.74	1.53	1.54	1.50	1.47	1.42	13.6	3.13	446.9	280.2	129.6		202.5	212.5	
	SD	0.416	0.155	0.229	0.169	0.216	0.220	0.186	0.191	0.504	35.1	33.0	11.5		18.0	11.5	

[1] differs by 1.00 to 1.49 SD from *P. mellipes.* [2] differs by 1.50 to 1.99 SD from *P. mellipes.* [3] differs by 1.00 to 1.49 SD from *P. carcamoi.* [4] differs by 1.00 to 1.49 SD from *P. pseudopallipes.* [5] differs by 1.50 to 1.99 SD from *P. pseudopallipes.* [6] differs by 2.00 to 2.99 SD from *P. pseudopallipes.*

Sex		*Peristenus otaniae* Goulet								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	623.7[3]	658.3[3]	256.4	362.3	209.9	228.7	72.3[1,3,5]	128.7	110.9
	SD	17.5	25.2	9.8	13.4	13.0	13.6	4.8	6.6	4.2
M	**Mean**	601.9	626.7	293.1	314.8	200.0	202.0	72.3[4]	133.6	110.0
	SD	28.7	28.0	18.7	13.0	15.3	14.9	6.7	5.2	10.9
M&F	**Mean**	612.8	642.5	274.8	338.6	204.9	215.3	72.3	131.2	110.4
	SD	25.7	30.6	23.8	27.6	14.8	19.5	5.7	6.3	8.0
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.95	1.41[1,6]	0.92	1.79[4]	1.54	0.86	1.55[1]	2.25	1.00
	SD	0.015	0.046	0.090	0.120	0.101	0.057	0.088	0.129	0.087
M	**Mean**	0.96	1.08	1.00	1.86	1.54	0.82	1.66	2.07	0.91
	SD	0.011	0.050	0.115	0.158	0.265	0.086	0.084	0.092	0.077
M&F	**Mean**	0.95	1.25	0.96	1.82	1.54	0.84	1.60	2.16	0.96
	SD	0.014	0.179	0.108	0.142	0.195	0.074	0.100	0.142	0.094

[1] differs by 1.00 to 1.49 SD from *P. mellipes.* [2] differs by 1.50 to 1.99 SD from *P. mellipes.* [3] differs by 1.00 to 1.49 SD from *P. carcamoi.* [4] differs by 1.00 to 1.49 SD from *P. pseudopallipes.* [5] differs by 1.50 to 1.99 SD from *P. pseudopallipes.* [6] differs by 2.00 to 2.99 SD from *P. pseudopallipes.*

TABLE 14. Measurements and ratios recorded from 10 females and 10 males of *Peristenus pseudopallipes* (Loan) from Ste. Clotilde, QC.

		***Peristenus pseudopallipes* (Loan)**															
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	148.5	115.3	98.0	97.5	94.0	94.0	90.6	90.1	84.6	86.1	82.2	81.2	75.7	77.7	73.8	73.3
	SD	9.0	8.1	3.9	5.7	5.7	4.0	4.1	5.1	5.4	3.5	4.8	6.3	5.2	4.7	3.6	3.1
M	**Mean**	138.1	117.8	102.5	104.4[4]	102.5[4]	103.0[4]	99.5[5]	101.0	95.5	98.0[4]	94.0	95.0	91.6	92.6	90.1	87.6[4]
	SD	10.6	7.7	7.0	4.3	5.2	4.5	4.9	6.3	8.1	5.6	6.1	6.1	5.3	6.6	5.1	3.3
M&F	**Mean**	143.3	116.6	100.2	101.0	98.3	98.5	95.0	95.5	90.1	92.1	88.1	88.1	83.7	85.1	81.9	80.4
	SD	10.9	7.8	6.0	6.5	6.9	6.2	6.3	7.9	8.7	7.6	7.6	9.3	9.6	9.4	9.4	8.0
		Flagellomere Length						**19/22**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	71.3	68.3					136.6	1738.9	48.5	53.5	58.9	60.4	59.4	59.4	59.4	59.4
	SD	4.2	2.1					21.8	84.2	3.1	3.1	4.3	3.1	2.3	2.3	2.3	2.3
M	**Mean**	86.1	82.7[4]	81.2[4]	77.2[5]	69.3[5]		115.8	2125.5[1,5]	56.4	54.4	53.0	52.0	52.0	51.5	50.0	47.0
	SD	5.8	4.7	4.2	2.6	6.2		11.5	95.3	2.6	3.3	3.3	2.6	3.5	3.5	4.3	3.5
M&F	**Mean**	78.7	75.5					126.2	1932.2	52.5							
	SD	9.1	8.2					20.0	216.8	4.9							
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**			
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**		
F	**Mean**	3.07	1.62	1.29	1.29	1.24	1.23	1.20	1.15	2.55[1,2]	506.2	317.5	144.5[1]	194.7	211.2		
	SD	0.299	0.099	0.090	0.112	0.093	0.056	0.087	0.038	0.054	27.8	27.9	10.4	14.4	13.8		
M	**Mean**	2.44	1.75	1.64	1.66	1.60	1.59	1.56	1.48	3.40[1,2,4]	453.7	285.5	141.7[1]	192.2	199.2[1]		
	SD	0.185	0.170	0.111	0.114	0.140	0.129	0.155	0.157	0.107	25.7	18.2	10.1	19.5	4.4		
M&F	**Mean**	2.76	1.68	1.46	1.47	1.42	1.40	1.37	1.31	2.97	480.0	301.5	143.1	193.5	205.2		
	SD	0.402	0.153	0.207	0.219	0.215	0.204	0.219	0.202	0.444	37.5	28.2	10.1	16.7	11.7		

[1] differs by 1.00 to 1.49 SD from *P. mellipes.* [2] differs by 1.00 to 1.49 SD from *P. otaniae.* [3] differs by 1.50 to 1.99 SD from *P. otaniae.* [4] differs by 1.00 to 1.49 SD from *P. carcamoi.* [5] differs by 1.50 to 1.99 SD from *P. carcamoi.* [6] differs by 3.00 to 3.99 SD from *P. carcamoi.*

Sex		*Peristenus pseudopallipes* (Loan)								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	651.4	683.1	280.2	369.3	223.7	228.7	60.4[3,6]	129.7	107.9
	SD	27.1	30.2	14.0	13.2	11.6	12.7	3.1	7.3	5.6
M	**Mean**	607.9	625.7	303.9	326.7	203.9	195.0	57.4[2,4]	120.8	99[4]
	SD	19.3	18.0	11.5	10.4	9.6	6.7	7.8	7.8	8.1
M&F	**Mean**	629.6	654.4	292.0	348.0	213.8	211.9	58.9	125.2	103.5
	SD	32.0	38.1	17.4	24.7	14.5	19.9	6.0	8.7	8.2
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.95	1.32	0.98	2.15[2,4]	1.79[2,4]	0.84	1.60	2.20	0.93
	SD	0.011	0.056	0.064	0.123	0.150	0.080	0.084	0.124	0.098
M	**Mean**	0.97	1.08	1.05	2.13	1.75	0.82	1.59	2.02[1]	0.96
	SD	0.012	0.053	0.057	0.274	0.265	0.901	0.075	0.114	0.088
M&F	**Mean**	0.96	1.20	1.01	2.14	1.77	0.83	1.60	2.11	0.95
	SD	0.014	0.136	0.68	0.206	0.211	0.084	0.077	0.148	0.093

[1] differs by 1.00 to 1.49 SD from *P. mellipes.* [2] differs by 1.00 to 1.49 SD from *P. otaniae.* [3] differs by 1.50 to 1.99 SD from *P. otaniae.* [4] differs by 1.00 to 1.49 SD from *P. carcamoi.* [5] differs by 1.50 to 1.99 SD from *P. carcamoi.* [6] differs by 3.00 to 3.99 SD from *P. carcamoi.*

TABLE 15. Measurements and ratios recorded from 10 females and 10 males of *Peristenus broadbenti* Goulet from Lethbridge, AB.

***Peristenus broadbenti* Goulet**																
		Flagellomere measurements														
Sex		**Flagellomere Length: Fl # (L)**														
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	145.5	116.8	99.0	98.5	92.6	94.5	88.6	89.1	84.6	86.1	80.2	81.2	75.7	74.7	71.8	70.3
	SD	8.5	5.3	4.7	5.9	4.7	5.4	3.6	4.7	4.9	4.2	4.5	4.2	4.1	4.3	2.6	3.1
M	**Mean**	132.7	119.3	104.9	106.4	104.9	104.4	102.5	104.4	100.0	101.5	97.5	100.5	93.1	95.0	92.1	92.1
	SD	9.6	7.2	8.0	7.8	7.7	8.9	6.6	9.2	6.9	6.7	6.2	6.6	7.3	7.7	8.8	4.8
M&F	**Mean**	139.1	118.1	102.0	102.5	98.8	99.5	95.5	96.8	92.3	93.8	88.8	90.8	84.4	84.9	81.9	81.2
	SD	11.0	6.3	7.1	7.9	8.9	8.8	8.8	10.6	9.8	9.6	10.3	11.3	10.6	12.0	12.2	11.8
		Flagellomere Length						**19/22**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	66.8	63.4					122.8	1702.3	48.0	54.9	56.9	56.9	56.4	56.9	54.9	55.4
	SD	2.6	3.9					20.4	69.7	2.4	4.3	4.2	4.2	5.3	4.8	3.6	3.1
M	**Mean**	87.6[1]	85.1	81.2	74.7	69.3		107.9	2122.6	50.5	53.4	50.5	50.0	50.0	48.5	46.5	46.5[1]
	SD	6.6	5.6	7.8	9.7	7.8		28.2	169.2	3.1	4.5	3.9	2.8	2.8	2.1	3.5	2.7
M&F	**Mean**	77.2	74.2					115.3	1912.4	49.2							
	SD	11.7	12.1					25.1	249.7	3.0							
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**		
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**	
F	**Mean**	3.03	1.57	1.33	1.32	1.28	1.24	1.22	1.14	2.52	486.2	308.7	138.5	213.7	208.7	
	SD	0.195	0.116	0.050	0.086	0.113	0.74	0.59	0.048	0.051	31.43	25.7	11.7	9.2	10.3	
M	**Mean**	2.63	1.83	1.74	1.83	1.73	1.70	1.68	1.48	3.53	432.5	255.0	119.0	200.0	201.2	
	SD	0.122	0.174	0.093	0.127	0.100	0.120	0.136	0.090	0.185	30.7	25.8	13.4	16.7	13.8	
M&F	**Mean**	2.83	1.70	1.54	1.57	1.51	1.47	1.45	1.31	3.02	459.4	281.9	128.7	206.9	205	
	SD	0.262	0.196	0.223	0.281	0.255	0.256	0.260	0.185	0.534	40.9	37.3	15.8	14.9	12.4	

[1] differs by 1.00 to 1.49 SD from *P. gillespiei.*

Sex		*Peristenus broadbenti* Goulet								
		Head Measurements								
	Stats	**MxGW**	**MxHdW**	**MnEy-Ey**	**EyH**	**GL**	**EyL**	**LOL**	**POL**	**OOL**
F	**Mean**	634.2	675.2	263.3	362.3	225.7	224.7	64.3	123.7	111.9
	SD	16.5	18.6	10.6	12.5	7.8	13.2	5.2	5.2	6.7
M	**Mean**	581.1	600.9	288.1	297.0	213.8	178.2	64.3	121.8	104.9
	SD	25.6	25.2	12.7	9.3	13.4	8.1	5.2	6.7	8.3
M&F	**Mean**	607.9	638.1	275.7	329.7	219.8	201.5	64.3	122.8	108.4
	SD	34.5	43.7	17.1	35.2	12.3	26.1	5.1	5.9	8.2
		Head Ratios						**Tergum 1 Ratios**		**Forewing Ratio**
		MxGW/ MxHdW	**EyH/ MnEy-Ey**	**GL/EyL**	**POL/LOL**	**OOL/LOL**	**OOL/POL**	**L/MxW**	**MxW/MnW**	**RcL/StW**
F	**Mean**	0.94	1.38	1.01	1.93	1.74	0.091	1.58	2.23	1.02
	SD	0.012	0.056	0.065	0.191	0.089	0.072	0.102	0.061	0.041
M	**Mean**	0.97	1.03	1.20	1.90	1.64	0.86	1.70	2.15	0.99
	SD	0.008	0.035	0.044	0.098	0.187	0.083	0.104	0.195	0.045
M&F	**Mean**	0.95	1.20	1.10	1.92	1.69	0.88	1.64	2.19	1.01
	SD	0.017	0.183	0.112	0.149	0.152	0.078	0.119	0.146	0.045

[1] differs by 1.00 to 1.49 SD from *P. gillespiei.*

TABLE 16. Measurements and ratios recorded from 10 females and 10 males of *Peristenus gillespiei* Goulet from Chilliwack, Delta Chilliwack Lake Road, West Harrison Road, Hemlock Valley, Skagit valley and Mount Cheam in British Columbia.

***Peristenus gillespiei* Goulet**																	
		Flagellomere measurements															
Sex		**Flagellomere Length: Fl # (L)**															
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	142.6	116.3	98.5	98.5	93.1	94.0	90.6	90.1	85.1	87.1	82.2	84.1	79.7	79.2	74.7	74.7
	SD	8.3	10.2	8.9	7.5	8.0	5.7	7.0	5.1	5.1	6.3	4.2	5.2	3.7	4.7	4.3	4.3
M	**Mean**	135.1	123.3	111.9	109.4	108.9	112.3	105.9	108.9	103.9	108.3	100.6	105.6	99.6	100.1	96.2	98.3
	SD	11.2	7.9	9.7	5.9	8.4	7.0	8.8	9.6	7.0	9.1	10.8	8.2	6.8	7.7	4.4	3.4
M&F	**Mean**	138.8	119.8	105.2	103.9	101.0	103.2	98.3	99.0	94.0	97.2	90.9	94.3	89.1	89.1	84.9	84.4
	SD	10.3	9.6	11.3	8.6	11.4	11.3	11.0	12.1	11.3	13.2	12.3	12.8	11.4	12.3	11.8	12.6
		Flagellomere Length						**19/22**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	71.3	68.3[2]					143.6	1753.8	48.5	54.0	57.4	60.0	60.4	60.9	59.4	59.4
	SD	2.6	3.1					21.0	83.3	2.1	2.8	3.5	2.8	3.1	3.3	2.3	2.3
M	**Mean**	96.5[1]	93.2	87.4	76.7	79.2		112.2	2284.4	53.5	53.3	51.1	50.2	52.0	50.3	49.5	47.0[1]
	SD	2.7	5.8	2.6	5.2	4.9		24.8	93.7	4.5	4.1	2.6	1.9	2.7	2.0	3.1	2.7
M&F	**Mean**	80.7	77.7					131.8	1952.8	51.0							
	SD	12.9	13.1					26.7	278.4	4.3							
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**			
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**		
F	**Mean**	2.94	1.62	1.39	1.32	1.24	1.23	1.20	1.15	2.59[2]	483.7	286.7	124.7	203.7	217.5[2]		
	SD	0.192	0.127	0.112	0.076	0.088	0.055	0.062	0.054	0.039	28.3	21.2	7.8	11.9	10.5		
M	**Mean**	2.54	1.90	1.90	1.88	1.89	1.81	1.74	1.60	3.67	451.2	262.5	127.5	210.0	208.7		
	SD	0.223	0.265	0.143	0.125	0.141	0.132	0.141	0.073	0.169	35.1	46.0	17.6	11.5	10.3		
M&F	**Mean**	2.74	1.75	1.63	1.55	1.48	1.45	1.41	1.32	2.99	467.5	274.6	126.1	206.9	213.1		
	SD	0.290	0.245	0.287	0.300	0.341	0.302	0.287	0.234	0.550	35.2	37.0	13.3	11.8	11.1		

[1] differs by 1.00 to 1.49 SD from *P. broadbenti.* [2] differs by 1.00 to 1.49 SD from *P. howardi.*

Sex		*Peristenus gillespiei* Goulet								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F	Mean	635.6	678.1	261.4	372.2	209.9	235.6	57.4	113.8	103.0
	SD	29.8	33.4	10.6	19.9	12.2	17.3	4.2	7.0	6.9
M	Mean	593.0	609.8	294.0	310.9	205.2	188.1	61.4	116.8	107.9
	SD	35.7	37.4	19.3	14.1	15.3	15.5	6.3	11.2	11.8
M&F	Mean	614.3	644.0	277.7	341.5	207.9	211.9	59.4	115.3	105.4
	SD	38.7	49.2	22.6	35.7	13.6	29.2	5.6	9.2	9.8
		Head Ratios						Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/MnW	RcL/StW
F	Mean	0.94	1.42	0.089	1.99	1.80	0.91	1.69	2.30	0.94
	SD	0.010	0.041	0.072	0.202	0.153	0.083	0.064	0.116	0.077
M	Mean	0.97	1.06	1.10	1.91	1.77	0.93	1.75	2.05	1.01
	SD	0.010	0.043	0.072	0.105	0.203	0.107	0.214	0.180	0.054
M&F	Mean	0.95	1.24	1.00	1.95	1.78	0.92	1.72	2.18	0.97
	SD	0.021	0.192	0.126	0.163	0.176	0.094	0.157	0.194	0.073

[1] differs by 1.00 to 1.49 SD from *P. broadbenti*. [2] differs by 1.00 to 1.49 SD from *P. howard.i*

TABLE 17. Measurements and ratios recorded from 10 females of *Peristenus howardi* Shaw from Parma, ID (Newark, DE, laboratory colony).

Peristenus howardi Shaw																
		Flagellomere measurements														
Sex		**Flagellomere Length: Fl # (L)**														
	Stats	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	**Mean**	145.0	107.4	93.6	92.1	90.1	89.1	83.7	86.1	78.7	80.7	74.7	75.7	73.8	72.8	69.8	69.3
	SD	7.4	5.7	6.8	6.7	4.5	4.7	4.3	4.2	3.6	5.2	4.3	4.7	4.3	4.1	3.7	3.3
M	**Mean**																
	SD																
M&F	**Mean**																
	SD																
		Flagellomere Length						**19**	**Length**	**Flagellomere Width: Fl # (W)**							
	Stats	**17**	**18**	**19**	**20**	**21**	**22**	**Last**	**Fl (L)**	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**
F	**Mean**	66.8	61.4[1]					119.8	1630.5	46.0	53.5	57.9	56.9	56.4	56.9	55.9	54.9
	SD	3.5	3.5					27.4	84.4	3.3	3.1	2.4	2.6	2.6	2.6	3.3	3.6
M	**Mean**																
	SD																
M&F	**Mean**																
	SD																
		Flagellomere Ratios: Fl # (L/W)								**Fl (L)/**	**Metasomal tergum 1**			**Forewing**			
	Stats	**1**	**Mid**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**MxHdW**	**L**	**MxW**	**MnW**	**RcL**	**StW**		
F	**Mean**	3.16	1.51	1.27	1.28	1.24	1.22	1.20	1.12	2.45[1]	436.2	266.2	118.7	195.0	191.2[1]		
	SD	0.143	0.095	0.069	0.055	0.063	0.049	0.042	0.103	0.066	42.3	25.0	13.5	12.1	10.3		
M	**Mean**																
	SD																
M&F	**Mean**																
	SD																

[1] differs by 1.00 to 1.49 SD from *P. gillespiei.*

Sex		*Peristenus howardi* Shaw								
		Head Measurements								
	Stats	MxGW	MxHdW	MnEy-Ey	EyH	GL	EyL	LOL	POL	OOL
F	Mean	629.6	665.3	260.4	369.3	210.9	222.7	60.4	123.7	111.9
	SD	21.0	25.5	9.4	13.2	9.4	9.6	3.1	5.2	6.7
M	Mean									
	SD									
M&F	Mean									
	SD									
		Head Ratios						Tergum 1 Ratios		Forewing Ratio
		MxGW/ MxHdW	EyH/ MnEy-Ey	GL/EyL	POL/LOL	OOL/LOL	OOL/POL	L/MxW	MxW/MnW	RcL/StW
F	Mean	0.95	1.42	0.095	2.05	1.86	0.091	1.64	2.25	1.02
	SD	0.015	0.051	0.059	0.146	0.150	0.079	0.064	0.139	0.062
M	Mean									
	SD									
M&F	Mean									
	SD									

[1] differs by 1.00 to 1.49 SD from *P. gillespiei.*

TABLE 18. *Leiophron* and *Peristenus* (Hymenoptera: Euphorinae) parasitoid species associated with *Lygus* plant bugs (Hemiptera: Miridae) in North America: distribution, hosts and life cycle.

Parasitoid	Host	Voltinism
Leiophron australis Goulet [**USA**: NY, DE]	*Lygus lineolaris* (Palisot)	bivoltine
Leiophron lygivorus (Loan) [**CANADA**: ON, QC, PE; **USA**: IA, ND]	*Lygus lineolaris* (Palisot)	bivoltine
Leiophron simoni Goulet [**CANADA**: ON]	*Lygus lineolaris* (Palisot)	univoltine (2nd generation) or bivoltine
Leiophron uniformis (Gahan) [**CANADA**: ON; **USA**: AZ, CA, DE, KS, LA, MD, MO, MS, NH, NJ, NY, OH, PA, UT; **MEXICO**: TAM]	[1]*Halticus bractatus* (Say) [main host] *Adelphocoris lineolatus* (Goeze) *Lygus lineolaris* (Palisot) *Lygus elisus* Van Duzee [2]*Pseudatomoscelis seriatus* (Reuter) [3]*Trigonotylus caelestialium* (Kirkaldy) [3]*Trigonotylus tenuis* Reuter	bivoltine
Peristenus braunae Goulet [**CANADA**: NT, NS, NB, QC, MB, SK, AB, BC; **USA**: AK, CA,CO,NV, UT]	*Adelphocoris lineolatus* (Goeze) *Lygus lineolaris* (Palisot)	univoltine (1st generation)
Peristenus broadbenti Goulet [**CANADA**: AB, BC; **USA**: MT, OR, WA, WY]	*Lygus* spp.	univoltine (2nd generation)
Peristenus carcamoi Goulet [**CANADA**: AB, BC]	*Lygus* spp.	univoltine
Peristenus dayi Goulet [**CANADA**: ON, QC; **USA**: DE, NJ, NY]	*Adelphocoris lineolatus* (Goeze) [main host] *Lygus lineolaris* (Palisot) [rarely]	univoltine (1st generation)
Peristenus digoneutis Loan [**CANADA**: NS, ON, QC; **USA**: CA, CT, DE, MA, ME, NH, NJ, NY, PA, VT; **Palaearctic**]	*Lygus lineolaris* (Palisot) [main host] *Adelphocoris lineolatus* (Goeze) [main host] [3]*Leptopterna dolobrata* (Linnaeus)	bivoltine
Peristenus gillespiei Goulet [**CANADA**: BC; **USA**: CA]	*Lygus* spp.	univoltine (1st generation)
Peristenus howardi Shaw [**USA**: ID, WA]	*Lygus hesperus* Knight	bivoltine

to be continued.

TABLE 18 (continued).

Parasitoid	Host	Voltinism
Peristenus mellipes (Cresson) [**CANADA**: NB, NS, QC, ON; **USA**: DE, GA, IL, KS, MA, MD, ME, MI, MO, MS, NJ, NY, SC, VA]	*Lygus lineolaris* (Palisot) [main host] *Adelphocoris lineolatus* (Goeze) [rarely]	univoltine (1st generation)
Peristenus otaniae Goulet [**CANADA**: NF, QC, MB, SK, AB, BC; **USA**: CO]	*Lygus lineolaris* (Palisot) *Lygus* spp. *Adelphocoris lineolatus* (Goeze)	univoltine (1st generation)
Peristenus pseudopallipes (Loan) [**CANADA**: NB, QC, ON; **USA**: CT, DE, GA, NC, NJ, NY, OH]	*Lygus lineolaris* (Palisot) *Lygus vanduzeei* Knight [Loan, 1980]	univoltine (2nd generation)
Peristenus relictus (Ruthe) [**USA**: CA; **Palaearctic**]	*Lygus lineolaris* (Palisot) *Lygus shulli* Knight	multivoline
Peristenus rubricollis (Thomson) [**CANADA**: QC; **USA**: DE, NJ, NY; **Palaearctic**]	*Adelphocoris lineolatus* (Goeze) [main host] *Lygus lineolaris* (Palisot)	univoltine (1st generation)

Unless otherwise noted all host species belong to Mirinae, Mirini. [1]Orthotylinae, Halticini; [2]Phylinae, Phylini; [3]Mirinae, Stenodemini

TABLE 19. Mean number (±SE) of *Lygus lineolaris* (Palisot) 4th and 5th instar nymphs collected and mean parasitism (±SE) 2000–2002 during 1st and 2nd generation peaks at Hemmingford (fallow field) and Ste. Clotilde (fallow field and alfalfa) Quebec.

Year – generation	Hemmingford – hay field	Ste. Clotilde – alfalfa	Ste. Clotilde – hay field
L. lineolaris			
2000 – 1st	28.0 ±11.7	93.7 ±12.4	.
– 2nd	82.7 ±28.8	88.3 ±30.3	.
2001 – 1st	5.0 ±1.2	146.3 ±28.3	40.0 ±15.9
– 2nd	56.0 ±9.0	258.0 ±183.3	48.0 ±24.1
2002 – 1st	26.3 ±12.1	37.2 ±13.3	23.0 ±8.0
– 2nd	23.7 ±4.9	432.0 ±44.2	18.7 ±5.2
Parasitism			
2000 – 1st	45.9 ±13.0	18.0 ±7.8	.
– 2nd	11.5 ±4.7	37.3 ±7.6	.
2001 – 1st	14.8 ±9.8	24.1 ±12.5	21.0 ±8.3
– 2nd	12.5 ±2.2	20.7 ±9.2	10.2 ±5.6
2002 – 1st	6.0 ±3.1	13.6 ±7.7	3.3 ±3.3
– 2nd	30.3 ±12.1	6.9 ±2.9	10.2 ±5.1