

# The Mantispidae (Insecta: Neuroptera) of Canada, with notes on morphology, ecology, and distribution<sup>1</sup>

Robert A. Cannings<sup>2</sup>

Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, Canada V8W 9W2

Sydney G. Cannings

NatureServe Yukon, Yukon Territorial Government, Box 2703, Whitehorse, Yukon Territories, Canada Y1A 2C6, and Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, Canada V8W 9W2

**Abstract**—Morphological, biological, and distributional data are presented for the four Canadian species of Mantispidae. A key for the identification of these species is provided. *Climaciella brunnea* (Say) is the most frequently collected Canadian species, occurring in southern British Columbia, Alberta, Manitoba, Ontario, and Quebec. *Dicromantispa interrupta* (Say) **comb. nov.** is given as a new combination for *Mantispa interrupta* Say; it is recorded in southern Ontario and Quebec. *Dicromantispa sayi* (Banks) occurs only in extreme southwestern Ontario. *Leptomantispa pulchella* (Banks) inhabits the dry Okanagan Valley of British Columbia; it is also known from Ojibway Prairie, Windsor, Ontario. The presence of the latter two species in Canada is published for the first time.

**Résumé**—Nous présentons des données sur la morphologie, la biologie et la répartition des quatre espèces canadiennes de Mantispidae, ainsi qu'une clef pour leur identification. *Climaciella brunnea* (Say) est l'espèce canadienne la plus fréquemment récoltée et elle se retrouve dans le sud de la Colombie-Britannique, de l'Alberta, du Manitoba, de l'Ontario et du Québec. *Dicromantispa interrupta* (Say) **comb. nov.** est une nouvelle combinaison pour désigner *Mantispa interrupta* Say; l'espèce habite le sud du Québec et de l'Ontario. *Dicromantispa sayi* (Banks) se rencontre seulement dans l'extrême sud-ouest de l'Ontario. *Leptomantispa pulchella* (Banks) se retrouve dans la vallée sèche de l'Okanagan en Colombie-Britannique; elle a été récoltée aussi à Ojibway Prairie, Windsor, Ontario. La présence de ces deux dernières espèces au Canada est signalée pour la première fois.

[Traduit par la Rédaction]

## Introduction

Adults of the neuropteran family Mantispidae, with their triangular head and large eyes, elongate prothorax and raptorial forelegs, strikingly resemble the Mantidae of the order Mantodea. However, the two families are only distantly related in the Insecta; the superficial resemblance is the result of convergent evolution. There are many differences, the most obvious

being that the Mantispidae are holometabolous and the Mantidae are not.

The four species of Mantispidae known from Canada are *Climaciella brunnea* (Say), *Dicromantispa interrupta* (Say) **comb. nov.**, *Dicromantispa sayi* (Banks), and *Leptomantispa pulchella* (Banks). Until recently, the last three species had been placed in *Mantispa*, but Hoffman (2002) created new genera for the

Received 20 June 2004. Accepted 16 September 2005.

<sup>1</sup>This paper is part of a special issue honouring Geoffrey G.E. Scudder for his significant contributions to entomology in Canada.

<sup>2</sup>Corresponding author (e-mail: rcannings@royalbcmuseum.bc.ca).

Nearctic and Neotropical species of the subfamily Mantispidae based on his findings that Old and New World clades were distinct (Hoffman 1992; K. Hoffman, personal communication).

Species of Mantispidae in Canada are at the northern limits of their range; none are recorded north of 49°N latitude in Ontario and Quebec and none north of 51°N latitude west of Ontario. However, this fauna represents the majority of Nearctic mantispines, because the most recent taxonomic work indicates that only six species of Mantispidae occur in North America: the four species recorded in Canada plus *Xeromantispa scabrosa* (Banks, 1912) and *Zeugomantispa minuta* (Fabr., 1775) (K. Hoffman, personal communication). This fauna is an extension of a primarily Central and South American one: all six species occur in Mexico and all except *D. interrupta* and *X. scabrosa* range at least as far south as Nicaragua (Hoffman 1992).

Canadian mantispids belong to the subfamily Mantispidae, apparently among the more derived mantispids, whose members all develop, as far as is known, by feeding on spider eggs in the larval stages. Other mantispids are less well known biologically and are considered more plesiotypic, the larvae, at least in some cases, remaining generalist predators (MacLeod and Redborg 1982; Redborg 1998).

In the Mantispidae, first-instar larvae are campodeiform and active and find spider eggs by searching for, and penetrating, egg sacs or by boarding a female spider and entering the egg sac as it is constructed (Redborg and MacLeod 1985). In some North American mantispines studied, one of these two behaviours is obligatory, although in *D. sayi*, either is possible. This is probably also the case in *D. interrupta* (Redborg 1998). Larvae of *C. brunnea* and *L. pulchella* are apparently obligate spider boarders. Larvae often feed on spider haemolymph while riding on the host (Redborg and MacLeod 1984). *Zeugomantispa minuta* (= *Mantispa viridis* Walker) actively searches out egg sacs and chews its way into them (Redborg and MacLeod 1985) and will feed on eggs presented to it (Davidson 1969). According to much of the literature, second- and third-instar larvae become sedentary and eruciform inside the egg cases (Imms 1957), although Redborg (1998) disputed the idea that mantispids are truly hypermetamorphic in the way, for example, meloid beetles are. The entire food supply for the insect's development is inside a single egg sac; adult size varies considerably and depends on the amount of food eaten by the larva (Redborg and MacLeod 1985). After pupation, the pharate adult chews its way out of the pupal cocoon and the egg sac before final adult ecdysis.

### Key to the Canadian species of Mantispidae

- 1a Wings with anterior half amber to brown; in anterior view, antennal flagellomeres at midlength of flagellum each 3 or more times as wide as long; pronotum with strong constrictions and with transverse ridges; pronotum in dorsal view usually 4 to 5.5 times as long as wide at the narrowest point; one species widely distributed in southern Canada from Quebec west to British Columbia. . . . *Climaciella brunnea*
- 1b Wings mostly clear, with any brown markings restricted to the costal/radial area; in anterior view, antennal flagellomeres at midlength of flagellum each less than 3 times as wide as long; pronotum without strong constrictions and with or without transverse ridges; pronotum in dorsal view usually 6 or more times as long as wide at the narrowest point . . . . . 2
- 2a Pronotum in lateral view with numerous short setae over its entire length; pronotum without evident transverse ridges; a species of extreme southwestern Ontario and dry valleys in the southern interior of British Columbia . . . . . *Leptomantispa pulchella*
- 2b Pronotum in lateral view with scattered fine setae, most of them at the anterior and posterior ends of the pronotum; pronotum with evident transverse ridges; species from Ontario and Quebec . . . . . 3
- 3a Wing tips and some crossveins of radial cells marked with brown spots . . . . *Dicromantispa interrupta*
- 3b Wing tips and crossveins without brown spots . . . . . *Dicromantispa sayi*

Specimens cited in the species accounts are housed in the following collections (abbreviations follow Arnett *et al.* (1993)):

BCAK British Columbia Ministry of Agriculture and Lands, Kelowna, British Columbia, Canada

BCPM	Royal British Columbia Museum, Victoria, British Columbia, Canada
BDMU	McMaster University, Hamilton, Ontario, Canada
BMNH	Natural History Museum, London, United Kingdom
CNCI	Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada
DEBU	University of Guelph, Guelph, Ontario, Canada
DNC	Dean Nicholson Collection, Cranbrook, British Columbia, Canada
EDUM	University of Manitoba, Winnipeg, Manitoba, Canada
GLFR	Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario, Canada
IFE	S. Ife Collection
LEMQ	Lyman Entomological Museum, McGill University, Sainte-Anne-de-Bellevue, Quebec, Canada
LUTB	Lakehead University, Thunder Bay, Ontario, Canada
MCZC	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, United States of America
NFRC	Northern Forest Research Centre, Edmonton, Alberta, Canada
OSUC	Ohio State University, Columbus, Ohio, United States of America
PFRS	Pacific Forestry Centre, Victoria, British Columbia, Canada
QMOR	Université de Montréal, Montréal, Quebec, Canada
ROME	Royal Ontario Museum, Toronto, Ontario, Canada
SMDV	Spencer Entomological Museum, University of British Columbia, Vancouver, British Columbia, Canada
USNM	United States National Museum, Washington, District of Columbia, United States of America
UVIC	University of Victoria, Victoria, British Columbia, Canada

### Species accounts

#### *Climaciella brunnea* (Say, 1824)

*Mantispa brunnea* Say, 1824; original description; syntype, St. Peter's River, Minnesota, probably destroyed.

*Mantispa burquei* Provancher, 1875.  
*Climaciella brunnea* (Say), Enderlein (1910); synonymy of *M. burquei*; new genus.  
*Climaciella brunnea* (Say) *occidentis* Banks, 1911; description of western form.

#### Range

Southern British Columbia and Alberta (probably occurs in southern Saskatchewan, but no specimens known), Manitoba, Ontario, and Quebec south to California, Arizona, New Mexico, Mississippi, and Florida; south through Mexico to Costa Rica (see Throne (1972) for a summary of the distribution in the United States).

#### Canadian specimens examined

**British Columbia:** Craig, 2.vii.1953, Forest Insect Survey (PFRS); Cranbrook, 3400 feet, 5.vii.2004, J. Collings (DNC); Goldstream, 9.vi.1917, E.H. Blackmore (CNCI); Kamloops, 9.vii.1944, 3.ix.1944, G.J. Spencer (SMDV); Kelowna, 8.vii.1968, Forest Insect Survey (CNCI); Kootenay Valley, 2500', 1900–1922, C.H. Polson (BMNH); Lillooet, 25.ix.1918, A.W.A. Phair (CNCI); Marron Lake, 26.ix.1923, C. de B. Green (CNCI); vii.1924 (3 specimens), C. de B. Green (BCPM); Okanagan Falls, Willowbrook, 12.viii.2002, M. Sarell (BCPM); Okanagan Landing, vi.1990, H. Philip (SMDV); Oliver, 25.viii.1950, P. Zuk (SMDV); 20.viii.1975, P.J. Procter (BCPM); ix.1991, T. Watson (BCAK); 11.ix.2000, D. Nemeth (SMDV); Oliver, 5 mi. N, 6.ix.1962, M. Preusse (SMDV); Osoyoos, no date, C. de B. Green (CNCI); 8.ix.1983, J. Belton (BCPM); Oyama, 20.ix.1926, J.A. Henderson (BCPM); 20.x.1929, G.J. Spencer (SMDV); Roosville, Tobacco Plains, 17.vii.1999, M. Fairbarns and S. Ford (BCPM); Summerland, 27.viii.1920, F.W. Sladen (CNCI); 9.ix.1981, P.J. Procter (BCAK); Trepanier, ix.1943, V. Nelson (SMDV); Vaseux Lake, 26.vi.1959, L.A. Kelton (CNCI), 20.viii.1989 (3 specimens), S. Ife (IFE); Vernon, 5.x.1940, G.R.N. (SMDV); Vernon, Commonage, 12.vi.2005, K. Iverson (BCPM); Vernon, Cosens Bay, 21.vii.1987, R.A. Cannings (BCPM); Victoria, no date, Rev. G.W. Taylor (MCZC), 1917 (USNM).

**Manitoba:** Beaver Creek, 26.vi.1962, J.A. Garland (EDUM); Birdshill Provincial Park, 25.vi.1978, D.G. Delf (EDUM); Fraserwood, 21.vii.1964, Forest Insect Survey (CNCI); Lockport, 28.vi.1976, 7.vii.1976, J.S. Lee (EDUM); St. Laurent, 23.vii.1961, Forest Insect

Survey W61-1672-02 (NFRC); Tenlon, 4.vii.1958, M. Ferley (EDUM); Winnipeg, 15.vii.1932, J.A. Cumming (EDUM); 11.vii.1960, J.A. Scott (EDUM); 5.viii.1972, S. Gibb (EDUM).

**Ontario:** Arnprior, 7.vii.1918, 13.vii.1919, C.M. MacNamara (CNCI); 14.vii.1936, W.J. Brown (CNCI); Avonmore, 13.vii.1939, G.H. Hammond (CNCI); Beachburg, Renfrew Co., 9.vii.1978 (2 specimens), E. Fuller and R. Jaagumagi (ROME); Bell's Corners, 18.vii.1948 (8 specimens), S.D. Hicks (CNCI); 18.vii.1948 (2 specimens), S.D. Hicks (MCZC); Calabogie, Renfrew Co., 26.vi.1978, E. Fuller (ROME); Chatterton, 19.vii.1951, J.C. Martin, 12.vii.1954, W.A. Dempsey, 13.vii.1954, R.W. Smith (CNCI); Constance Bay, Ottawa, 22.vi.1965, H.F. Howden (CNCI); 24.vi.1965, W.C. McGuffin (LUTB); vii.1970, M. Sanborne (LEMQ); 11.vii.1976, M. Sanborne (BDMU); Constance Lake, South March, 20.vi.1939, J.R. Vockeroth (CNCI); Crosby P.O., Kemptville, 22.vii.1960, Forest Insect Survey 560-447806 (GLFR); Crotch Lake, 25.vi.1988, J. Denis (CNCI); Cummings Bridge, Ottawa, 30.vii.1919, J. Thomsen (CNCI); Deep River, 5.vii.1977, D.J. Aspinall (DEBU); Eastview, 1928, R. Painter (CNCI); Foxboro, Sydney Field Station, 8.vii.1970, J.F. McAlpine (CNCI); Essex Co., Windsor, Ojibway Prairie, 21.vii.2000, S.A. Marshall (DEBU); 18-19.vi.2002, O. Lonsdale (DEBU); Fuller, Hastings Co., 26.vi.1953 (ROME); Glenburnie, 2.vii.2001, R. Harmsen (DEBU); Haldimand-Norfolk Co., Long Point, Wilson Tract, 9.vii.1992, R.A. Cannings (BCPM); Hamilton, 5.vii.1932, B.L. Guyatt (ROME); Lambton Co., Walpole Island, 4.viii.1996 (12 specimens), J. and A. Skevington (DEBU, BCPM); La Salle, 20.vii.1966, 21.vii.1967 (2 specimens), K. Stephan (MCZC); Leonard, 3 mi. E, 12.vii.1970, E.C. Becker (CNCI); Madoc, 11.vii.1944, G.S. Walley (CNCI); Marmora, 23.vi.1942, G.H. Hammond (MCZC); 26.vii.1943, 10.vii.1944, G.H. Hammond (CNCI); 25.vi.1952, R. Lambert (CNCI); 2.vii.1957, K.D. Southern (DEBU); Mer Bleue, 17.vii.1936, W.J. Brown (CNCI); Merivale, 21.vi.1943, W.J. Brown (CNCI); Norfolk Co., Manestar Tract, 6 km NNW St. Williams, 30.vi.2000, S.A. Marshall (DEBU); 23.vi.2002, M. Buck (DEBU); N. Burgess Township, Lanark Co., 19.vii.1970, G.C. Wood (CNCI); Ottawa, 12.vii.1940, G.A. Hobbs (CNCI); 12.vii.1940, G.A. Hobbs (DEBU); 24.vi.1975, 26.vi.1976, M. Sanborne (BDMU);

24.vi.1975, M. Sanborne (LEMQ); Pelee Island, vii (OSUC); Presqu'île Provincial Park, Jobs' Trail, 10.vii.1996, M. Gurr (DEBU); Presqu'île Provincial Park, north of day-use 1, 21.viii.2000, P. Careless (DEBU); Prince Edward Co., 15.vii.1914 (2 specimens), Brimley (ROME); Rockcliffe, 6.vii.1908, E.W. Ingall (CNCI); 24.vii.1928, J.A. Adams (CNCI); St. Williams, 6.vi.1997, S.A. Marshall (DEBU); Simcoe, 19.vi.1939, G.E. Shewell (CNCI); South March, 7.vii.1957, S.D. Hicks (CNCI); 24.vi.1959 (MCZC); 30.vi.1959, C.H. Mann (CNCI); Stittsville, 27.vi.1946, Forest Insect Survey 046-418 (GLFR); 12.vii.1961, D. Brown (CNCI); Thousand Islands, Miss Coleman (ROME); Thurlow Township, 18.vii.1940 (3 specimens) (CNC); Turkey Point, 17.vii.1940, F.S. Loqier (ROME); Tweed, 6.vii.1944, G.S. Walley (CNCI); Wagarville, 14.vii.1967, H.J. Teskey (MCZC); White Lake, 27.vi.1968, J. Robillard (DEBU); ?, 1.vii.1944, Forest Insect Survey ONT 1270 (GLFR).

**Quebec:** Abbotsford, 14.vii.1932 (LEMQ); 22.vi.1937, 25.vi.1937, G.E. Shewell (MCZC); 25.vi.1937 (2 specimens), 26.vi.1937, G.E. Shewell (CNCI); Aylmer, 16.vii.1905, W. Metcalfe (CNCI); 15.vi.1913, J.I. Beaulne (CNCI); 30.vi.1919, G.H. Hammond (CNCI); 16.vii.1926, R. Painter (CNCI); 12.vi.1936, W.J. Brown (CNCI); Aylmer, Queen's Park, 25.vii.1919, C.B. Hutchings (CNCI); 25.viii.1924, A.R. Graham (CNCI); Beech Grove, 17.vii.1951, J.F. McAlpine (CNCI); Bertierville, 16.vii.1950, A. Robert (QMOR); Deschenes, 23.vi.1930, G.S. Walley (CNCI); 30.vi.1933, R. Ozburn (CNCI); Harrington Lake, Gatineau Park, 24.vi.1953, S.D. Hicks (CNCI); Hull, 17.vi.1936, W.J. Brown (CNCI); Iberville Co., Saint-Grégoire, 21.vii.1985, Larochelle and Larivière (LEMQ); Kazabazua, 16.viii.1927, G.S. Walley (CNCI); Lac Roddick, 4.vii.1979, L. Masner (CNCI); Ladysmith, 24.vii.1958, L.A. Kelton (CNCI); La Trappe, 21.vi.1933, 23.vi.1933 (3 specimens), 25.vi.1933, 30.vi.1933, 4.vii.1933, 17.vii.1934 (2 specimens), 8.vii.1942, 22.vi.1944, 29.vii.1945, 3.vii.1951, J. Ouellet (QMOR); Laval, 24.vi.1938 (QMOR); Lévis, T.W. Fyles (LEMQ); Masham Township, Gatineau Co., 2.vii.1977, O.S. Flint, Jr. (USMN); Montréal, vii.1885, G.J. Bowles (LEMQ); 28.vi.1896, H.H. Lyman (LEMQ); no date, W. Couper (MCZC); Montréal, Outremont, vi (QMOR); Old Chelsea, King Mountain, 6.viii.1968, J.R. Vockeroth (CNCI); Otter Lake, 24.vii.1958, L.A.

Kelton (CNCI); Papineau Co, Papineauville, 2.vi.1985, Larochelle and Larivière (LEMQ); Pincourt, Île Perrot, 10.vii.1984, V.R. Vickery (LEMQ); Rigaud, 8.vii.1920, J. Ouellet (QMOR); 24.vi.1939, 29.vi.1939, 3.vii.1939, A. Robert (QMOR); 26.vi.1941, 27.vi.1942, J. Ouellet (QMOR); 9.vii.1941, A. Robert (QMOR); Rigaud, summit of mountain, 7.vii.1986, B.E. Cooper (CNCI); Ste. Annes, 21.vii.1938, 8.vii.1939, D.J. MacDonald (QMOR); 10.vii.1940, D.J. MacDonald (LEMQ); Saint-Bruno (QMOR); Sainte-Dorothée, 17.vi.1951, 2.vii.1951, 29.vii.1952 (CNCI); Saint-Hilaire, 1.vii.1920, G.A. Moore (LEMQ); Sainte-Rose; vii.1896, G.R. Kearley (LEMQ).

#### Other records

We have not seen the two Alberta specimens: Milk River, Lost River Ranch, vi/vii.1965, D. Larson (D. Larson, personal communication); Milk River, 3 km east of North Pinhorn Grazing Reserve Ranch Headquarters, 10.vii.1996, T. Pike (T. Pike, personal communication). Robert (1949) recorded other Quebec specimens that we did not examine (he mentioned others noted above): Montréal, 28.vi.1896, H.H. Lyman; Montréal, vii, A.C. Sheppard; Laval-des-Rapides, 28.vi.1938, G.A. Moore; Fort Coulonge, 17.vii.1919, J.-I. Beaulne; Saint-Hilaire, 11.vii.1938, A.A. Beaulieu; Quebec, 20.vi.1940, P.E. Mercier. We examined photographs of the following specimens: Kamloops, British Columbia, 14.viii.2003, K. West; Perth Road, Ontario, 10.vii.2000, R.-M. Burke.

#### Description

*Climaciella brunnea* is distinguished by its robust build, broad frons, and relatively short, thick prothorax (Fig. 1). Measurements of 12 males and 13 females (mean  $\pm$  SE (except for ratios) and range in mm): head width, males  $2.44 \pm 0.06$  (2.08–2.78), females  $2.83 \pm 0.13$  (2.03–3.63); ratio of frons width to head width, males 0.41 (0.29–0.44), females 0.42 (0.37–0.48); pronotum length, males  $3.62 \pm 0.17$  (2.67–4.40), females  $4.23 \pm 0.19$  (3.00–5.40); ratio of pronotum least width to length, males 0.22 (0.17–0.41), females 0.21 (0.18–0.27); forewing length, males  $14.27 \pm 0.27$  (10.65–18.75), females  $15.04 \pm 0.62$  (11.20–19.35); metafemur length, males  $3.63 \pm 0.19$  (2.72–4.60), females  $4.23 \pm 0.24$  (2.72–5.88).

Canadian specimens are variably patterned in yellow, brown, and black; yellow areas in many specimens may be darkened to reddish brown.

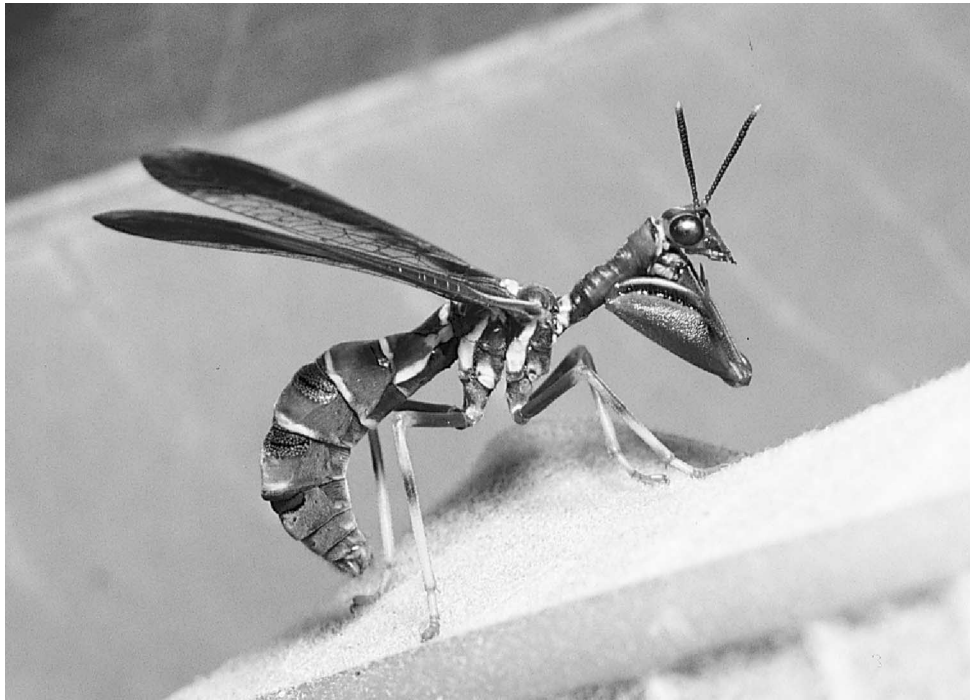
The frons, clypeus, and labrum are yellow or brown; a black band crosses the frons below the antennae. Mouthparts are brown, the palps brown or yellow. The vertex ranges from orange to brown and, in British Columbia specimens, often has a black or brown band across the posterior. The prothorax is dark brown, often yellow anteriorly and posteriorly, with a black band across the apex and base. The front legs are mostly brown, darker on inner faces of the femora; the tibiae are sometimes yellow. The middle and hind femora are brown and the tibiae and tarsi are yellow; the tibiae have a dark mark dorsally. Dorsally, the mesothorax and metathorax have yellow posterior margins. The wings are brown on the anterior half, the colour usually more sharply delineated posteriorly in eastern specimens (Fig. 1). In British Columbia specimens the brown wash sometimes covers the entire wing, but the pigment is lighter posteriorly. The colour of the abdomen is variable; often there are large patches of yellow laterally on the basal segments and the abdomen is frequently banded with yellow, black, and brown, or more or less mostly reddish brown. Welch and Kondratieff (1991) described the genitalia, noting that the elongate pseudopenis is distinctive.

#### Remarks

Many authors, at least as early as Wheeler (1889), have noted the striking coloration of this insect and have described its mimicry of polistine wasps. Some (*e.g.*, Batra 1972) thought that the larval host might be hymenopterous, but Redborg (1998) emphasised that larvae of *C. brunnea*, like those of all other mantispines as far as is known, feed on spider eggs. Wasps are often collected in the vicinity of congregations of mantispids and, in Utah, Batra identified the probable model of the mimicry as *Polistes fuscatus utahensis* Hayward, 1933. In Costa Rica, Opler (1981) postulated that five separate colour morphs each mimic a different polistine model. Redborg and MacLeod (1983) cautioned that the limits of this variable species are not well known; in Arizona they reared both yellow-marked and brown morphs from the same egg mass.

*Climaciella brunnea* is the most widespread and most frequently collected mantispid in Canada. Banks (1911) described *C. b. occidentis* as a western variety. Among other characteristics he noted the black vertex band present in many British Columbia specimens. The colour

Fig. 1. *Climaciella brunnea*. St. Williams, Ontario. Photo: S.A. Marshall.



patterns of eastern and western populations are so variable, however, that no subspecific differences hold up under scrutiny. Welch and Kondratieff (1991) synonymized this variety with the nominate form. Western Canadian specimens (from British Columbia) tend to be larger than their eastern (Manitoba, Ontario, Quebec) counterparts, however (head width (mm): western males ( $n = 6$ ),  $2.55 \pm 0.07$  (2.33–2.78); eastern males ( $n = 6$ ),  $2.33 \pm 0.07$  (2.08–2.58); western females ( $n = 7$ ),  $3.15 \pm 0.18$  (2.68–3.63); eastern females ( $n = 6$ ),  $2.43 \pm 0.11$  (2.03–2.80)).

In body proportions, the most striking differences between *C. brunnea* and the other species of Canadian Mantispidae are the broad frons and the prothoracic proportions. In *C. brunnea* the mean ratio of frons width to head width is 0.41 ( $n = 25$ ), whereas it is 0.31 ( $n = 21$ ) in *L. pulchella* and 0.29 ( $n = 12$ ) in *D. interrupta*. The mean of the ratio of prothoracic least width to length is 0.21 ( $n = 25$ ) in *C. brunnea*, 0.10 ( $n = 21$ ) in *L. pulchella*, 0.14 ( $n = 12$ ) in *D. sayi*, and 0.15 ( $n = 12$ ) in *D. interrupta*.

#### Natural history

The flight season in British Columbia differs from that farther east (Manitoba, Ontario, and

Quebec). British Columbia dates range from 9 June (Goldstream, Victoria) to 20 October (Oyama) ( $n = 29$ ); eastern ones are from 2 June (Papineauville, Quebec) to 23 August (Aylmer, Quebec) ( $n = 121$ ). Eleven dates from British Columbia are later in the year than the latest eastern date; seven of these are in September and two are in October. Probably the flight season begins in early June in most years in all Canadian regions within the range but, at least in some years, may last 2 months longer in British Columbia than in Manitoba, Ontario, and Quebec.

Canadian specimens give the following label data regarding habitat: Douglas-fir trees (*Pseudotsuga menziesii* (Mirbel) Franco) (Craig, BC); oak trees (*Quercus* sp.) (St. Williams, ON); ironweed (*Vernonia altissima* Nutt.) (Walpole Island, ON); round-leaved milkweed (*Asclepias ovalifolia* Dcne.) in grassland (Milk River, AB); grassland, bare clays with grass, cactus (*Opuntia polyacantha* Haw.), and sage (*Artemisia* sp.) (Milk River, AB); grassland adjacent to open ponderosa pine (*Pinus ponderosa* Dougl. ex P. & C. Lawson) woods (Vernon, BC); grassland with bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A. Löve) / arrowleaf balsamroot (*Balsamorhiza sagittata* (Pursh) Nutt.) (Okanagan Falls, BC); at base of

grass clump in Idaho fescue grassland (*Festuca idahoensis* Elmer) (Vernon, BC); three were knocked from lakeside willows (*Salix* sp.) during a rainstorm (Vaseux Lake, BC); one flew into a black widow spider (*Latrodectus hesperus* Chamberlin and Ivie, 1935) web at noon (Oliver, BC); and one was collected ambush-hunting on a dogwood (*Cornus* sp.) inflorescence along a forest edge at 1900, in sunshine (Glenburnie, ON).

*Climaciella brunnea* is perhaps the most diurnal of North American mantispids and is often found in feeding and mating aggregations on flowers probably formed and maintained through the influence of a male pheromone (Redborg and MacLeod 1983).

First-instar larvae spend most of their time standing vertically and motionless on caudal suckers or swaying back and forth with legs outstretched (Redborg 1998). The larvae must wait for a spider, climb onto it, and reach freshly laid eggs before the eggs are encased in silk (Redborg and MacLeod 1983). Unlike *D. sayi* larvae, those of *C. brunnea* cannot penetrate spider egg cases; indeed, *C. brunnea* larvae do not even recognize egg cases as food, and boarding a spider is obligatory for normal development (Redborg and MacLeod 1983). Larvae sit on the dorsum of the carapace with their mouthparts adjacent to the membrane between the carapace and the leg bases (Redborg 1998).

First-instar larvae overwinter on spiders, at least in the north. Redborg and MacLeod (1983) discussed this phoretic behaviour and development in detail. Host range is rather narrow: all documented wild-caught hosts are lycosid spiders from the genera *Schizocosa*, *Lycosa* (Redborg and MacLeod 1983; LaSalle 1986), *Rabidosa* (Redborg 1998), and *Tarantula* (George and George 1975). Larvae that board male spiders can switch to females during spider mating or cannibalism of males by females (Scheffer 1992). Redborg and Redborg (2000) found *C. brunnea* on 19% of *Schizocosa* sp. in forest leaf litter, while sympatric *D. sayi* (= *Mantispa uhleri* Banks) were phoretic on spider species above the forest floor. On an adjacent grassy field, the two mantispids were both found on the lycosid *Rabidosa punctulata* (Walckenaer, 1837).

### ***Dicromantispa interrupta* (Say, 1825), comb. nov.**

*Mantispa interrupta* Say, 1825; original description; type material, Philadelphia, Pennsylvania, probably destroyed.

*Mantispa cincticornis* Banks, 1911; original description; holotype, Brownsville, Texas, MCZC 10768.

*Mantispa interrupta* Say, Welch and Kondratieff (1991); synonymy of *M. cincticornis*.

#### **Range**

Restricted in Canada to southern Ontario and Quebec; in the rest of North America, found west to Minnesota and south to Florida and southern Mexico (Throne 1972; Hoffman 1992).

#### **Canadian specimens examined**

**Ontario:** Chaffey's Locks, 24.vii.1963, J.C.E. Riotte and I. Smith (ROME); 11.vii.1966 (2 specimens), Riotte and Kohalmi (ROME); 16.vii.1969, 2.viii.1969, 4.viii.1969, J.C.E. Riotte (ROME); 30.viii, 3.x.1969, I.M. Smith (ROME); 30.vii.1971, J.C.E. Riotte (ROME); 2.vii.1979, F. Phelan (ROME); Chatteron, 7.vii.1951 (CNCI); Hamilton (DEBU); Huntley, 19.vii.1960, D. Brown (CNCI); Lanark, Patterson Lake, 13.viii.1977, S.A. Marshall (DEBU); Marmora, 15.vii.1951, R. Lambert (CNCI); Niagara-on-the-Lake, 14.viii.1932, G.G. Duston (DEBU); North Burgess Township, Lanark Co., 27.vii.1967, 18.ix.1967, D.M. Wood (CNCI), 21.vi.1970, 5.vii.1970, G.C. Wood (CNCI); Ottawa-Carleton Regional Municipality, Granite Hill farm, 1.ix.1981 (BMNH); Perth Road, Frontenac Co., 28.vii.1971, P. Ward and J. Edsall (CNCI); 23.vii.1971 (2 specimens), U. Luciuk, 15.viii.1970, P. Ward and J. Edsall (ROME); Stirling, 25.viii.1963, A.F. Johnson (DEBU); Walsh, 28.vi.1915 (DEBU).

**Quebec:** Aylmer, Queen's Park, 29.vii.1946, G.S. Walley (CNCI); Burnet, 12.vii.1966, Marguerite Job (CNCI); Kirk's-Ferry, 9.viii.1950, B.P. Beirne (CNCI); La Trappe, 8.vii.1942, 22.vi.1944, 3.vii.1951, J. Ouellet (QMOR); Luskville, Belisle Beach, 12-19.viii.1961, E.G. Munroe (CNCI); Pontiac, Eardley, 26.vi.1991, S. LaPlante (CNCI); Rigaud, 3.vii.1939, A. Robert (QMOR).

Robert (1949) listed the Aylmer, La Trappe (1942, 1944), and Rigaud records noted above. Riotte (1968) commented on the Chaffey's Locks, Ontario, collections and Barr and Barr (1980)

published a photograph of a specimen from the same locality.

### Description

*Dicromantispa interrupta* is the largest species of Canadian Mantispidae, at least in most linear measurements. Measurements of 6 males and 6 females (mean  $\pm$  SE and range in mm): head width, males  $2.56 \pm 0.13$  (1.95–2.85), females  $2.77 \pm 0.15$  (2.23–3.25); ratio of frons width to head width, males 0.31 (0.28–0.32), females 0.31 (0.29–0.34); pronotum length, males  $4.77 \pm 0.23$  (3.70–5.28), females  $5.29 \pm 0.21$  (4.46–5.92); ratio of pronotum least width to length, males 0.15 (0.13–0.16), females 0.14 (0.10–0.17); forewing length, males  $16.4 \pm 0.85$  (12.40–18.30), females  $18.33 \pm 0.97$  (15.00–21.75); metafemur length, males  $3.8 \pm 0.24$  (2.75–4.44), females  $4.19 \pm 0.20$  (3.58–4.84).

Specimens are mainly yellow with variable brown markings. The frons has a brown midline, usually broader between the antennae and usually widening below on the clypeus and labrum. The vertex behind the antennae sometimes has brown markings and the whole head is washed with brown in some specimens. The mouthparts are usually brown; the antennae are yellow. The prothorax has a middorsal brown stripe at the anterior and posterior ends; the inner faces of the profemora and protibiae are brown. The wings are clear with mostly yellow venation and are distinctively marked with brown in the costal/radial space (especially in the pterostigma area), at the origins of the veins along the radius, at the wing tips and, to a lesser extent, at the wing bases. The brown markings on the abdomen are variable, but usually a dark middorsal stripe occurs. Welch and Kondratieff (1991) described the male and female genitalia, noting that the epiproct and other male terminalia structures are distinctive.

### Natural history

The flight season, based on Canadian records, is 21 June (North Burgess Township, Lanark Co., Ontario) to 3 October (Chaffey's Locks, Ontario). Recorded sites of capture are usually trees and shrubs, although one specimen (Lanark Co., Ontario, 13.viii.1997) was collected at lights at night. Throne (1972) reported sweeping specimens from oak, eastern white pine (*Pinus strobus* L.), and eastern redcedar (*Juniperus virginiana* L.). At Niagara-on-the-

Lake, one was "taken sweeping edge of oak bush" (label data).

Hoffman and Brushwein (1990) and Redborg and MacLeod (1985) suggested that *D. interrupta* larvae board spiders and enter spider egg sacs as they are produced, although Redborg (1998) indicated that they may also be able to penetrate completed egg sacs. In South Carolina, Hoffman and Brushwein (1990) recorded immature stages of *D. interrupta* associated with 10 species of spiders from the Gnaphosidae, Lycosidae, Ctenidae, and Pisauridae. Host species are predominantly ground-wandering hunters. Having boarded the host, the larva wraps tightly around the spider's pedicel (Redborg 1998); during a spider molt, the mantispid may enter the host's book lungs (Hoffman and Brushwein 1990; Redborg 1998) if the opening is large enough.

### *Dicromantispa sayi* (Banks, 1897)

*Mantispa sayi* Banks, 1897; original description; lectotype male, Brazos Co., Texas, MCZC 10767.

*Mantispa fuscicornis* Banks, 1911; original description; lectotype male, Kissimmee, Florida, MCZC 10769.

*Mantispa uhleri* Banks, 1943; original description; holotype, Pennsylvania, MCZC 22132.

*Mantispa sayi* Banks, Hoffman (1989); synonymy of *M. uhleri* and *M. fuscicornis*.

*Dicromantispa sayi* (Banks), Hoffman (2002); new genus.

### Range

In Canada the species is known only from extreme southern Ontario from the Windsor area east to Niagara-on-the-Lake. In the United States, it occurs across most of the eastern states south to Florida and west to South Dakota, Nebraska, Utah, and eastern Arizona. It ranges southwards through Mexico to Panama and is also found in the Bahamas, Cuba, and Puerto Rico.

### Canadian specimens examined

**Ontario:** Essex Co., Point Pelee National Park, West Beach, 20.vii.2000, S.A. Marshall (DEBU); Point Pelee National Park, group campground, mercury vapour (mv) light, 24.vii.2003, S.M. Paiero (DEBU); Point Pelee National Park, Northwest Beach, mv light, 29.vii.2003, D. Cheung (DEBU); Essex Co.,



Windsor, Ojibway Prairie, 4.ix.1994, W. Bennett (DEBU); Harrow, 17.vii.1976, C.D. Neilson (DEBU); Kent Co., Rondeau Provincial Park, 28.vii.1967, I.M. Smith (ROME); Rondeau Provincial Park, Marsh Trail North, 42°18'N, 81°51'W, 10.viii.2003, M. Buck (DEBU); 20.vii.2004, S.M. Paiero (DEBU); Rondeau Provincial Park, Visitor Centre, 42°46'50"N, 81°50'38"W, mv light, 14.viii.2003, S.M. Paiero (DEBU); Rondeau Provincial Park, group campground, 42°17'35"N, 81°50'52"W, 20–22.vii.2004 (3 specimens), S.A. Marshall (DEBU), (2 specimens) S.M. Paiero (DEBU); Niagara-on-the-Lake, 15.vii.1934, W.L. Putman (DEBU); Norfolk Co., Turkey Point Tract, 18.vii.2001, A. Timpf and M. Gartshore (DEBU); Wheatley, 22.vii.1976, M.J. Sharkey (DEBU).

### Description

Measurements of 6 males and 6 females (mean  $\pm$  SE and range in mm): head width, males  $2.14 \pm 0.15$  (1.58–2.70), females  $2.20 \pm 0.18$  (1.58–2.75); ratio of frons width to head width, males 0.29 (0.27–0.30), females 0.29 (0.28–0.30); pronotum length, males  $3.78 \pm 0.26$  (2.88–4.80), females  $4.21 \pm 0.31$  (2.60–4.84); ratio of pronotum least width to length, males 0.14 (0.10–0.17), females 0.14 (0.13–0.15); forewing length, males  $12.10 \pm 0.88$  (9.45–15.45), females  $14.05 \pm 0.94$  (9.75–16.95); metafemur length, males  $2.90 \pm 0.24$  (2.08–3.92), females  $3.14 \pm 0.23$  (2.00–3.80).

The head, body, and legs are pale yellow with extremely variable brown or black markings; Figure 2 shows one of the darkest specimens. Canadian specimens usually have the face with a dark median vertical stripe from the labrum to the antennae, the stripe branching in a Y-shaped or trident-shaped mark behind the antennae and forming an extensive pattern of dark lines on the vertex, usually isolating several pale spots — a pair immediately behind the antennae and three larger ones (the middle one more elongate) crossing the posterior half of the vertex. In some specimens the dark pigment spreads over much of the vertex, obscuring these spots. The mandibles are brown; the antennae are brown with the basal segments yellow. The prothorax ranges from mostly yellow to mostly brown, but the anterolateral corners are dark and usually a middorsal stripe is visible, often present only anteriorly and posteriorly. The procoxae are normally lined with brown ventrally, and the profemora and protibiae are mostly brown. The other legs are mostly pale, with dark lines often

present ventrally on the femora and dark marks on the trochanters. The meso- and meta-coxae are largely brown in females but the latter are mostly pale in males; in both sexes the posterior faces of the metacoxae are brown or spotted with brown. The pleural sclerites are mostly brown and margined with pale lines, but those of the metathorax in males are pale. The mesothorax and metathorax are largely brown dorsally but the dark areas on the mesothorax are normally divided into lateral and medial patches. The wings are clear with brown venation; other brown pigment is mainly restricted to the costal/radial space (pterostigma) midway along the wing. The abdomen is strongly marked with black or brown on the sternites and mid-dorsally and posterolaterally on the tergites. As indicated above, females usually are more extensively darkened on the thorax than males; this is also true of the abdomen, which sometimes is all black. Specimens from the southern parts of the range in the United States (formerly known as *M. fuscicornis*) are darker overall; especially notable is the pale brown wash on the wing membrane posterior to the first radial vein in some specimens. Welch and Kondratieff (1991) figured the male and female genitalia and described the male's distinctive epiprocts with their spine-bearing projections.

### Remarks

If we assume *D. sayi* is a single species, it is extremely variable in colour over its large range. Indeed, three species were originally named to account for this variation: *M. fuscicornis* from Florida and Texas, *M. sayi* mostly west of the Mississippi River and in Florida, and *M. uhleri* east of the Mississippi and northward. MacLeod (in Hughes-Schrader 1979) and Redborg (1982a) considered them sibling species; Hughes-Schrader (1979) found no cytological differences among them. Hoffman (1989; personal communication) synonymized them under *M. sayi*, finding absolutely no genitalic differences among populations from the northeastern United States to Panama. Nevertheless, Redborg (1998; personal communication), based on his field experience with live insects, maintains that these taxa should still be considered separate until more evidence of their status is presented. He has collected and reared hundreds of specimens of the darker, more eastern (*uhleri*) form (with little or no colour variation) from wooded areas in eastern Iowa, Illinois, Indiana, and Minnesota, evidently representing the western

**Fig. 2.** *Dicromantispa sayi*. Point Pelee, Ontario. Photo: S.A. Marshall.



edges of the historic eastern deciduous forest. He considers the paler (*sayi*) form a sibling species of the historic grassland areas stretching west from Iowa; he has also collected adults in sandy areas of central Illinois that support pines and live oaks (K. Redborg, personal communication).

Nevertheless, we find Hoffman's taxonomic work compelling and have followed his systematic revisions, calling the combined species *D. sayi*, but we are sympathetic to Redborg's conservative position on the matter. If biological information is recorded under only one name and the three taxa, after further study, are confirmed as different, it will be difficult to sort out the details, at least in regions where the populations are sympatric.

The most northerly American populations formerly were identified as *Mantispa* (= *Dicromantispa*) *uhleri*, and most Canadian specimens have the dark coloration characteristic of this taxon (Fig. 2). Four or five specimens with a similar, but somewhat lighter, colour pattern come from scattered localities in the Canadian range, including the remnant tallgrass prairie at Ojibway Prairie, Windsor. This has suggested that a pale-coloured population (*i.e.*, the original *D. sayi*) might be typical of remnant tallgrass prairie habitats in extreme southwestern

Ontario, while a darker one occurs in Carolinian woodland sites elsewhere along the Lake Erie shore (Paiero *et al.* 2006; S. Marshall, personal communication). However, we can find no real evidence in the small sample that there are two separate populations, one dark and one pale, that equate to the original species, *D. uhleri* and *D. sayi*, respectively. Until more taxonomic, genetic, molecular, or ecological work clarifies this situation, we prefer to consider all known Canadian specimens as constituting one species, *D. sayi*. This species has not been previously reported in the literature from Canada, although Kevan (1979) suspected that it occurred in the country.

#### Natural history

The extensive work of Redborg (1982a, 1982b, 1983) and Redborg and MacLeod (1985) on the developmental ecology of this species (cited as *M. uhleri*) has revealed more about its biology than is known for any other North American mantispid. In Canada all records are from the Carolinian zone near Lake Erie; dates are from 15 July to 4 September ( $n = 17$ ). Redborg and MacLeod (1985) light-trapped adults in Illinois from mid-June to mid-

October, with the majority caught from July through mid-September.

Most first-instar larvae probably are spider boarders, entering the egg sac as it is spun by the host; however, they can also find and penetrate sacs already constructed (Redborg and MacLeod 1985). Larvae usually fix themselves to the spider's pedicel and then enter the host's book lungs (Redborg 1998), where they feed on haemolymph; such parasitism increases the development time and decreases the adult size of the spider (Redborg 1982*b*). Larvae can switch hosts during spider cannibalism (O'Brien and Redborg 1997); this is perhaps more efficient than switching during copulation, given the short copulation times of the major host, *Phidromus vulgaris* (Hentz, 1847) (Redborg and MacLeod 1985). A wide variety of hunting spiders are boarded: 31 species in 21 genera from almost all families of Lycosoidea and Clubionoidea have been documented (Redborg and MacLeod 1985). The first-instar larva overwinters on the spider host and, in Illinois, the first adult mantispids emerge in late June from late-spring or early-summer egg sacs of spiders that overwintered as adults. From one to three generations of mantispids could be produced by any given lineage each year, depending on the life history of the spider (Redborg and MacLeod 1985).

### ***Leptomantispa pulchella* (Banks, 1912)**

*Mantispa pulchella* Banks, 1912; original description; holotype, Eureka, Utah, MCZC 10766.

*Mantispa pulchella* Nakahara, 1913; synonymy.

*Leptomantispa pulchella* (Banks), Hoffman (2002); synonymy.

#### **Range**

In Canada *L. pulchella* is known from the Okanagan Valley in south-central British Columbia and the Windsor area of extreme southwestern Ontario. In the United States it ranges over most of the western states, south through California and Utah to Arizona and Texas, east to Illinois, Ohio, and New York, and south to the Carolinas and Georgia. Farther south, *L. pulchella* ranges from Mexico to Costa Rica and is also recorded in Cuba.

#### **Canadian specimens examined**

**British Columbia:** Oliver, 12.vii.1985, M. Sarell (UVIC); Oliver, Gallagher Lake, 13.viii.1985, M. Sarell (BCPM); Oliver, UBC Geology Camp, 19.vii.1989, 22.vii.1990, 23.vii.1990, S.G. Cannings (BCPM, SMDV); Osoyoos, East Bench, 6.vi.2001, J. Scudder (SMDV), 23.vii.2001, G. Scudder (SMDV); Summerland, Trout Creek Point, 16.vii.1977, L. Dale (BCPM); Vaseux Lake, 26.vi.1959, L.A. Kelton (CNCI); Vernon, 21.viii.1924, E.A. Rendell (CNCI).

**Ontario:** Windsor, Ojibway Prairie, 13.viii.2002, S.A. Marshall (DEBU).

#### **Description**

*Leptomantispa pulchella* is the smallest of the Canadian mantispids. Measurements of 11 males and 10 females: head width, males  $1.83 \pm 0.06$  (1.38–2.00), females  $1.86 \pm 0.09$  (1.35–2.25); ratio of frons width to head width, males 0.30 (0.28–0.32), females 0.32 (0.30–0.36); pronotum length, males  $3.26 \pm 0.08$  (2.64–3.60), females  $3.15 \pm 0.14$  (2.32–3.80); ratio of pronotum least width to length, males 0.10 (0.08–0.12), females 0.22 (0.09–0.12); forewing length, males  $9.44 \pm 0.23$  (7.20–11.75), females  $9.44 \pm 0.50$  (6.60–11.55); metafemur length, males  $2.14 \pm 0.07$  (1.64–2.44), females  $2.13 \pm 0.12$  (1.48–2.60).

Canadian specimens are yellow, patterned in brown and black (Fig. 3). The head is yellow with a black vertical stripe on the face forking between the antennal bases; there is a small brown spot between the arms of the fork at the front of the vertex. Although any brown marks on the vertex are frequently diffuse, there is often a brown bar, sometimes interrupted, crossing the centre of the vertex from eye to eye. The antennae are brown or black with the basal segment yellow. The prothorax is mostly brown, although dorsally it is yellow, except for the base. The legs are mostly yellow; the profemur has a brown inner face and marks at the apex and base of the outer face; the mesofemur and metafemur bear a brown line ventrally in the basal half. The meso- and meta-coxae are marked with brown. The mesothorax and metathorax each have a pair of wide brown stripes dorsally; the lateral thoracic sclerites and coxae are margined and spotted with brown. The wings are clear; the venation ranges from yellow to dark brown; the radius is yellow or light brown; the pterostigma is orange. The venter and dorsal margins of the abdominal sternites are dark

**Fig. 3.** *Leptomantispa pulchella*. Ojibway Prairie, Windsor, Ontario. Photo: S.A. Marshall.



brown or black; the tergites have paired brown spots dorsally and vertically paired stripes laterally. Welch and Kondratieff (1991) showed that the structure of the epiproct is different from that of the two Canadian *Dicromantispa* species; the ventromedial lobes are reduced to a patch of spines.

#### Remarks

The size of British Columbia specimens is, on average, greater than that of the United States specimens examined. For example, in males, the head width of BC specimens ( $n = 5$ ) is  $1.96 \pm 0.02$  mm (1.18–2.00 mm), while that of US specimens ( $n = 6$ ) is  $1.72 \pm 0.08$  mm (1.38–1.90 mm). The forewing length is  $10.02 \pm 0.35$  mm (9.30–11.75 mm) in BC material and  $8.96 \pm 0.43$  mm (7.20–9.90 mm) in US material. The means of these two measurements from the single Ontario male (1.49 mm and 8.00 mm, respectively) are similar to those of smaller US specimens. The Ontario specimen is less strongly marked with dark pigment than the BC specimens. Most specimens we have examined from the eastern United States have the yellow base colour darkened to light brown, rendering the brown colour pattern less

obvious. *Leptomantispa pulchella* has not been previously reported from Canada.

#### Natural history

In the Okanagan Valley, *L. pulchella* apparently is both diurnal and nocturnal. During the day, specimens have been taken from the side of a tent, from vegetation, and from a Malaise trap in open ponderosa pine woods. They have also been captured in houses and at night in a mercury vapour lamp in pine woods. The captures range from 6 June to 21 August ( $n = 10$ ). The Ontario specimen was collected on 13 August at Ojibway Prairie, a relict tallgrass prairie at Windsor.

The developmental ecology of the species has been detailed by Hoffman and Brushwein (1989). First-instar larvae board spiders to gain access to freshly laid eggs; they will not feed on eggs unless they have spent some time aboard spiders. Their obligatory boarding behaviour is more similar to that of *C. brunnea* larvae than to that of other Nearctic mantispid larvae. These larvae are usually found singly on the dorsum of the spider pedicel, where apparently they feed on the host's haemolymph. The spiders involved are all commonly found on foliage: Anyphaenidae, 65.7%; Salticidae, 19.4%; Clubionidae, 10.4%; and others, 4.5%. These

spiders also build silken retreats on leaves and under bark; they may be easier for mantispid larvae to find and board than other species that do not use such retreats.

### Acknowledgements

We thank the following people, who made material available for study: P. Arnaud, Jr. (California Academy of Sciences, San Francisco, California), R. Duncan (Pacific Forestry Centre, Victoria, British Columbia), N. Duffey (Lyman Entomological Museum, McGill University, Sainte-Anne-de-Bellevue, Quebec), O. Flint, Jr. (US National Museum, Washington, D.C.), T. Galloway (University of Manitoba, Winnipeg, Manitoba), K. Kevan (Lyman Entomological Museum), S. Marshall (University of Guelph, Guelph, Ontario), J. Martin (CNCI, Agriculture Canada, Ottawa, Ontario), N. Penny (California Academy of Sciences), M. Thayer (Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts), P. Harper, (Université de Montréal, Montréal, Quebec), G. Scudder (Spencer Entomological Museum, University of British Columbia, Vancouver, British Columbia), and G. Wiggins (Royal Ontario Museum, Toronto, Ontario). P. Belton, R.-M. Burke, S. Ford, K. Hoffman, K. Iverson, D. Larson, K. MacKenzie, D. McMullen, K. Needham, D. Nicholson, S. Paiero, H. Philip, T. Pike, K. Redborg, M. Sarell, J. Skevington, G. Scudder, K. West, T. Wheeler, and M. Wood also supplied specimens and information. C. Borkent helped with the production of the manuscript. K. Hoffman, S. Marshall, and K. Redborg commented on manuscript drafts; we particularly thank them for their help. K. Hoffman generously provided unpublished information on taxonomic matters and suggested that I publish the new combination of *Dicro-mantispa interrupta* (Say). S. Marshall kindly allowed us to reproduce the photographs in Figures 1–3.

### References

- Arnett, R.H., Jr., Samuelson, G.A., and Nishida, G.M. 1993. The insect and spider collections of the world. 2nd ed. Sandhill Crane Press, Gainesville, Florida.
- Banks, N. 1897. New North American neuropteroid insects. Transactions of the American Entomological Society, **24**: 21–31.
- Banks, N. 1911. Descriptions of new species of North American neuropteroid insects. Transactions of the American Entomological Society, **37**: 335–360.
- Banks, N. 1912. Notes on Nearctic Mantispidae. Proceedings of the Entomological Society of Washington, **14**: 178–179.
- Banks, N. 1943. New Neuroptera and Trichoptera from the United States. Psyche (Cambridge), **50**: 74–81.
- Barr, D., and Barr, N. 1980. The miniature world of Aubrey Critch. Readers Digest, **117**: 178–183.
- Batra, S.W.T. 1972. Notes on the behavior and ecology of the mantispid *Climaciella brunnea occidentalis* [sic]. Journal of the Kansas Entomological Society, **45**: 334–340.
- Davidson, J.A. 1969. Rearing *Mantispa viridis* Walker in the laboratory (Neuroptera, Mantispidae). Entomological News, **80**: 29–31.
- Enderlein, G. 1910. Klassifikation der Mantispiden nach dem material des Stettiner Zoologischen Museums. Stettiner Entomologische Zeitung, **71**: 341–379.
- George, L.D., and George, N.L. 1975. Notes on the three hundred and fifty-eighth meeting: a new record of mantispid reared from spider. Pan-Pacific Entomologist, **51**: 90.
- Hoffman, K.M. 1989. Taxonomic status of *Mantispa sayi*, *Mantispa fuscicornis* and *Mantispa uhleri* (Neuroptera: Mantispidae). Proceedings of the Entomological Society of Washington, **91**: 637–639.
- Hoffman, K.M. 1992. Systematics of the Mantispinae (Neuroptera: Mantispidae) of North, Central and South America. Ph.D. thesis, Clemson University, Clemson, South Carolina.
- Hoffman, K.M. 2002. Family Mantispidae. In A guide to the lacewings (Neuroptera) of Costa Rica. Edited by N. Penny. Proceedings of the California Academy of Sciences, **53**: 161–457. pp. 251–275.
- Hoffman, K.M., and Brushwein, J.R. 1989. Species of spiders (Araneae) associated with the immature stages of *Mantispa pulchella* (Neuroptera, Mantispidae). Journal of Arachnology, **17**: 7–14.
- Hoffman, K.M., and Brushwein, J.R. 1990. Spider (Araneae) taxa associated with the immature stages of *Mantispa interrupta* (Neuroptera: Mantispidae). Entomological News, **101**: 23–28.
- Hughes-Schrader, S. 1979. Diversity of chromosomal segregational mechanisms in mantispids (Neuroptera: Mantispidae). Chromosoma, **75**: 1–17.
- Imms, A.D. 1957. A general textbook of entomology. Methuen, London.
- Kevan, D.K.McE. 1979. Neuroptera. In Canada and its insect fauna. Edited by H.V. Danks. Memoirs of the Entomological Society of Canada, **108**: 1–573. pp. 354–356.
- LaSalle, M.W. 1986. Notes on the mantispid *Climaciella brunnea* (Neuroptera: Mantispidae) in a coastal marsh habitat. Entomological News, **97**: 7–10.

- MacLeod, E.G., and Redborg, K.E. 1982. Larval platymantispine mantispids (Neuroptera: Planipennia): possibly a subfamily of generalist predators. *Neuroptera International*, **2**: 37–41.
- Nakahara, W. 1913. A revision of the Mantispidae of Japan. *Annotationes Zoologicae Japonenses*, **8**: 229–237.
- O'Brien, L.C., and Redborg, K.E. 1997. Copulation duration in the spider *Philodromus vulgaris* (Hentz) (Araneae: Philodromidae) and its influence on the evolution of host transfer behavior during cannibalism by *Mantispa uhleri* Banks (Neuroptera: Mantispidae). *Journal of Insect Behavior*, **10**: 469–477.
- Opler, P.A. 1981. Polymorphic mimicry of polistine wasps by a Neotropical neuropteran. *Biotropica*, **13**: 165–176.
- Paiero, S.M., Marshall, S.A., Pratt, P.D., and Buck, M. 2006. The insects of a southern Ontario tallgrass prairie. In *Arthropods of Canadian grasslands: ecology and interactions in grassland habitats*. Edited by T.A. Wheeler and H.V. Danks. Biological Survey of Canada (Terrestrial Arthropods), Ottawa, Ontario. In press.
- Provancher, L. 1875. Description de plusieurs insectes nouveaux. *Le Naturaliste Canadien*, **7**: 247–251.
- Redborg, K.E. 1982a. Mantispidae parasitic on spider egg sacs: an update of a pioneering paper by B.J. Kaston. *Journal of Arachnology*, **10**: 92–93.
- Redborg, K.E. 1982b. Interference by the mantispid *Mantispa uhleri* with the development of the spider *Lycosa rabida*. *Ecological Entomology*, **7**: 187–196.
- Redborg, K.E. 1983. A mantispid larva can preserve its spider egg prey: evidence for an aggressive allomone. *Oecologia*, **58**: 230–231.
- Redborg, K.E. 1998. Biology of the Mantispidae. *Annual Review of Entomology*, **43**: 175–194.
- Redborg, K.E., and MacLeod, E.G. 1983. *Climaciella brunnea* (Neuroptera: Mantispidae): a mantispid that obligately boards spiders. *Journal of Natural History*, **17**: 63–73.
- Redborg, K.E., and MacLeod, E.G. 1984. Maintenance feeding of first instar mantispid larvae (Neuroptera, Mantispidae) on spider (Arachnida, Araneae) hemolymph. *Journal of Arachnology*, **11**: 337–341.
- Redborg, K.E., and MacLeod, E.G. 1985. Developmental ecology of *Mantispa uhleri* Banks (Neuroptera: Mantispidae). *Illinois Biological Monographs*, **53**: 1–130.
- Redborg, K.E., and Redborg, A.H. 2000. Resource partitioning of spider hosts (Arachnida, Araneae) by two mantispid species (Neuroptera, Mantispidae) in an Illinois woodland. *The Journal of Arachnology*, **28**: 70–78.
- Riotte, J.C.E. 1968. Notes on the insect population of Queen's University Biological Station at Chaffey's Locks, Leeds Co., in the light of recent findings in phytogeographic research. *Proceedings of the Entomological Society of Ontario*, **98**(1967): 60.
- Robert, A. 1949. Les Mantispides de la Province de Québec (Planipennes). *Le Naturaliste Canadien*, **76**: 5–14.
- Say, T. 1824. Order Neuroptera. In *Narrative of an expedition to the source of St. Peter's River, Lake Winnepeek, Lake of the Woods, &c. &c. performed in the year 1823, by order of the Hon. J.C. Calhoun, Secretary of War, under the command of Stephen H. Long, Major U.S.T.E. Vol. 2*. Edited by W.H. Keating. Carey and Lea, Philadelphia, Pennsylvania. pp. 303–310.
- Say, T. 1825. *American entomology, or descriptions of the insects of North America*. Vol. 2. Philadelphia Museum, Philadelphia, Pennsylvania.
- Scheffer, S. 1992. Transfer of a larval mantispid during copulation of its spider host. *Journal of Insect Behavior*, **5**: 797–800.
- Throne, A.L. 1972. The Neuroptera — Suborder Planipennia of Wisconsin. Part III. Mantispidae, Ascalaphidae, Myrmeleontidae and Coniopterygidae. *Great Lakes Entomologist*, **5**: 119–128.
- Welch, J.L., and Kondratieff, B.C. 1991. The Mantispidae (Neuroptera) of Colorado. *Journal of the Kansas Entomological Society*, **64**: 69–76.
- Wheeler, W.M. 1889. Two cases of insect mimicry. *Proceedings of the Wisconsin Natural History Society*, **1889**: 217–221.