Microctonus melanopus (Ruthe) (Hymenoptera: Braconidae), a Parasitoid of Adult Cabbage Seedpod Weevil (Coleoptera: Curculionidae): Distribution in Southern Alberta and Female Diagnosis[1]

Andrew S. Fox,[2] Scott R. Shaw,[3] Lloyd M. Dosdall[4] and Byron Lee[5]

Alberta Agriculture, Food and Rural Development, Crop Diversification Centre South, SS#4 Brooks, Alberta T1R 1E6, Canada

J. Entomol. Sci. 39(3): 350-361 (July 2004)

Abstract *Microctonus melanopus* (Ruthe) were reared and dissected from adult cabbage seedpod weevil, *Ceutorhynchus obstrictus* (Marsham), collected in southern Alberta in 2000 and 2001, and *M. melanopus* females were collected near Creston, British Columbia in 2001. These collections represent the first records for this European species in Canada. Previously published records of *M. melanopus* in North America are from the northwestern United States. A first diagnosis for adult female *M. melanopus* is provided that places *M. melanopus* in Loan's (1969) key for *Microctonus* species of North America, north of Mexico. Scanning electron photomicrographs of female morphology are provided to illustrate important diagnostic characters: the mesonotal sculpture with a distinct median longitudinal carina posteriorly, and the sculpture of metasomal tergite 1 with costae distinctly converging posteriorly. It is probable that *M. melanopus* has long been established in the southern interior of British Columbia because its host, *C. obstrictus,* has occurred there for many years. The occurrence of *M. melanopus* in southern Alberta is likely more recent, as its host only recently dispersed to that region. Rates of parasitism of *C. obstrictus* by *M. melanopus,* with one exception, were low in southern Alberta (<10%), and only one parasitized weevil was found on spring-seeded *Brassica napus* L., the primary brassicaceous oilseed crop associated with the weevil on the Canadian prairies. We hypothesize that *M. melanopus* will not provide substantial control of *C. obstrictus* in the mixed grassland ecoregion of its new range.

Key words *Microctonus melanopus,* parasitoid, diagnosis, cabbage seedpod weevil, *Ceutorhynchus obstrictus*

The cabbage seedpod weevil, *Ceutorhynchus obstrictus* (Marsham) [= *C. assimilis* (Paykull), Colonnelli (1993)], (Coleoptera: Curculionidae) is a recent and serious pest of canola, *Brassica napus* L. and *Brassica rapa* L. (Brassicaceae), on the Canadian prairies (Dosdall et al. 2002). Of European origin, the cabbage seedpod weevil was

[1]Received 20 June 2003; accepted for publication 12 October 2003.

[2]Address inquiries (email: andy.x.fox@calgary.ca).

[3]U.W. Insect Museum, Department of Renewable Resources, University of Wyoming, Laramie, Wyoming 82071-3354.

[4]Department of Agricultural, Food and Nutritional Science, 4-10 Agriculture/Forestry Centre, University of Alberta, Edmonton, Alberta T6G 2P5, Canada.

[5]Agriculture and Agri-Food Canada, 5403 - 1 Avenue South, P.O. Box 3000, Lethbridge, Alberta T1J 4B1, Canada.

first documented in North America in 1931 in British Columbia (McLeod 1953). It was discovered in southern Alberta in 1995, and since then has dispersed to the north and east at a rate of approximately 60 km per year. It is predicted to eventually inhabit the entire region of canola production in western Canada (Dosdall et al. 2002).

In southern Alberta weevils overwinter primarily in shelterbelt areas (Dosdall unpubl. data), and in spring they disperse to wild Brassicaceae for a period of feeding before dispersing to canola crops in the bud to early flowering stages (Dosdall and Dolinski 2001). Eggs are deposited in newly-formed pods, and larvae feed within pods on developing seed. When mature, larvae chew an opening in the pod wall, drop to the soil, pupate, and adults emerge about 12 days later to feed on ripening canola before dispersing to overwintering sites (Bonnemaison 1957, Dmoch 1965).

Microctonus melanopus (Ruthe) (Hymenoptera: Braconidae) is an endoparasitoid of adults of *Ceutorhynchus* species in Europe. Jourdheuil (1960) and Speyer (1925) [*Perilitus* = *Microctonus,* Shaw (1985, 1997)] found *M. melanopus* infesting primarily *Ceutorhynchus quadridens* (Panzer). Jourdheuil reported that *C. obstrictus* was an important secondary host, but Speyer (1925) found no field parasitism of cabbage seedpod weevil. Both researchers found limited parasitism of *Ceutorhynchus pleurostigma* Marsh in the field. At the higher end of its parasitism success in records from Europe, Bonnemaison (1957) found up to 60% of cabbage seedpod weevils parasitized by *M. melanopus.* In North America *M. melanopus* was found parasitizing cabbage seedpod weevil in 1991; distribution was limited to Latah Co., ID, and Walla Walla Co., Washington (Harmon and McCaffrey 1997).

Jourdheuil (1960) provided a detailed account of the life history of *M. melanopus* with a description and illustrations of the immature stages. Generally, there is only one parasitoid per host and a fairly equal emergence ratio of males to females. The mature parasitoid larva exits the weevil posteriorly to pupate. The weevil is univoltine, and the parasitoid is usually bivoltine. The parasitoid overwinters in adult weevils as a first-instar larva and emerges to parasitize the same generation of weevils in the spring. The second generation of parasitoids emerges and parasitizes the new generation of weevils where it overwinters (Jourdheuil 1960, Harmon and McCaffrey 1997, Kuhlmann et al. 2002, Murchie and Williams 1998). A third generation of adult parasitoids is possible where the second generation of parasitoids has a choice of new and old generation weevils (Jourdheuil 1960).

In the current study we document the occurrence and distribution of *M. melanopus* on the Canadian prairies for the first time, and we provide a diagnosis of the female that places *M. melanopus* in Loan's (1969) key of North American *Microctonus* species.

Materials and Methods

Sample collection. Adult weevils were collected for dissection from Brassicaceae by sweeping a 37-cm diam net through a 180° arc in the plant canopy. Brassicaceous weeds sampled were *Lepidium* spp. [*Cardaria* = *Lepidium,* Al-Shehbaz and Mummenhoff (2002)], *Descurainia sophia* (L.) Webb, and *Sinapis arvensis* L. Cultivated Brassicaceae sampled were *Sinapis alba* L. (crop and volunteer plants), *B. napus* (canola crop and volunteer plants), and *B. rapa* (canola crop). In 2000, one *S. arvensis* site, one *Lepidium* spp. site and one *B. napus* crop site were routinely sampled. Weed sites were along the eastern perimeter of the City of Lethbridge, Alberta (49°38′ N, 112°48′ W), and the crop site was near Nobleford, Alberta (49°53′ N,

113°03′ W). In 2000, weekly collections (n = 11) of 100 weevils were made from canola crops near Lethbridge from late May to early August. In 2001, weed sites were reused with the addition of a routinely sampled *D. sophia* site, and a volunteer *B. napus* site to replace the crop site. The new sites were located along the eastern perimeter of the City of Lethbridge. Collections from routinely sampled sites began when weevils first left their overwintering sites and ended when weevils dispersed or host plants were destroyed at some sites.

In 2000 and 2001, additional sites were sampled on a one-time basis. In 2001, a survey of 25 randomly selected sites was conducted across southern Alberta from 26 to 30 June. Site distribution was affected by the availability of host plants. Sweep net samples (n = 5 sweeps) were generally taken prior to the collection of weevils for dissection to determine whether adult parasitoids were present. In 2001, weevil samples were taken from volunteer *B. napus* near Creston, British Columbia.

Sample processing and analysis. Freshly-killed weevils were dissected in physiological saline, and weevils were preserved in Kahle's solution (Borror et al. 1981), stored in 70% ethanol, and dissected at a later date. Dissected adult weevils were examined for the presence of endoparasitoids using a dissecting microscope. Parasitoid larvae were scored as early or late-instar larvae. Early-instar larvae have a distinct chitinous head, mandibles and caudal appendage; illustrations were provided by Jourdheuil (1960) and Speyer (1925). Parasitism by *M. microctonus* of male and female weevils was compared using chi-square analysis to test the hypothesis that the numbers of parasitized males and females were equal.

Laboratory emergence. In 1998 and 1999 weevils were collected from canola crops near Lethbridge in May, June, July and August. In total, there were eight collections with a mean of 199 ± 105 (± SD) weevils per collection. Weevils were individually maintained for 21 d in Petri dishes provisioned with 30% honey water in cotton-stoppered plastic tubes. Weevils were observed daily for parasitoid emergence until they died.

In 2000, weevils (n = 508) collected from a parasitoid positive site on 27 June (*S. arvensis,* Lethbridge) were individually transferred to a screened rearing cage. Weevils were provided with a 5% sucrose wick and maintained for 13 d at 25°C and a photoperiod of 16L:8D.

Weevils (n = 131), collected from a routinely-sampled parasitoid negative site (*B. napus* Site-1, Fox and Dosdall 2003), were exposed to laboratory-reared adult parasitoids (n = 11) in a screened cage for 70 h beginning 11 July 2000. Weevils and adult parasitoids were provided with a 5% sucrose wick and maintained at 25°C and a photoperiod of 16L:8D. Weevils were maintained for 14 d from the first day of exposure to parasitoids. Dead and surviving weevils were dissected at the end of the holding period.

In 2001, several hundred weevils were collected from three parasitoid positive sites (*D. sophia* and *S. arvensis,* Lethbridge) from 21 June to 9 July, and were held communally until 13 July. Weevils were maintained under conditions described above except that cleaned canola racemes (pods and stems only) also were provided.

Scanning electron microscopy. A Hitachi S-570 scanning electron microscope (SEM) was used in conjunction with Quartz PCI image acquisition software (Version 4, Quartz Imaging Corp.) to examine morphological characters of *M. melanopus* adults. Specimens used for SEM analysis were reared from *C. obstrictus* collected in southern Alberta.

Diagnosis of female *Microctonus melanopus.* Specimens reared from *C. obstrictus* in southern Alberta were initially identified as *M. melanopus* by H. Goulet, Agriculture and Agri-Food Canada (AAFC), Ottawa, ON. Specimens from Idaho were sent to H. Goulet by B. Harmon and J. McCaffrey, University of Idaho. Idaho specimens were previously identified as *M. melanopus* by the second author of the current study, and compared with European specimens by T. Huddleston, Natural History Museum, London. Voucher specimens from southern Alberta are deposited in the Canadian National Collection, AAFC, Ottawa, ON, and in the Insect Museum, University of Wyoming, Laramie, WY. The diagnosis was completed to place *M. melanopus* in Loan's (1969) key to *Microctonus* species north of Mexico, and provide a comparison with *Microctonus vittatae* Muesebeck (Hymenoptera: Braconidae), commonly found concurrently in habitats of wild and cultivated Brassicaceae.

Results

Incidence of parasitism by *Microctonus melanopus.* In 2000, four sites were found to be parasitoid positive through dissection. The *S. arvensis* site at Lethbridge had 3.8% of weevils (n = 52) parasitized on 26 June. This prompted the 27 June collection for cage emergence. Preserved weevil samples dissected at a later date from this site had 0.8% (n = 131) and 8.8% (n = 148) of weevils parasitized on 12 and 26 June, respectively. A *B. rapa* crop near Lethbridge had 1.4% of weevils (n = 140) parasitized on 23 June (one weevil contained two parasitoid larvae), and a *B. rapa* crop near Nobleford had 0.8% of weevils (n = 123) parasitized on 21 June. The *D. sophia* site at Lethbridge had 0.9% and 2.6% of weevils (each sample n = 117) parasitized on 12 and 23 June, respectively.

No parasitism was found in the May to August 2000 dissections of 1100 weevils collected from canola crops near Lethbridge, and no parasitism was found in dissections from the *Lepidium* spp. site in 2000, or the routinely sampled *B. napus* crop near Nobleford (*Lepidium* spp. Site-1 and *B. napus* Site-1, respectively, Fox and Dosdall 2003).

In 2000, all parasitoids dissected from weevils were larvae except for one embryo from the 26 June *S. arvensis* site dissections. A parasitoid larva was clearly visible in embryos that we encountered (illustrated by Jourdheuil 1960). The overall female to male ratio was 1:1.8 from the preserved sample of weevils (n = 148, 8.8% parasitism) collected from the *S. arvensis* site on 26 June. The ratio of parasitized females to males was 1:5.5 ($P > 0.05$).

In 2001, the earliest record of parasitism was 4 June. All four routinely sampled Lethbridge sites were parasitoid positive. Two weevils contained two parasitoids and the highest rate of parasitism was 9.0% (Table 1). There were three parasitoid positive sites in Lethbridge aside from the sites in Table 1: a volunteer *B. napus* site with 2.0% parasitism (n = 100) on 13 June, a *S. arvensis* site with 4.0% parasitism (n = 100) on 24 June, and a *D. sophia* site with 2.9% parasitism (n = 170) on 19-22 June.

Forty per cent of sites (n = 25) were parasitoid positive in the 26-30 June 2001 survey (Fig. 1, Table 2). There were no positive sites in the eastern range of the survey. Rates of parasitism were low; the highest rate (Site 5, 9.2%) was within a parasitoid positive region west of Lethbridge (near Fort Macleod) that was associated

Table 1. Parasitism of adult *Ceutorhynchus obstrictus* at different host plant sites in Lethbridge, Alberta, 2001

Site	Date	No. Weevils	% Parasitism	Parasitized weevil gender	Parasitoid larval stage
Sinapis arvensis	31-May	100	0.0		
	8-Jun	100	2.0	2M	3 embryos
	18-Jun	101	6.9	6M, 1F	1 early, 6 late
	25-Jun	100	3.0	3M	3 late
	3-Jul	19	0.0		
	10-Jul	19	0.0		
Lepidium spp.	22-May	100	0.0		
	28-May	100	0.0		
	4-Jun	100	1.0	1M	1 early
	11-Jun	100	1.0	1M	1 early
	18-Jun	100	6.0	4M, 2F	3 early, 3 late
	27-Jun	26	0.0		
Descurainia sophia	23-May	100	0.0		
	30-May	110	0.0		
	6-Jun	100	0.0		
	14-Jun	100	4.0	3M, 1F	4 late
	19-Jun	100	9.0	8M, 1F	5 early, 4 late
	22-Jun	39	2.6	1M	1 late
Volunteer *Brassica napus*	15-Jun	100	1.0	1M	1 early
	20-Jun	100	0.0		
	25-Jun	100	1.0	1M	1 early
	4-Jul	100	0.0		
	9-Jul	98	4.1	3M, 1F	2 embryos, 3 early

with *S. alba* crops and *S. arvensis.* Parasitoid negative sites were *B. napus* crops (nine sites), volunteer *B. napus* (three sites), *S. alba* crop (one site), volunteer *S. alba* (one site), and *D. sophia* (one site). The mean weevil sample size for parasitoid negative sites (n = 15) was 79.7 ± 32.1 (± SD) weevils. Parasitism was higher in male than in female weevils. For parasitoid positive sites the overall ratio of female to male weevils was 1:1.4 (n = 702), but the ratio of parasitized females to males was 1:9.5 ($P < 0.05$). Parasitoid positive Site 8 had 2.0% parasitism (n = 100) on 12 June, and positive Site 9 had 3.0% parasitism (n = 100) on 6 July.

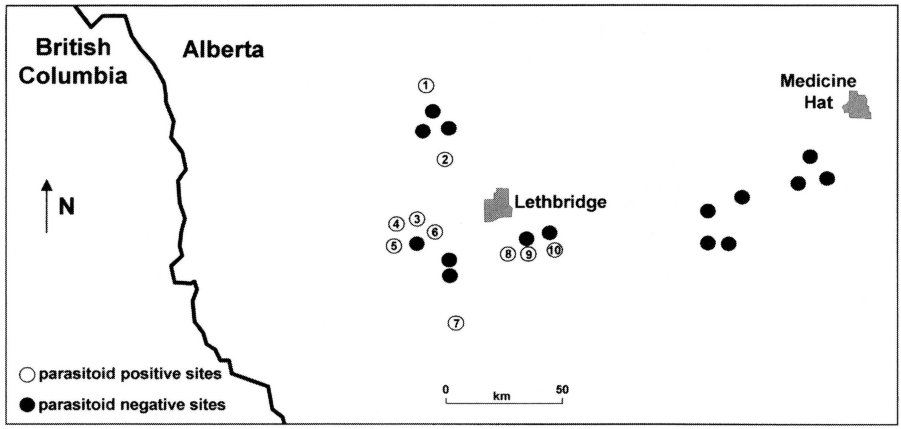

Fig. 1. Parasitoid positive and negative sites in a survey of southern Alberta conducted 26-30 June 2001.

Table 2. Parasitism surveillance of adult *Ceutorhynchus obstrictus* in southern Alberta, 26-30 June 2001

Map site	No. weevils	% Parasitism	Plant host
1	102	1.0	*Sinapis alba* crop
2	66	1.5	*Sinapis alba* crop
3	38	2.6	*Sinapis alba* crop
4	67	1.5	*Sinapis arvensis*
5	65	9.2	*Sinapis alba* crop
6	47	2.1	*Sinapis arvensis*
7	100	1.0	*Brassica napus* crop
8	93	4.3	*Sinapis arvensis*
9	100	4.0	*Sinapis arvensis*
10	24	4.2	*Descurainia sophia*

Parasitoid larvae at late stages of development were either curled within the abdomen occupying the entire abdominal cavity, or they were straight, extending into the thorax of the weevil. Despite the parasitism weevils were still active during capture.

The use of Kahle's solution to preserve weevils was effective in the 2001 sampling period because parasitoid larvae were generally well developed, and extensive sampling could be conducted in a short time span. However, only dissections of freshly-killed weevils were effective for locating embryos and first-instar larvae. Teratocytes,

which were observed as larvae developed, spilled out freely in dissections of freshly-killed weevils. Teratocytes are released into the body cavity of a host when a parasitoid hatches (Vinson 1970). Teratocytes were an immediate and reliable indication of parasitism, increasing in size and decreasing in number as parasitoid larvae matured (Jourdheuil 1960).

Two female *M. melanopus* were collected in sweep net samples in southern Alberta in 2001; one at the *S. arvensis* site on 3 July (n = 5 sweeps), and one at the volunteer *B. napus* site on 9 July (n = 5 sweeps). Three female *M. melanopus* and five female *M. vittatae* were collected in volunteer *B. napus* on 17 July 2001 near Creston, British Columbia ($n \approx 50$ sweeps, n = 469 weevils). Weevils (n = 150) dissected on 22 June from the Creston site were parasitoid negative.

Laboratory emergence. No Hymenoptera emerged from adult weevils collected and maintained in 1998 and 1999. In 2000, seven final-instar larvae, 12 cocoons containing pupae, and 16 fully-eclosed male (Fig. 2A, B) and 13 female (Fig. 3A) *M. melanopus*, were removed from the rearing cage (n = 48 parasitoids) within 13 d of the 27 June collection of weevils. Examination of dead weevils showed that parasitoid larvae had only exited posteriorly, although Jourdheuil (1960) reported that parasitoids that were unusually oriented were able to push off the host's head and exit anteriorly.

The 9.4% parasitism (n = 508) based on emergence for this Lethbridge *S. arvensis* site is an underestimation of potential parasitoid emergence, as at least 11 dissected weevils had a parasitoid larva that was close to emerging. The poor condition of weevils that died during the 13 d holding period prevented a reliable estimate of total parasitism, but it was clearly the highest rate of any site sampled in this study. One weevil contained two parasitoid larvae.

For laboratory parasitism in 2000, 7 of 11 adult parasitoids (males and females) survived the 70 h exposure to weevils. Adult parasitoids were observed pursuing

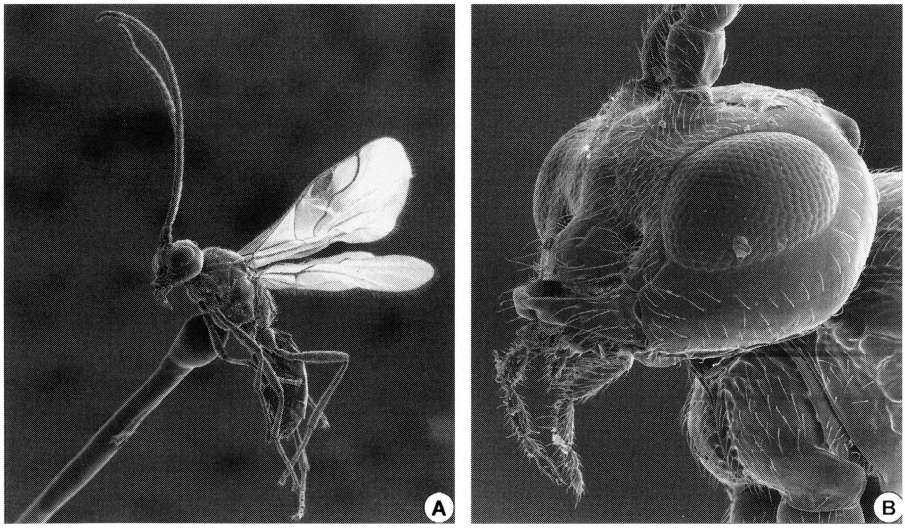

Fig. 2A, B. *Microctonus melanopus;* male.

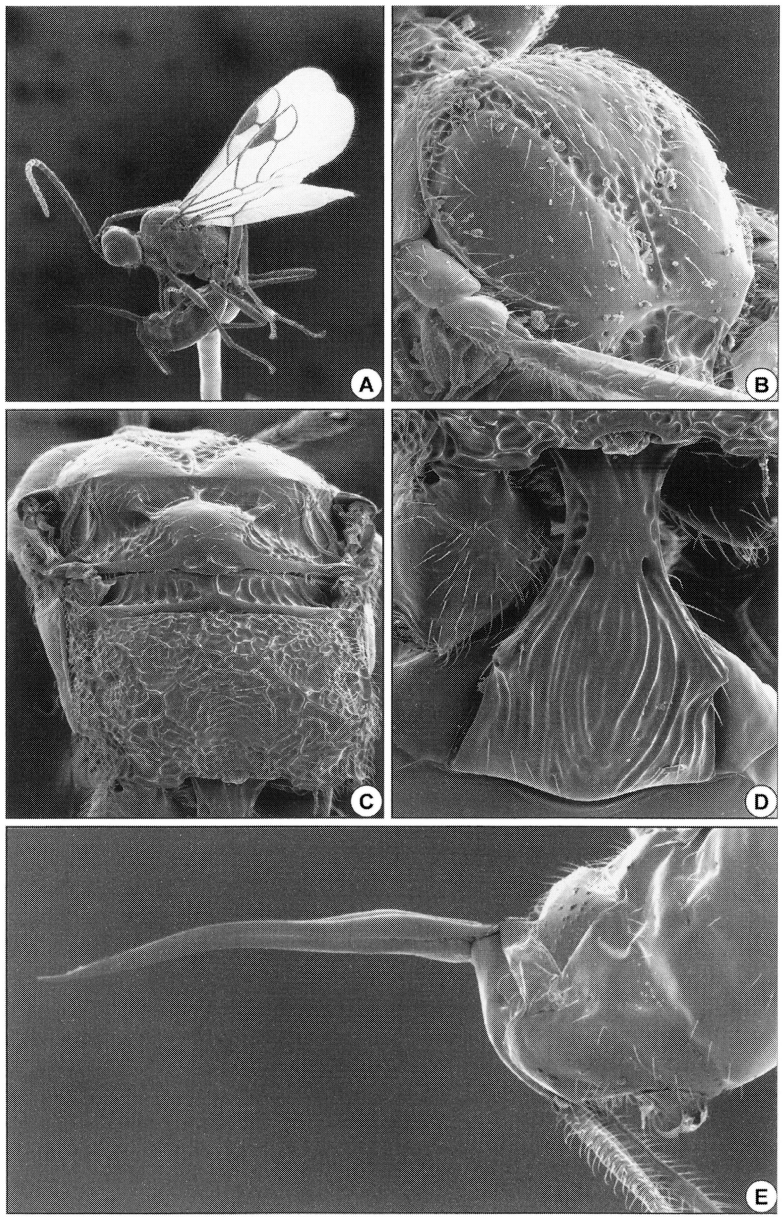

Fig. 3A to E. *Microctonus melanopus;* female.
Fig. 3B. Mesonotum; notauli and median longitudinal carina.
Fig. 3C. Propodeum; regulose-reticulate.
Fig. 3D. Metasomal tergite 1; costae converging posteriorly.
Fig. 3E. Ovipositor sheath.

weevils from behind but no contact was observed. One adult male parasitoid emerged, and 10 parasitoid larvae were found in dissections 14 d after the weevils ($n = 131$) were first exposed to adult parasitoids. Six larvae were first-instar larvae and there was no multiple parasitism. The ratio of parasitized male to female weevils was 1:4.0 with an overall male to female ratio of 1:2.1.

In 2001, a total of nine adult parasitoids emerged from weevils collected from parasitoid positive sites. One adult emerged by 30 June, six more by 7 July, and a further two by 12 July.

Diagnosis of female *Microctonus melanopus*. Length of body 1.8 mm (excluding antenna and ovipositor). Forewing length 2.0 mm. Antennal flagellum, ocellar triangle, mesosoma mostly, and first metasomal tergum dark reddish brown to black. Remainder of head, legs, sometimes pronotum and mesopleuron, and remainder of metasoma yellow to light yellowish brown. Head in dorsal view transverse, about 1.5X wider than long. Shortest distance between eyes 1.25X greater than clypeus width. Temple width 2/3 eye width. Eyes, in anterior view, converging ventrally. Antenna distinctly longer than head and mesosoma combined, with 19-20 flagellomeres. F1-15 distinctly longer than wide. F16 and beyond more compact, about as long as wide. Apical flagellomere about 2X longer than wide, tapering to a blunt point. Malar space about 1/5 eye height, slightly narrower than basal width of mandible. Mandible width basally about 1/2 mandible length. Ocellar triangle obtuse, posterior margin of median ocellus slightly ahead of anterior margins of lateral ocelli. Lateral ocelli separated from compound eye by distance 5X ocellar width. Occipital carina absent dorsally, with lateral parts of carina widely separated. Mesosoma with scattered large setae about the same size as those on the head posteriorly, except for bare patches on pronotum dorsolaterally, lateral mesonotal lobes, center of scutellar disc, posterior scutellar rim, and central disc of mesopleuron. Mesonotum with notauli distinctly foveate, converging posteriorly in small foveate patch with short but distinct median longitudinal carina (Fig. 3B). Lateral mesonotal lobes mostly smooth and lacking sculpture or setae. Marginal cell of forewing 0.5 to 0.6X length of pterostigma. RS + Ma vein of forewing entirely absent (first submarginal and discal cells entirely confluent). Propodeum rugulose-reticulate, without a clearly formed areola posteriorly (Fig. 3C). First metasomal tergite about 1.8X longer than wide, strongly longitudinally costate, with costae converging posteriorly (Fig. 3D). Ovipositor sheath (Fig. 3E) about equal to length of first metasomal tergite.

Discussion

The discovery of *M. melanopus* in southern Alberta in 2000 and its distribution in 2001 indicate that this European species has become established in the mixed grassland ecoregion of the Canadian prairies. The highest rate of parasitism that we found in southern Alberta was 9%, compared to 71% in northwestern U.S.A. (Harmon and McCaffrey 1993) and 60% in Europe (Bonnemaison 1957).

In the fall-seeded canola cropping system of the northwestern U.S.A., parasitized weevils that emerge from overwintering sites have the opportunity to disperse directly to crops. In southern Alberta canola crops are spring-seeded, and weevils utilize brassicaceous weeds and volunteer canola for sustenance before dispersing to crops (Fox and Dosdall 2003).

Although parasitized weevils were active at the time of capture, late stages of parasitism could negatively affect the ability of parasitized weevils to disperse from

weed sites to crops. Adult parasitoids that emerge from weevils that failed to disperse would miss the opportunity to parasitize weevils that already dispersed. The overwintered generation of parasitoids, unless they are able to disperse as adults, would then be isolated in weed habitat with few weevils. This would limit opportunities to amplify numbers of second-generation parasitoids, and limit opportunities for second-generation parasitoids to parasitize new generation weevils.

The absence of parasitized weevils in *B. napus* crops, and the presence of parasitized weevils in volunteer *B. napus* and other weed sites in the current study, does suggest that *M. melanopus* is not effectively dispersing from weed sites to crops. Therefore, we hypothesize that *M. melanopus* may not be able to provide substantial control of *C. obstrictus* in the mixed grassland ecoregion of its new range.

Protecting stands of volunteer *B. napus* to maintain populations of *M. melanopus* would be unacceptable as stands of volunteer *B. napus* are generally considered to be undesirable from a weed management perspective, especially if they are herbicide-resistant strains. Also, their destruction is recommended to reduce weevil populations (Fox and Dosdall 2003). Furthermore, protecting low populations of parasitoids in volunteer canola may not result in a benefit to weevil control in crops.

The occurrence of parasitized weevils in *S. alba* is possibly linked to a slightly earlier development of this crop compared to *B. napus*. Also, annual fluctuations in spring seeding conditions may have played a role. However, the population of new generation weevils needed to complete the seasonal life cycle of the parasitoid would be exceedingly low, because *S. alba* pods are poor hosts for weevil reproduction (Doucette 1947, Brown et al. 1999).

We believe that the first parasitoids we encountered in the spring were the overwintering generation. However, if the parasitoid overwinters as a first-instar larva, which is generally established in the literature, then the occurrence of embryos on 8 June indicates an encounter with the second generation. This would only occur if overwintering parasitoids emerge from their weevil host at overwintering sites and parasitize the overwintering generation before weevils disperse to weed sites. We believe that this is unlikely in southern Alberta's variable spring climate. A more likely explanation is that the life history of *M. melanopus* is more elastic than generally documented. Jourdheuil (1960) found embryos as well as first-instar larvae in *C. obstrictus* in October, and Speyer (1925) found parasitoids overwintering as eggs and larvae in *C. quadridens*.

The occurrence of weevils containing embryos on 9 July, and results of laboratory parasitism, provide some insight into the time frame of parasitoid activity and readiness to oviposit. Jourdheuil (1960) reported that the adult male to female parasitoid ratio was close to one, and males lived for up to 2, and females for 8 to 10, days. Harmon and McCaffrey (1997) found few adult male parasitoids in the field relative to females (3:287 in 1992) but found 60% male emergence in the laboratory. In 2000, in the current study, there was 55% male emergence in the laboratory (n = 29). We documented only females in the field and the incidence was low.

Microctonus melanopus will run to couplet 16 (near *Microctonus colesi* Drea) in Loan's (1969) key for *Microctonus* species, and can easily be distinguished from *M. colesi* by color, antennal length, host associations, and distribution. *Microctonus melanopus* females have the head, legs, and posterior metasoma mostly yellow (black in *M. colesi*), and antenna with 19-20 flagellomeres (23 flagellomeres in *M. colesi*). *Microctonus melanopus* parasitizes *Ceutorhynchus* species; whereas, *M. colesi* parasitizes *Hypera postica* (Gyllenhal) (Coleoptera: Curculionidae).

The only other *Microctonus* species that occurs commonly with *M. melanopus* in Canadian canola fields is *M. vittatae,* a parasitoid of *Phyllotreta* species (Coleoptera: Chrysomelidae). *Microctonus vittatae* can be distinguished from *M. melanopus* by host association or by several morphological characters including antennal length and sculpture patterns of the mesonotum, propodeum, and first metasomal tergite. *Microctonus vittatae* has a smaller body size and shorter antenna (16-18 flagellomeres) than in *M. melanopus. Microctonus vittatae* differs in mesonotal sculpture by not having a median longitudinal carina in the area where the notauli converge, by having more distinct propodeal carinae forming a posterior areola, and by having less distinct sculpture on the first metasomal tergite (without converging costae posteriorly). The best characters for straightforward identification of *M. melanopus* may be the mesonotal sculpture with a distinct median longitudinal carina posteriorly, and the sculpture of metasomal tergite 1 with costae distinctly converging posteriorly.

Kuhlmann et al. (2002) listed *M melanopus* as a potential candidate for release to control cabbage seedpod weevil, but cautioned that potential negative effects of this parasitoid on non-endemic Ceutorhynchinae released for weed control, and other endemic Ceutorhynchinae, must first be established. Bousquet (1991) listed 35 species of Ceutorhynchinae in Alberta. Now that *M. melanopus* is documented in southern Alberta it may be best to monitor its natural expansion and performance, and further investigate its life history, prior to considering releases.

Acknowledgments

We thank A. Willms, D. Wright, J. Blackmore and H. Cárcamo for providing collection sites, K. Floate, AAFC, Lethbridge, for the use of laboratory facilities, and provincial agriculture specialists R. Dunn, Alberta, and H. Philip and D. Lowe, British Columbia, for their support. Sections of Speyer (1925) were translated into English by P. Davis, and sections of Jourdheuil (1960) and Bonnemaison (1957) were translated into English by N. Fournier. Technical support was provided by M. McFarlane, B. Delisle, and A. Kalischuk. This project was funded by grants awarded to L. M. Dosdall by the Alberta Agricultural Research Institute and the Canola Council of Canada.

References Cited

Al-Shehbaz, I. A. and K. Mummenhoff. 2002. *Cardaria, Coronopus,* and *Stroganowia* are united with *Lepidium* (Brassicaceae). Novon 12: 5-11.

Borror, D. J., D. M. DeLong and C. A. Triplehorn. 1981. An introduction to the study of insects. 5th ed. Saunders College Publishing, Philadelphia.

Bonnemaison, L. 1957. Le charançon des siliques (*Ceuthorrynchus assimilis* Payk.), biologie et méthodes de lutte. Annales des Épiphyties 4: 387-543.

Bousquet, Y. 1991. Checklist of beetles of Canada and Alaska. Agriculture Canada Publication 1861/E.

Brown, J., J. P. McCaffrey, B. L. Harmon, J. B. Davis, A. P. Brown and D. A. Erickson. 1999. Effect of late season insect infestation on yield, yield components and oil quality of *Brassica napus, B. rapa, B. juncea* and *Sinapis alba* in the Pacific Northwest region of the United States. J. Agric. Sci. 132: 281-288.

Colonnelli, E. 1993. The Ceutorhynchinae types of I.C. Fabricius and G. von Paykull (Coleoptera: Curculionidae). Koleopterologische Rundschau 63: 299-310.

Dmoch, J. 1965. The dynamics of a population of the cabbage seedpod weevil (*Ceuthorrhynchus assimilis* Payk.) and the development of winterape. Part I. Ekologia Polska Ser. A. 13: 249-287.

Dosdall, L. M. and M. G. Dolinski. 2001. Biology and control of the cabbage seedpod weevil, a new pest of canola in Alberta. Alberta Agriculture, Food and Rural Development Technical Report, Edmonton, AB.

Dosdall, L. M., R. M. Weiss, O. Olfert and H. A. Cárcamo. 2002. Temporal and geographic distribution patterns of cabbage seedpod weevil (Coleoptera: Curculionidae) in canola. Can. Entomol. 134: 403-418.

Doucette, C. F. 1947. Host plants of the cabbage seedpod weevil. J. Econ. Entomol. 40: 838-840.

Fox, A. S. and L. M. Dosdall. 2003. Reproductive biology of *Ceutorhynchus obstrictus* (Coleoptera: Curculionidae) on wild and cultivated Brassicaceae in southern Alberta. J. Entomol. Sci. 38: 533-544.

Harmon, B. L. and J. P. McCaffrey. 1997. Parasitism of adult *Ceutorhynchus assimilis* (Coleoptera: Curculionidae) by *Microctonus melanopus* (Hymenoptera: Braconidae) in northern Idaho and eastern Washington. J. Agric. Entomol. 14: 55-59.

Jourdheuil, P. 1960. Influence de quelques facteurs écologiques sur les fluctuations de population d'une biocénose parasitaire: Etude relative à quelques Hyménoptères (Ophioninae, Diospilinae, Euphorinae) parasites de divers Coléoptères inféodés aux Crucifères. Annales des Epiphyties 11: 445-658.

Kuhlmann, U., L. M. Dosdall and P. G. Mason. 2002. *Ceutorhynchus assimilis* Paykull, cabbage seedpod weevil (Coleoptera: Curculionidae). Pp. 52-58. *In* P. G. Mason and J. T. Huber [eds.], Biological control programmes in Canada 1981-2000. CABI Publishing, Wallingford, UK.

Loan, C. C. 1969. A summary of species of *Microctonus* north of Mexico with five new species (Hymenoptera: Braconidae: Euphorinae). Proc. Entomol. Soc. Washington 71: 404-416.

McLeod, J. H. 1953. Notes on the cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.) (Coleoptera: Curculionidae), and its parasites. Proc. Entomol. Soc. British Columbia 49: 11-18.

Murchie, A. K. and I. H. Williams. 1998. A bibliography of the parasitoids of the cabbage seed weevil (*Ceutorhynchus assimilis* Payk.). Integrated Control in Oilseed Crops IOBC Bulletin 12: 163-169.

Shaw, S. R. 1985. A phylogenetic analysis of the subfamilies Meteorinae and Euphorinae. Entomography 3: 277-370.

1997. Subfamily Euphorinae, Pp. 234-254. *In* Manual of the New World genera of the family Braconidae (Hymenoptera). Special publication of the International Society of Hymenopterists, Number 1.

Speyer, W. 1925. *Perilitus melanopus* Ruthe (Hym. Braconidae) als imaginalparasit von *Ceutorrhynchus quadridens* Panz. Zeitschrift für Angewandte Entomologie 11: 132-146.

Vinson, S. B. 1970. Development and possible functions of teratocytes in the host-parasite association. J. Invertebr. Pathol. 16: 93-101.