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MICRODONTOMERUS ANTHONOMI (CRAWFORD) (HYMENOPTERA: TORYMIDAE), AN INDIGENOUS PARASITOID OF THE INTRODUCED BIOLOGICAL CONTROL INSECTS *BANGASTERNUS ORIENTALIS* (CAPIOMONT) (COLEOPTERA: CURCULIONIDAE) AND *UROPHORA AFFINIS* FRAUENFELD (DIPTERA: TEPHRITIDAE)

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Abstract.—The indigenous parasitoid wasp *Microdontomerus anthonomi* (Crawford) (Hymenoptera: Torymidae) was found associated with the weevil *Bangasternus orientalis* (Capiomont) (Coleoptera: Curculionidae) in California and with the fly *Urophora affinis* Frauenfeld (Diptera: Tephritidae) in Montana. *Bangasternus orientalis* was first introduced from Greece into California and other parts of the U.S. in 1985 for biological control of the naturalized weed yellow starthistle (*Centaurea solstitialis* L., Asteraceae). *Urophora affinis* was first introduced from Europe into Montana in 1973 for biological control of the naturalized weeds spotted knapweed (*Centaurea maculosa* Lamarck) and diffuse knapweed (*C. diffusa* Lamarck). *Microdontomerus anthonomi* appears to be an external parasitoid of the larvae of *B. orientalis* and *U. affinis*. This is the first report of a parasitoid associated with *B. orientalis* and *U. affinis* in their introduced ranges in North America. *Microdontomerus anthonomi* appears to be a host species generalist but microenvironment specialist on hosts enclosed by plant tissues, and its host records are summarized.

Key Words.—Insecta, parasitoid, weed, knapweed, yellow starthistle, biological control

Parasitoids can exert a strong impact on insect populations. An important protocol component of biological control programs involves the effort to introduce biological control insects without also introducing their own parasitoid natural enemies from their area of origin. However, after their field release, there is no way to prevent their exposure to indigenous parasitoids. Although indigenous parasitoids often have little impact on insects introduced for the biological control of weeds, they may on occasion reduce their effectiveness (Goeden & Louda 1976, Ehler & Andres 1983, Wehling & Piper 1988). We report that the indigenous wasp *Microdontomerus anthonomi* (Crawford) (Hymenoptera: Torymidae) has

been reared in association with two insect species introduced for the biological control of *Centaurea* (Asteraceae) weeds in North America: *Bangasternus orientalis* (Capiomont) (Coleoptera: Curculionidae) and *Urophora affinis* Frauenfeld (Diptera: Tephritidae).

Bangasternus orientalis

Bangasternus orientalis was first introduced from Greece into California, Idaho, Oregon, and Washington in 1985 for biological control of the naturalized annual weed yellow starthistle (*Centaurea solstitialis* L., Asteraceae) (Maddox & Mayfield 1985, Maddox et al. 1986). The general biology of *B. orientalis* is described in Sobhian & Zwölfer (1985) and Maddox et al. (1986). Adult *B. orientalis* feed on the foliage, mate, and oviposit on yellow starthistle in late spring. Eggs usually are affixed to the exterior of scale leaves subtending immature capitula. Hatched larvae tunnel through the scale leaves into the flowering shoot axis where they then tunnel upwards into the capitulum. The larvae feed and develop inside the capitula. The mature larvae pupate in chambers constructed inside capitula. Next generation adults emerge by late summer and overwinter until the following spring. *Bangasternus orientalis* is univoltine. Sobhian & Zwölfer (1985) reported several parasitoids of *B. orientalis* in Greece, where the weevil is native: The egg parasitoids *Pterandrophysalis levantina* Novicki (Hymenoptera: Trichogrammatidae) and an unknown mymarid species, which can cause 40% to 80% mortality in *B. orientalis* eggs; and the larval parasitoids *Bracon* sp. (Hymenoptera: Braconidae), *Eurytoma* sp. (Hymenoptera: Eurytomidae), and *Exeristes roborator* (Fabr.) (Hymenoptera: Ichneumonidae). *Pyemotes* sp. (Acarina: Pyemotidae) was also reported to attack the larvae (Sobhian & Zwölfer 1985).

During the summers of 1988 and 1989, *M. anthonomi* was found associated with the weevil in California at four sites. *Bangasternus orientalis* was first released near Mariposa, Mariposa Co., on 1 Jun 1988. On 16 Aug 1988, a *M. anthonomi* pupa was found at the site inside the pupal chamber of a dead *B. orientalis* larva. The capitulum was collected and kept in a vial in the lab, and an adult female wasp emerged by 29 Aug 1988. *Bangasternus orientalis* was first released near Oakdale, Stanislaus Co., on 1 Jun 1988. On 16 Aug 1988, a *M. anthonomi* pupa was found at the site inside a *B. orientalis* pupal chamber with a dead *B. orientalis* larva. This capitulum was also collected and kept in a vial in the laboratory, and an adult female wasp emerged by 29 Aug 1988. *Bangasternus orientalis* was first released near Lincoln, Placer Co., on 29 May 1985 (Maddox et al. 1986). On 17 Aug 1988, an adult female *M. anthonomi* was collected there while apparently searching among *B. orientalis*-infested capitula of yellow starthistle. *Bangasternus orientalis* was first released near Montague, Siskiyou Co., on 29 May 1985 (Maddox et al. 1986). On 13 Sep 1989, a total of 253 sampled yellow starthistle capitula (with or without *B. orientalis*) were collected at this site and brought back to the laboratory for dissection. Of the sampled capitula, 124 were infested by a total of 142 *B. orientalis* (some capitula were infested by two or, rarely, three *B. orientalis*). One dead, adult female *M. anthonomi* was found inside the pupal chamber of a dead *B. orientalis* larva. This amounts to a parasitization rate of 0.8% of the *B. orientalis*-infested capitula. *Microdontomerus anthonomi* appears to be an external parasitoid of *B. orientalis* larvae. Note that at two of the above sites, *M. anthonomi* parasitized the weevil during the same summer of its initial release.

This is the first report of a parasitoid associated with *B. orientalis* in its introduced range in the United States.

Urophora affinis

Urophora affinis was first introduced from Europe in 1970 into Canada, and in 1973 into the U.S. for biological control of the naturalized weeds spotted knapweed (*Centaurea maculosa* Lamarck) and diffuse knapweed (*Centaurea diffusa* Lamarck) (Harris 1980, Maddox 1982). Diffuse knapweed is a biennial, while spotted knapweed is a short-lived perennial. By 1987, the fly was established in the U.S. on both knapweeds in Idaho, Montana, Oregon, and Washington, and also on spotted knapweed in New York (Julien 1987). The general biology of *U. affinis* is described in Harris (1980). Female *U. affinis* oviposit in immature capitula of spotted and diffuse knapweed. In the capitula, the larvae induce unilocular gall formation from the receptacle tissue, and feed on parenchymatous tissue within the galls. Mature larvae overwinter within galls inside the capitula, and adult flies emerge the following spring. There can be multiple unilocular galls in a capitulum, with one larva per gall. The fly is partially bivoltine in North America. In European native populations of *U. affinis, Eurytoma* wasps and *Pyemotes* mites are important biotic mortality factors, often killing more than 50% of the larvae (Zwölfer 1970).

While surveying the indigenous parasitoids of *U. affinis* in Montana in 1988, six adult *M. anthonomi* (two males, four females) were reared from spotted knapweed capitula with *U. affinis* galls. The capitula were collected at a site near Belgrade, Gallatin Co., on 19 Oct 1988, and were vernalized until the following spring. On 7 Mar 1989, 456 vernalized capitula were placed individually in 1 ounce, clear plastic diet cups to monitor emergence and facilitate host association. The emerged *M. anthonomi* were recovered on 10 May 1989. Six of the 456 capitula yielded a *M. anthonomi* wasp, a parasitization rate of 1.3%. *Urophora affinis* galls with host larvae parasitized by *M. anthonomi* were readily identified by the small circular exit hole chewed by the emerged wasp. Microscopic examination of the contents of the parasitized galls revealed a meconium deposited by the developing parasitoid larva, host remains (spiracular plate of *U. affinis*), and pupal exuviae of *M. anthonomi.* This is a new host record and the first record of *M. anthonomi* parasitizing a species of Diptera, and also is a new state record for this parasitoid.

Microdontomerus anthonomi

Little is known about the biology of *M. anthonomi,* and some of the published information is erroneous. *Microdontomerus anthonomi* was described from specimens "bred from *Brachytarsus* (= *Trigonorhinus*) (Coleoptera: Anthribidae) in heads of *Sideranthus rubiginosus* (= *Machaeranthera phyllocephalus* (DC.) Shinn., Asteraceae)" (Crawford 1907), but this host record is probably wrong. Crawford's report was titled "New hymenopterous parasites of *Anthonomus grandis,* Boh.," and *M. anthonomi* was obviously named for its *Anthonomus* host. This is substantiated by the type material of *M. anthonomi,* which all bear labels reading *Anthonomus grandis.* Additionally, *Trigonorhinus* larvae inhabit dead wood and

would not likely occur in capitula (R. White, personal communication). It appears that Crawford made a mistake in citing the host in his paper.

Since the original description, additional hosts for *M. anthonomi* have been reported by Peck (1963), Grissell (1979), Wilson & Andres (1986), and Hetz & Johnson (1988). Reliable host records include Coleoptera: Bruchidae—(*Acanthoscelides aureolus* (Horn), *A. compressicornis* (Schaeffer), *A. desmanthi* Johnson, *A. derifieldi* (Johnson), *A. horni* (Pic), *A. mixtus* (Horn), *A. pullus* (Fall), *Bruchus brachialis* Fahraeus, *B. pisorum* (L.), *Sennius morosus* (Sharp), *Stator limbatus* (Horn), and *S. pruininus* (Horn); Curculionidae—*Anthonomus grandis* Boheman, and *Rhinocyllus conicus* Froelich. In addition, Goeden & Ricker (1970) reported a *Microdontomerus* sp. reared from the weevil *Microlarinus lareynii* (Jaquelin du Val) (Curculionidae). We have seen a specimen reared during that study and deposited in the collection of the University of California, Riverside, and confirm the identity of the specimen as *M. anthonomi.* Two lepidopteran host records, *Coleophora malivorella* Riley (Coleophoridae) and *Ancylis comptana* (Froelich) (Olethreutidae), have been confirmed based on U.S. National Museum specimens. *Bracon mellitor* Say (Hymenoptera: Braconidae), a parasitoid of *A. grandis,* is also a reliable host record for *M. anthonomi.* A hymenopteran host record for the Eumenidae (*Leptochilus* sp.) (Burks 1967) cannot be confirmed. The specimens upon which the record is based have not been found in the U.S. National Museum. The record is probably a misidentification of *Microdontomerus anthidii* (Ashmead), which is nearly identical to *M. anthonomi,* but attacks aculeate Hymenoptera.

Microdontomerus anthonomi is a solitary ectoparasitoid of *A. grandis,* and can also function as a secondary parasitoid of *Bracon mellitor* (Pierce 1908). Pierce (1910) reported that *M. anthonomi* was capable of superparasitism with at most one larva surviving when two to eight larvae occurred on a single host individual. He also reported that *M. anthonomi* tended to be the sole survivor when "superparasitism" (actually multiple parasitism) involved competing species of parasitoid larvae such as pteromalids, eurytomids, or braconids. Pierce et al. (1912) discussed the population fluctuations of *M. anthonomi* over a 4 year period, and illustrated the egg and pupa.

Pierce (1908) showed that *M. anthonomi* was both a primary and secondary parasitoid (i.e., a facultative parasitoid) of the weevil *A. grandis.* Although we could not establish the exact host-parasitoid relationship, we demonstrated that *M. anthonomi* is directly linked to its phytophagous hosts, and we have not seen any evidence that *M. anthonomi* has anything other than a primary parasitic relationship with them. The collective evidence suggests that *M. anthonomi* is a host species generalist, but a microenvironment specialist on hosts enclosed by plant tissues. *Microdontomerus anthonomi* is widely distributed in the U.S. (Grissell 1979), and there is no evidence of host selection based on geographic limits. Although *M. anthonomi* is known to parasitize two other weevil species (*Microlarinus lareynii* and *Rhinocyllus conicus*) introduced for biological control of weeds in California, this parasitization has had an inconsequential effect on these biocontrol insects (Goeden & Ricker 1970, Wilson & Andres 1986). It is too early to know whether the indigenous parasitoid *M. anthonomi* will have a significantly negative impact on *B. orientalis* and *U. affinis* populations in their introduced range in North America.

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