Parasitism of the biological control agent *Hyles euphorbiae* (Lepidoptera: Sphingidae) by *Winthemia datanae* (Diptera: Tachinidae): a new host record

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Abstract — Leafy spurge, *Euphorbia esula* L. (Euphorbiaceae), is an invasive perennial weed for which a number of biological control agents have been released in Canada. In surveys of biological control agents in patches of *E. esula* in Spruce Woods Provincial Park, Manitoba, tachinid eggs were detected on final instar larvae of the biological control agent, *Hyles euphorbiae* (L.) (Lepidoptera: Sphingidae). The tachinids were reared and identified as the Nearctic species, *Winthemia datanae* (Townsend) (Diptera: Tachinidae). This is a new host record for *W. datanae*. Mechanisms by which the new host association arose are discussed.

Euphorbia esula L. (Euphorbiaceae) is an invasive weed that was introduced into North America approximately 200 years ago (Selleck *et al.* 1962). It has now been reported in the Yukon, in all Canadian provinces except Newfoundland and Labrador, and in 37 of the 49 continental U.S. states including all western, mid-western and north-eastern states (USDA 2009). The north-central states and prairie provinces are severely infested (Bourchier *et al.* 2002). In Manitoba, the estimated area infested by *E. esula* has risen from 3250 ha in 1953 (Craig 1953), to about 285,000 ha in 2008 (Rural Development Institute 2009). Through its competitive advantages of early emergence, persistent root growth, vegetative root budding (Messersmith *et al.* 1985), and avoidance by many grazing animals (Lym and Kirby 1987), *E. esula* spreads rapidly (Selleck *et al.* 1962), threatens native flora (Belcher and Wilson 1989) and fauna (Schieman *et al.* 2003). Also, *E. esula* has significant economic impacts, particularly through reduction of pasture value (Leitch *et al.* 1996). Herbicidal control of *E. esula* is impractical on pasturelands and ecological preserves (Harris and Alex 1971). As it is an alien species and there are no native North American insects that utilize it as a food source (Harris *et al.* 1985), *E. esula* is a good candidate for classical biological control. To this end, 15 Eurasian insect species have been released in Canada against E. *esula* (Harris 1984; Bourchier *et al.* 2002). The first of these species was

Hyles euphorbiae (L.) (Lepidoptera: Sphingidae), of which 44,000 were released across Canada from 1965 to 1985, including more than 2200 in Manitoba (Harris 1984; Bourchier *et al.* 2006).

The native range of *H. euphorbiae* includes central Asia, northern India, and south and central Europe (Harris 1984). In Canada and in the northern part of its native range, *H. euphorbiae* is univoltine (Harris and Alex 1971); more southerly populations are bivoltine or trivoltine (Harris 1984; Rees and Fay 1989). Adult moths are first seen in late spring or early summer, and females lay eggs at the base of *E. esula* plants (Harris and Alex 1971). The larvae emerge, progress through five instars (Rees and Fay 1989), feeding on foliage of a narrow range of *Euphorbia* species (Harris 1984). *Hyles euphorbiae* has established in several states and provinces but does not provide adequate control of *E. esula* (Bourchier *et al.* 2002; Hansen 2010).

In 2009, a survey of herbivorous insects in patches of *E. esula* was carried out in the Big Prairie (centred at approximately 49°40'N 99°02'W) of Spruce Woods Provincial Park, Manitoba. Except for *E. esula*, vegetation in this location is native mixed-grass prairie interspersed with aspen-oak and spruce forest stands (Bird 1930). During the survey, *H. euphorbiae* larvae with visible tachinid eggs on them were collected and brought back to the laboratory. The larvae were reared in 948 ml plastic containers (Bug Tub, Inc.®) with a screened hole in the lid. Cut shoots of *E. esula*, with the base wrapped in moist paper towel, were provided as food. A crumpled paper towel at the bottom of the container offered a pupation site. Newly pupated *H. euphorbiae* were placed in 1 cm of damp sand in a rectangular plastic container, 20 x 9.5 x 7 cm, and examined daily for emergence. Tachinid larvae that emerged from *H. euphorbiae* pupae were individually placed in 15 ml plastic vials with about 4 ml of moistened sand. Vials were checked daily for emergence of tachinid adults. All rearing was in an incubator at 30° C and 16:8 h L:D. A representative sample of adults was pinned and sent for identification and the remaining specimens were deposited in the J.B. Wallis Museum of Entomology at the University of Manitoba.

One *H. euphorbiae* larva bearing tachinid eggs was collected 8 August 2009 at 49°41.006′ N 99°02.418′ W. It pupated on 14 August and 23 tachinid larvae emerged from the pupal case on 21 August. The tachinid larvae formed puparia on 29 August and emergence of adult flies began on 8 September; a total of five adult tachinids emerged. A second *H. euphorbiae* larva with tachinid eggs was collected on 22 August at 49°40.264′ N 99°02.128′ W and pupated on 30 August. On 8 September, 29 tachinid larvae emerged from the pupal case and formed puparia that same day. A total of 20 adult tachinids emerged from these puparia between 11 and 16 September. The tachinids were identified as *Winthemia datanae* (Townsend) (Diptera: Tachinidae). This rearing of *W. datanae* from *H. euphorbiae* is a new host record.

Because of the survey methodology, the level of parasitism by *W. datanae* on *H. euphorbiae* in Spruce Woods Provincial Park could not be estimated. However, we expect the addition of *W. datanae* as a mortality factor to contribute to the low population growth rates of *H. euphorbiae* that are a factor in its poor efficacy as a biological control agent. The failure of introduced *H. euphorbiae* populations to grow rapidly has been attributed to predation, parasitism and disease (Harris and Alex 1981; Batra 1983; Forewood and McCarty 1980).

A great concern in classical biological control is the threat of introducing parasitoids with the introductions of the biological control agent (Howarth 1991). This possibility could not account for parasitism of *H. euphorbiae* by *W. datanae: H. euphorbiae* is native to Eurasia (Harris 1984), whereas Peigler's (1994) world catalogue records the distribution of *W. datanae* as eastern North America. In fact, the North American distribution of *W. datanae* is transcontinental in Canada and the United States (O'Hara and Wood 2004), and the species has been previously reported from Manitoba (Henne 2004). The new host record is almost certainly the result of a host range expansion, in which the introduced biological control agent is utilized by an indigenous parasitoid.

Winthemia datanae already has a broad host range, consisting of at least 29 species in eight families of Lepidoptera (Arnaud 1978; Henne 2004; Peigler 1994). Of these, species that are relatively common in Manitoba include *Malacasoma disstria* Hübner (Lasiocampidae) (Prentice 1963), *Hemerocampa leucostigma* (J.E. Smith) (Lymantriidae) (Prentice 1962), *Pseudaletia unipuncta* (Haworth) (Noctuidae) (Ayre 1985), *Datanae ministra* (Drury) (Notodontidae) (Prentice 1962), *Platysamia cecropia* (L.) (Saturniidae) (McGugan 1958) and *Anisota virginiensis* (Citheroniidae) (McGugan 1958; Henne 2004). All of these hosts are polyphagous and, with the exception of *P. unipuncta* (Tietz 1972), the majority of their host plants are deciduous trees or shrubs (McGugan 1958; Prentice 1962, 1963). Many of the host plants are characteristic of aspen parkland (Bird 1930) and occur near our collection sites. Tachinid host selection is strongly influenced by ecological characteristics of the host, rather than by physiological constraints or phylogenetic relationships (Stireman and Singer 2003). Searching females of another generalist tachinid (*Exorista mella* (Walker)) are thought to use general visual or olfactory cues to select appropriate macrohabitats. Within these macrohabitats they initiate restricted area searching using cues, including host motion, that are not initially host-species specific, but may become so with female experience (Stireman 2002). It seems likely that the use of *H. euphorbiae* as a host is a consequence of overlap of its habitat with that selected at the macrohabitat level by *W. datanae* for restricted area search. The timing of this overlap is critical: *W. datanae* oviposits on larvae in their last instar before pupation, thus avoiding the shedding of eggs when the host moults (Marsh 1937; Hitchock 1961). Therefore, the level of parasitism of *H. euphorbiae* is likely to depend upon the proximity to, and synchronization with, alternative hosts of *W. datanae*.

We thank J.E. O'Hara, Agriculture and Agri-Food Canada, Ottawa for identifying *W. datanae*, and K. Schykulski and the staff of Manitoba Conservation, for facilitation and access to sites.

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