Hymenopterous parasitoids of house fly and stable fly puparia in Prince Edward Island and New Brunswick, Canada

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Abstract—Puparia of house flies, *Musca domestica* L., and stable flies, *Stomoxys calcitrans* (L.) (Diptera: Muscidae), were collected on dairy farms in Prince Edward Island (PEI) and New Brunswick (NB) and held for emergence of hymenopterous parasitoids. Percent parasitism for PEI in 2003 and 2004 was 6.7 (n = 10 060 puparia) and 1.0 (n = 36 992 puparia), respectively. Percent parasitism for NB was not determined in 2003, but was 9.1% (n = 3052 puparia) in 2004. A parasitoid provisionally identified as *Phygadeuon* ?*fumator* Gravenhörst (Ichneumonidae) predominated in both provinces. Additional species recovered included *Aphaereta pallipes* (Say) (Braconidae) and *Muscidifurax raptor* Girault and Saunders, *Spalangia cameroni* Perkins (PEI only), *Spalangia nigra* Latreille (NB only), *Spalangia subpunctata* Förster (NB only), *Trichomalopsis americana* (Gahan) (PEI only), and *Urolepis rufipes* (Ashmead) (Pteromalidae). Dissection of host puparia from which neither flies nor wasps emerged yielded a relatively large number of additional parasitoids, particularly *S. nigra*.

Résumé—Nous avons récolté des puparium de mouches domestiques, *Musca domestica* L., et de mouches piquantes des étables, *Stomoxys calcitrans* (L.) (Diptera: Muscidae), dans des fermes laitières de l'Île-du-Prince-Édouard (PEI) et du Nouveau-Brunswick (NB) et les avons gardés en élevage jusqu'à l'émergence des hyménoptères parasitoïdes. Le pourcentage de parasitisme était respectivement de 6,7 (n = 10 060 puparium) et de 1,0 (n = 36 992 puparium) en 2003 et 2004 à PEI. Le pourcentage de parasitisme au NB n'a pas été déterminé en 2003, mais en 2004 il était de 9,1 (n = 3052 puparium). Le parasitoïde dominant dans les deux provinces est identifié de façon provisoire comme *Phygadeuon* ?*fumator* Gravenhörst (Ichneumonidae). Les autres espèces obtenues incluent *Aphaereta pallipes* (Say) (Braconidae), ainsi que *Muscidifurax raptor* Girault et Saunders, *Spalangia cameroni* (Perkins) (PEI seulement), *S. nigra* Latreille (NB seulement) *S. subpunctata* Förster (NB seulement), *Trichomalopsis americana* (Gahan) (PEI seulement) et *Urolepis rufipes* (Ashmead) (tous des Pteromalidae). La dissection des puparium des hôtes d'où n'ont émergé ni mouches ni guêpes a fourni un nombre relativement grand d'autres parasitoïdes, principalement des *S. nigra*.

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House flies, *Musca domestica* L., and stable flies, *Stomoxys calcitrans* (L.) (Diptera: Muscidae), are cosmopolitan pests associated with dairy farms and cattle feedlots. Development of pesticide resistance by these flies has led to research on their natural enemies. Most attention

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Table 1. Parasitoids (Hymenoptera) recovered from puparia of house flies, *Musca domestica*, and stable flies, *Stomoxys calcitrans*, in New Brunswick (NB) and on Prince Edward Island (PEI).

	Percentage of puparia parasitized by:									
Province	Apal	Pfum	Mrap	Scam	Snig	Ssub	Tame	Uruf	Un	No. of puparia
NB	1	69	1	—	17	<1	—	<1	13	421
PEI	<1	47	19	10	—	—	1	10	13	1046

Note: Apal, *Aphaerta pallipes*; Pfum, *Phygadeuon ?fumator*; Mrap, *Muscidifurax raptor*; Scam, *Spalangia cameroni*; Snig, *Spalangia nigra*; Ssub, *Spalangia subpunctata*; Tame, *Trichomalopsis americana*; Uruf, *Urolepis rufipes*; Un, unidentified species.

has focused on wasps (Hymenoptera) that parasitize the puparia of these flies (*e.g.*, Rueda and Axtell 1985). In regional surveys in Canada using comparable methods, 14 species from sites in Alberta (Lysyk 1995; Floate *et al.* 1999, 2000), 10 species from sites near Winnipeg, Manitoba (McKay and Galloway 1999), and 14 species from sites near Ottawa, Ontario (Gibson and Floate 2004), have been identified. These surveys indicate considerable regional variation in species composition.

To gain knowledge of house fly and stable fly parasitoids in Canada, a 2 year study was undertaken in Atlantic Canada. The only data from this region are included in a report of two species (*Muscidifurax raptor* Girault and Saunders, *Spalangia nigroaenea* Curtis (Pteromalidae)) reared from 77 house fly puparia collected near Fredericton, New Brunswick (NB) (Legner *et al.* 1967).

House fly and stable fly puparia were collected from dairy farms on NB and Prince Edward Island (PEI). Five and six farms on PEI and four and five farms in NB were sampled in 2003 and 2004, respectively. Puparia were collected weekly or every second week from June into October, both inside and outside barns. Collection sites included spilled feed, soiled bedding piles, calf hutches, manure mounds, silage pits, and rotting debris near water troughs. Efforts were made to collect several hundred puparia per dairy farm during each visit.

Puparia were placed individually in 96-well tissue culture plates and held at room temperature (approximately 22 °C) for at least 2 months. To prevent the escape of emergent parasitoids, openings to wells were covered with a double layer of Parafilm® and then a 1 mm thick layer of packing foam. These layers were held in place by the culture-plate lid, which was taped in position. Parasitoids in this guild normally complete development in less than 1 month at room temperature (Rueda and Axtell 1985; Smith and Rutz 1986; Hall and Fischer 1988). Emerged parasitoids and the associated host puparia were preserved in ethanol for identification. Puparia from which neither flies nor parasitoids emerged were dissected to recover unemerged parasitoids. All parasitoids were identified by G.A.P. Gibson. Voucher specimens are deposited at the Canadian National Collection of Insects, Ottawa, Ontario.

For PEI, parasitoids were recovered from 672 of 10 060 (6.7%) puparia in 2003 and from 374 of 36 992 (1.0%) puparia in 2004. Observed parasitism within years at individual farms ranged from 0% to 14%. The parasitoids included *Aphaereta pallipes* (Say) (Braconidae), a species provisionally identified as *Phygadeuon fumator* Gravenhörst (Ichneumonidae), *M. raptor*, *Spalangia cameroni* Perkins, *Trichomalopsis americana* (Gahan), and *Urolepis rufipes* (Ashmead) (Pteromalidae). Immature parasitoids dissected from host puparia generally could not be identified to species, so the combined total of puparia for which parasitism could be assigned to species was 914. *Aphaereta pallipes* was the only gregarious species, and eight individuals were recovered from one puparium in 2003 (0.1%); otherwise, *P. ?fumator* parasitized 53.9% of puparia (49.3% in 2003, 64.2% in 2004), followed by *M. raptor* at 22.2% (18.9%, 29.5%), *S. cameroni* at 11.3% (16.4%, 0.0%), *U. rufipes* at 11.3% (14.8%, 3.5%), and *T. americana* at 1.2% (0.5%, 2.8%).

For NB, 150 parasitoids were recovered in 2003 but percent parasitism was not determined because puparia from which nothing emerged were not retained early in the season. In 2003, 95 *P. ?fumator*, 7 *Spalangia nigra* Latreille, 1 *M. raptor*, and 5 *A. pallipes* (from one puparium) were reared. Parasitoids dissected from later-season puparia included 19 *P. ?fumator* and 23 *Spalangia* spp., of which 1 was *Spalangia subpunctata* Förster and 18 were *S. nigra*. In 2004 there were 277 parasitism events involving 3052 puparia (9.1%). Parasitoids from 228 reared or dissected puparia were identified as follows:

176 *P.* ?*fumator*, 46 *S. nigra*, 45 *A. pallipes* from 3 puparia, 2 *M. raptor*, and 1 *U. rufipes*. In addition, 2 *Spalangia erythromera* Förster were reared from puparia of non-pest flies for which species determinations could not be made.

Dissection of intact puparia allowed more accurate assessment of both parasitism and species dominance. For PEI, dissections resulted in the additional recovery of 160 (23.4% of the total recovered) and 207 (55.2%) specimens in 2003 and 2004, respectively. For NB, dissections resulted in the additional recovery of 42 (28.8%) and 104 (37.3%) specimens in 2003 and 2004, respectively. The recovery of parasitoids from dissected puparia did not greatly affect estimates of species dominance for PEI. For NB, however, 78 (88.6%) of the 88 specimens of *S. nigra* recovered from NB were from dissected puparia. Thus, *S. nigra* composed 3.5% of the parasitoids emerging from puparia but 20.7% of the total number of parasitoids emerging or dissected from puparia. Most unemerged *S. nigra* were live and fully developed adults. An additional 21 specimens of *Spalangia* spp. were recovered during dissections, but were not sufficiently developed to permit species identification. A high prevalence of unemerged *S. nigra* was similarly reported for dairy farms near Ottawa (Gibson and Floate 2004). The species composition of parasitoids recovered from parasitized puparia during the 2 year study is summarized in Table 1.

Nine parasitoid species have now been recovered from Atlantic Canada. In the current study, six species were identified from each of the two provinces, for a combined total of eight species. Legner *et al.* (1967) also recovered *S. nigroaenea*, which can easily be mistaken for *S. nigra*. The apparent dominance of *P.* ?*fumator* in particular, but also *M. raptor* and *U. rufipes*, is indicative of more northerly, typically wetter and cooler climates. Additional collections made in the Atlantic provinces may increase the known number of parasitoids from the region. However, current results indicate the absence of species that are important parasites of house fly and stable fly, two in western Canada (*Muscidifurax zaraptor* Kogan and Legner, *Trichomalopsis sarcophagae* (Gahan)) and one in eastern Canada (*S. nigroaenea*).

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