N O T E

Parasitism of the Multicolored Asian Lady Beetle (Coleoptera: Coccinellidae) by *Strongygaster triangulifer* (Diptera: Tachinidae) in North Carolina[1]

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The exotic multicolored Asian lady beetle, *Harmonia axyridis* (Pallas), was first reported in North Carolina in the fall of 1992 (Kidd et al. 1995, Proc. Entomol. Soc. Wash. 97: 729-731). The following year (1993), dissections of adults flying into aggregation sites indicated substantial levels of parasitism (14.2%) by the tachinid *Strongygaster triangulifer* (Loew) (Nalepa et al. 1996, Ann. Entomol. Soc. Am. 89: 681-685). In samples taken from 10 sites, half were parasitized at levels >15%, with a maximum of 31.1% at one site in Wake Co. There were also indications of superparasitism, as six beetles contained two larvae, and one beetle contained three. Parasitism levels dropped in 1994, averaging just 1.4% with a range of 0.0 to 6.5% among sites.

If the establishment of *H. axyridis* in the U.S. was the result of planned U.S. Department of Agriculture introductions (see Day et al. 1994, Entomol. News 105: 244-256; Tedders and Schaefer 1994, Entomol. News 105: 228-243), then it is reasonable to assume the beetles entered the country without associated natural enemies; parasites would have been detected and eliminated in quarantine. Only tachinids of the genus *Medina* (=*Degeeria* sp.) and the cosmopolitan braconid *Dinocampus coccinellae* (Schrank) are reported from adult *H. axyridis* in the Palearctic (Kuznetsov 1997, Mem. Center Syst. Entomol. 1: 1-248; Hodek and Honek 1996, Ecology of Cocinellidae, Kluwar Acad. Pub., Dordrecht). Parasitism of *H. axyridis* in the U.S. by the Nearctic tachinid *S. triangulifer,* then, is a new association, with potential for having a substantial impact on the population dynamics of the coccinellid (Holt and Lawton 1993, Am. Nat. 142: 623-645; 1994, Ann. Rev. Ecol. Syst. 25: 495-520). The goal of this study was to document trends in parasitism of *H. axyridis* by the tachinid in North Carolina during the 5 years subsequent to 1994.

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Between 1993 and 1999, adult *H. axyridis* were collected from 28 sites in 12 counties of the Piedmont and mountains of North Carolina, one site in Virginia (Highland Co.) and one site in Tennessee (Greene Co.) (total = 3,593 beetles). Twenty sites were sampled just once during the study; however, four sites were sampled in four separate years, three sites were sampled three times, and three sites were sampled twice. The data from 1993 and 1994 were reported previously (Nalepa et al. 1996) but are included here for comparison.

Beetles were collected as they flew into aggregation sites (October-November), then held at approximately 9°C until dissected and examined for parasitoids. Identity of the tachinid was re-confirmed in 1999; a subsample of beetles from one site (Wake Co.) was held at room temperature and emerged adults identified by North Carolina Department of Agriculture taxonomist K. R. Ahlstrom.

Beetles from one Wake Co. site were held through the winter of 1999-2000 to determine parasite-associated mortality. Twenty beetles were placed into each of 50 48-mm diam. plastic Petri dishes (n = 1000 beetles). Each dish was floored with a cellulose pad, and four 2-mm holes were drilled into the cover. Dishes were assembled as insects flew into aggregation sites between 29 October and 15 November, then placed into loosely covered metal canisters in a screened outdoor enclosure. The insects were provisioned with water once per month. The study was terminated on 11 March 2000, when *H. axyridis* was first noted in area gardens. The numbers of dead beetles and tachinid puparia were noted for each dish (larvae leave the host to pupate-Thompson 1954, Can. Entomol. 86: 137-144).

Parasitism of *H. axyridis* by *S. triangulifer* has remained consistently low since 1994 (2 to 4%, Table 1), with a maximum of 9.6% at one Watauga Co. site (1996). The site most heavily parasitized in 1993 (31.1%, Wake Co.) was re-examined in 1994 and 1999; no parasites were found. Overall, we detected 181 parasitized beetles: 178 by *S. triangulifer* and three (one from each of three sites) by an unidentified hymenopteran [probably *Dinocampus coccinellae* (Schrank), as in the western U.S.-LaMana and Miller 1996, Biol. Cont. 6: 232-237]. Ten beetles were superpara-

Table 1. Parasitism of *Harmonia axyridis* (Coccinellidae) by *Strongygaster triangulifer* (Tachinidae) in North Carolina. Data from 1993 and 1994 were reported in Nalepa et al. (1996) and are included for comparison

Year	# Sites	# Dissected	# Parasitized	% Parasitism	Range of parasitism
1993	10	557	79	14.2	3.0–31.1
1994	14	831	12	1.4	0.0–6.5
1995	10	789	34	4.3	2.7–8.5
1996	11	852	35	4.1	0.0–9.6
1997	2	48	1	2.1	0.0–5.6
1998	1	48	1	2.1	—
1999	4	516	20	3.9	0.0–8.2

sitized by *S. triangulifer;* of these, 8 had two larvae, and 2 had three larvae. Seven of the 10 superparasitized beetles were found in 1993.

Mortality totaled 15.7% in beetles held over the winter of 1999. Assuming that parasitism was fatal by March and that one beetle was the source of each puparium (no superparasitism was detected at this site), 3.5% of the mortality may be attributed to *S. triangulifer.* This result is in general agreement with dissection results for the site (2.0%).

Parasitoids established in the U.S. were presented with potentially new host material when *H. axyridis* first appeared in this country. Initially, the tachinid *S. triangulifer* appeared to be taking advantage of the opportunity, as parasitism levels up to 31% were detected immediately after the coccinellid appeared in North Carolina. Since that time, however, parasitism has remained consistently low. Our results indicate that while there may have been an initial opportunistic response of the tachinid to abundant new host material, *H. axyridis* quickly became integrated into the complex food web of this highly polyphagous parasitoid. *Strongygaster traingulifer* is widely distributed (Stone et al. 1965, A Catalogue of the Diptera North of Mexico, USDA-ARS Agric. Handbook No. 276) and parasitizes adult beetles in a number of families, including Alleculidae, Chrysomelidae, Curculionidae, Elateridae, Halticidae, Lampyridae and Scarabaeidae, as well as Coccinellidae. There are records of parasitism among the Lepidoptera, Dermaptera and Hemiptera as well (Thompson 1954; Sabrosky and Braun 1970, Entomol. News 81: 185-187). Among hosts of *S. trangulifer* are insects both common and widespread in North Carolina, including cereal leaf beetle [*Oulema melanopus* (L.)], alfalfa weevil [*Hypera postica* (Gyllenhal)], Mexican bean beetle [*Epilachna varivestris* Mulsant] and bean leaf beetle [*Cerotoma trifurcata* (Förster)] (Wellso and Hoxie 1969, Ann. Entomol. Soc. Amer. 62: 923-924; Howard and Landis 1936, Parasites of the Mexican Bean Beetle in the U.S., USDA Circ. No. 418; Marrone et al. 1983, J. Georgia Entomol. Soc. 18: 359-363). *Strongygaster triangulifer* appears to have no problem in exploiting new hosts, as nine introduced insect species additional to *H. axyridis* are reported as parasitized by the tachinid (Smith and Kok 1983, Can. Entomol. 115: 1533-1534).

Some of the variation we observed in parasitism levels may be related to late season proximity of *H. axyridis* to alternate hosts of the tachinid. The *H. axyridis* in our study were probably parasitized at their feeding site, prior to fall flight; beetles collected as they arrive at aggregation sites contain well-developed tachinid larvae (Nalepa et al. 1996). Parasitism levels during spring and summer are unknown; however, *S. triangulifer* has been collected from *C. trifurcata* from May through July in North Carolina, with peak parasitism (7%) in June (Marrone et al. 1983), and from the clerid *Thanasimus dubius* (F.) in June and July (Turnbow and Franklin 1979, J. Georgia Entomol. Soc. 14: 174-177). Broad host ranges are typical for Tachinidae (Feener and Brown 1997, Ann. Rev. Entomol. 42: 73-97), and the impact on a particular victim species is influenced by the availability of alternative hosts (Holt and Lawton 1994). The range of dates on which *S. triangulifer* has been collected suggests it has several generations per year (Sabrosky and Braun 1970, Entomol. News 81: 185-187). Consequently, the parasitoid may shift sequentially among seasonally abundant hosts.

Reported levels of parasitism by *S. triangulifer* are generally low – 5% or less (Smith 1960, Can. Entomol. 92: 652; Williams et al. 1981, J. Kansas Entomol. Soc. 54: 521-522; Smith and Kok 1983; Purrington et al. 1990, Great Lakes Entomol. 23:

171-172), but levels of 20-21% have been noted in *T. dubius* and *H. postica* (Turnbow and Franklin 1979). Katsoyannos and Aliniazee (1998, Can. Entomol. 130: 905-906) reported that *H. axyridis* from two aggregation sites in Oregon were parasitized at 11.4% (n = 88 beetles dissected) and 15.4% (13 beetles) during 1997. Although levels may be relatively high in selected sites in certain years, our results suggest that, overall, parasitism of *H. axyridis* by *S. triangulifer* in autumn is not a significant source of mortality.

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