Phenology and Parasitism of Harlequin Bugs, *Murgantia histrionica* (Hahn) (Hemiptera: Pentatomidae), in Southwest Virginia[1]

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Abstract Field plots containing broccoli, mustard, and rape were sampled weekly between June and October in 1994 and 1995 to determine parasitism and phenology of the harlequin bug, *Murgantia histrionica* (Hahn) (Hemiptera: Pentatomidae). Naturally-occurring wild turnips also were sampled in early spring 1995 for harlequin bugs before cultivated crops were planted. Weekly samples of harlequin bug adults, egg masses, and nymphs were field collected and returned to the laboratory. They were maintained in the laboratory until emergence to recover parasitoids and to determine the parasitization rates. No adult or nymphal parasitoids were recovered. Two species, *Trissolcus murgantiae* Ashmead (Hymenoptera: Scelionidae) and *Ooencyrtus johnsoni* Howard (Hymenoptera: Encyrtidae), were identified as egg parasitoids. The overall parasitization rates for 1994 and 1995 were 8% and 37%, respectively. *Trissolcus murgantiae* was more common than *O. johnsoni* and accounted for 87% and 96% of the parasitization, respectively. This is the first record of *T. murgantiae* in Virginia. The harlequin bugs had two and a partial third generation a year. Overwintered adults oviposited on wild turnips, where the first generation completed development. The subsequent generation migrated to cultivated plants in June and July. The second generation completed development on cultivated crops producing the adults which overwinter.

Key Words *Murgantia histrionica, Trissolcus murgantiae, Ooencyrtus johnsoni,* harlequin bug, *Brassica* crops, biological control

The harlequin bug, *Murgantia histrionica* (Hahn) (Hemiptera: Pentatomidae), an exotic pest from Central America, was first recorded in the United States in 1864 (Walsh 1866). It overwinters south of the 40° N latitude, and individuals occurring north of the 40°N latitude are believed to be carried by wind currents or seasonal migration (Hodson and Cook 1960). It has a wide host range (McPherson 1982), including cabbages, collards, broccoli, mustard, turnip, radish, rape, and cauliflower as well as many wild plants (White and Brannon 1933).

The number of harlequin bug generations per year varies by location. In North Carolina, there are three and a partial fourth generation each year (Brett and Sullivan 1974). Chittenden (1908) speculated on the possibility of four or five generations in

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the South and two generations in the North, but information on the insect's phenology in Virginia is lacking.

Harlequin bugs have few natural enemies. In North Carolina, the two dominant egg parasitoids are *Ooencyrtus johnsoni* (Howard) (Hymenoptera: Encyrtidae) and *Trissolcus murgantiae* Ashmead (Hymenoptera: Scelionidae), with parasitization rates of 30% and 45%, respectively (Huffaker 1941). In Virginia, *O. johnsoni* was reported to parasitize between 35% to 55% of the eggs (Walker and Anderson 1933).

Maple (1937) provided the only documented study on the biology of *O. johnsoni.* Females may oviposit two or three eggs into each harlequin bug egg. An average of 2.05 parasitoid adults emerged per parasitized host egg. Parasitoid development is possible in eggs ranging from a few hours old up to less than 24 h before eclosion, with eggs in the advanced stage of development preferred.

Much less is known about *T. murgantiae,* which parasitizes the eggs of only the harlequin bug. It has been recorded in seven states (DeBach 1942; Drake 1920, Fullaway 1947, Miller 1971), including Maryland (Howard 1898) and North Carolina (Huffaker 1941).

The objectives of this study were to determine seasonality of the harlequin bug and its egg parasitoids and to evaluate levels of egg parasitism of the harlequin bug in Virginia.

Materials and Methods

Broccoli (*Brassica oleracea* 'Packman Hybrid'), mustard (*B. kabar* 'Southern Giant Curled'), and rape (*B. napus* 'Dwarf Essex') were planted in spring and fall at the Kentland Farm (VPI&SU) in Montgomery Co., VA, in 1994 and 1995. The field design consisted of four replicates, each containing three plots, mustard with broccoli, rape with broccoli, and broccoli alone. Plots were 8 m × 9 m. In 1994, the spring and fall plantings were 50 m apart. In 1995, the spring replicates were spaced 17 m apart with the fall replicates placed between the spring replicates. Twelve plants from each of the 12 plots were sampled weekly for harlequin bug eggs, nymphs, and adults. Sampling was conducted between early June and late October each year. Individuals were caged under laboratory conditions to observe parasitism. Sampling was discontinued once the adult population dispersed due to senescing host plants. The harlequin bug eggs in all treatments were combined to get an estimate of the rate of parasitization. Data from both years were used to determine harlequin bug population phenology and parasitism in the spring and fall plantings.

In addition, natural stands of wild turnip, *Brassica rapa* (L.), were sampled weekly from 3 April to 18 May during 1995. Six sites along a 0.5 km transect at the Kentland Farm were selected and four plants per site were selected each week and sampled for eggs, nymphs, and adults. Sampling was discontinued when the turnips senesced in late May.

To monitor harlequin bug egg parasitoids, eight egg masses were removed weekly from infested plants in each replicate between 26 July to 3 September in 1994 and between 3 August and 29 August in 1995. Each egg mass was placed in a 29-ml cup and stored in a growth chamber with 14-10 h photoperiod and 25°C, and monitored for hatch or for parasitoid emergence. Harlequin bug nymphs or parasitoids were removed as they emerged. Egg parasitoids were sent for identification at the USDA Systematic Entomology Laboratory, Taxonomic Services Unit in Beltsville, MD. Eggs that did not eclose were checked for signs of being preyed upon by a predator with

piercing-sucking mouthparts. If no signs of predation were evident, the eggs were dissected to determine if they were parasitized, infertile, or that the harlequin bug nymph died before eclosion. Eggs which were infertile or produced nymphs that died were considered as unhatched.

Results and Discussion

Harlequin bug seasonality. One distinct harlequin bug generation was identified in 1994. The first harlequin bug adults were observed in late June and their population peaked in early August (Fig. 1A). A few adults were observed at the beginning of October and may suggest a small second generation. Nymphs were recorded from mid-June through mid-October. Most of these nymphs were progeny from the first-generation adults, although some may have been from second-generation adults.

One distinct oviposition peak was recorded in 1994. Eggs were first detected in late June in low numbers and, as the adult population increased in August, so did the number of egg masses. The few eggs oviposited in September may have been from newly-emerged adults or from first-generation adults. It is doubtful that nymphs emerging in late September would have been capable of reaching the adult stage before winter. These data indicate that there is at least one generation of harlequin bugs on planted crops in Montgomery Co., with the possibility of a partial second generation.

In 1995, three peaks in the adult population were observed (Fig. 1B). In mid-April the first peak occurred on wild turnips. These were likely overwintered adults. The next two peaks occurred in early August and late September. The first peak in the nymphal population occurred in mid-May and the second occurred in mid-August.

Two oviposition peaks were observed in 1995. The first peak occurred in mid-April, resulting from eggs oviposited by the overwintered adults. The second oviposition peak occurred in mid-August, showing the same trend as in 1994.

Two distinct generations were identified in 1995. The first generation developed on wild turnips, which were not sampled the first year. Adults emerged at about the beginning of April, beginning of July, and mid-September. The resulting egg masses showed peaks occurring in mid-April and mid-August. It is possible that adults in the second generation, which reached reproductive maturity early, may have oviposited. Nymphs from these eggs would account for a partial generation because they would not have a chance to develop to the adult stage before overwintering.

Thus, the data indicate that harlequin bugs had two and possibly a partial third generation a year in southwest Virginia. Overwintered harlequin bug adults oviposited on wild turnips where the first generation completed development. The subsequent generation migrated to cultivated plants in June and July. The second generation completed development on the cultivated crops producing the adults which overwinter. In both years, few eggs were oviposited by these overwintering adults, and the resulting nymphs probably did not develop to the adult stage before winter.

Harlequin bug egg parasitoids. No parasitoids of nymphs or adults were recovered, but two parasitoid species were recovered from eggs on the spring plantings of rape plants that had consistently high levels of eggs. The two species of egg parasitoids were *T. murgantiae* and *O. johnsoni.*

In 1994, the parasitization rate was below 10% for three of the first four wks (Fig. 2A). The parasitoid populations increased towards the end of the sampling periods; parasitization rates were 21% and 40% for August 26 and September 3, respectively.

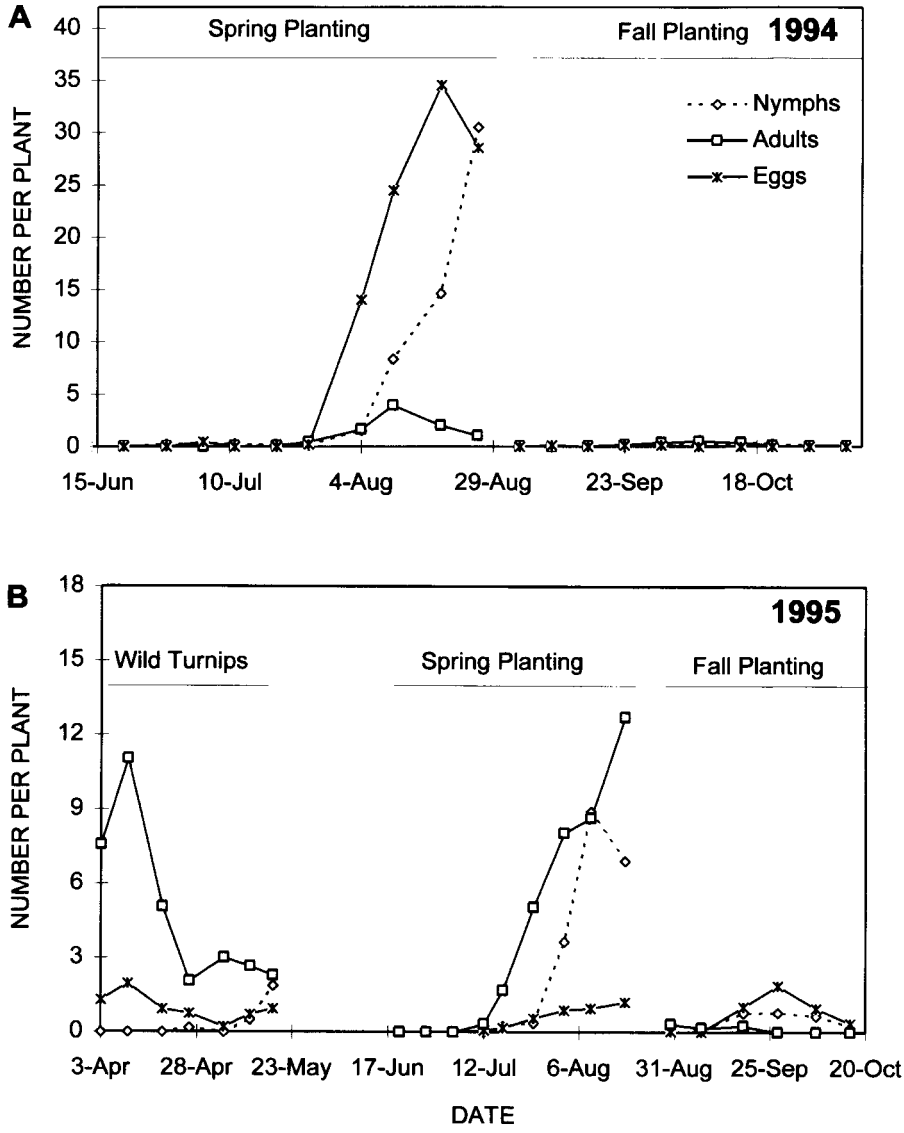

Fig. 1. Seasonal abundance of harlequin bugs in (A) 1994 and (B) 1995.

Of all the eggs collected (n = 1936), 77% hatched, 8% were parasitized, and 15% that did not hatch were not parasitized.

Trissolcus murgantiae, collected on 26 August and 3 September, caused 19% and 21% mortality, respectively (Table 1). This was the first documented occurrence of *T. murgantiae* in Virginia. *Ooencyrtus johnsoni* was collected every week except 10 August, but caused <4% egg mortality. In an earlier study in Virginia, Walker and

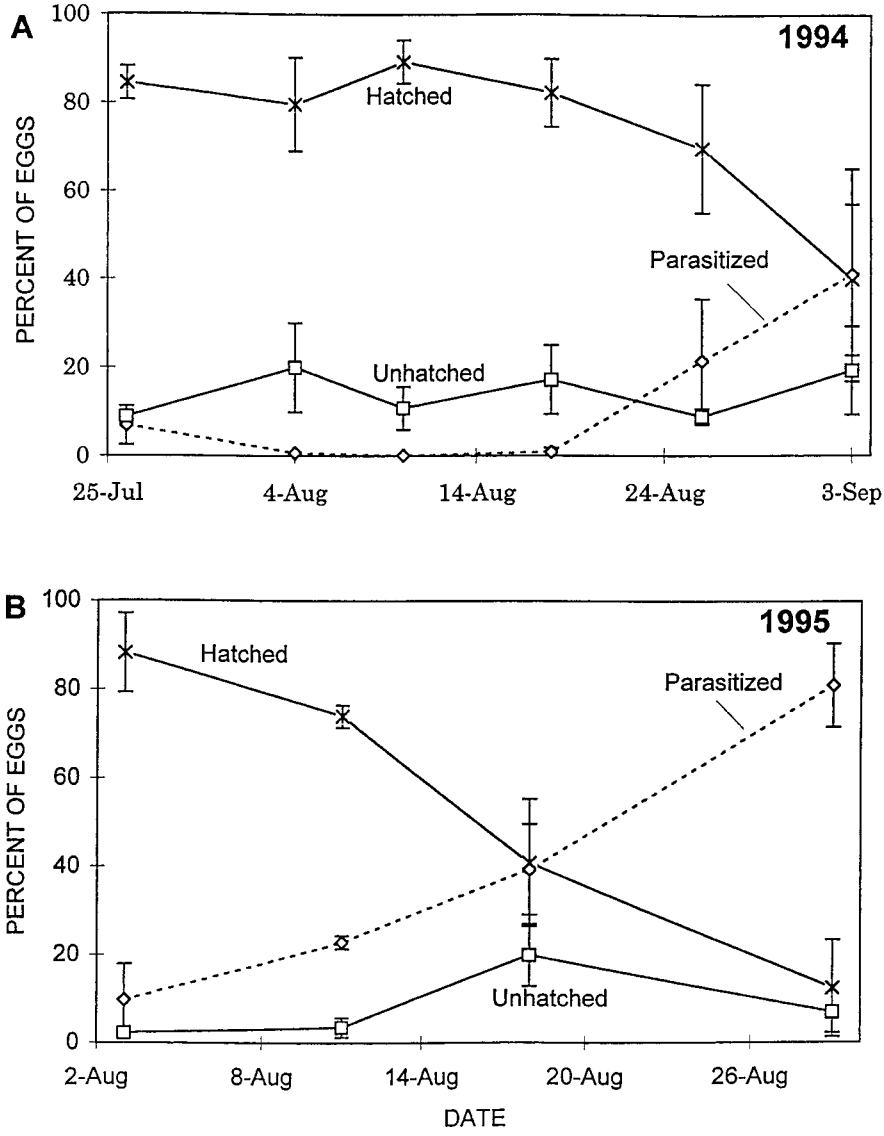

Fig. 2. Percent of hatched, unhatched and successfully parasitized harlequin bug eggs in (A) 1994 and (B) 1995.

Anderson (1933) recovered *O. johnsoni*, but not *T. murgantiae*. The arrival of *T. murgantiae* may have allowed it to displace *O. johnsoni* as the dominant parasitoid species.

A difference was noted in how the parasitoids exited the host. *Trissolcus murgantiae* chewed a hole through the top of the egg, whereas *O. johnsoni* exited by chewing

Table 1. Percent of eggs parasitized by *T. murgantiae* and *O. johnsoni*

Date	Percent parasitism ± SEM*	
	T. murgantiae	*O. johnsoni*
1994		
26 July	0.00	2.78 ± 0.02
4 August	0.00	0.69 ± 0.01
10 August	0.00	0.00
18 August	0.00	0.91 ± 0.01
26 August	19.49 ± 0.13	1.90 ± 0.01
3 September	21.09 ± 0.20	3.70 ± 0.04**
1995		
3 August	8.60 ± 0.09	1.05 ± 0.01**
11 August	20.98 ± 0.03	1.75 ± 0.02**
18 August	38.26 ± 0.10	1.06 ± 0.01**
29 August	77.62 ± 0.07	2.30 ± 0.01

* 4 replicates, **3 replicates, 8 egg masses/replicate.

a hole in the side of the egg. *Trissolcus murgantiae* is larger than *O. johnsoni,* and only one adult developed per host egg, suggesting that *T. murgantiae* is a solitary parasitoid. For *O. johnsoni,* 60 adults were collected from 37 host eggs for a ratio of 1.6 adults per egg in 1994, and 1.9 adults per egg in 1995 (32 adults from 17 host eggs). These were slightly lower than that observed by Maple (1937) who reported 2.05 *O. johnsoni* adults emerged per host egg under laboratory conditions. It is known that gregarious reproduction occurs in *O. johnsoni* in which 2 to 3 eggs are laid in each host egg (Maple 1937), but the number of eggs per host egg for *T. murgantiae* is not known.

In 1995, parasitism was higher than in 1994 (Fig. 2B). Of the total (n = 1068), 55% of the eggs hatched, 8% did not hatch, and 37% were parasitized. Both *T. murgantiae* and *O. johnsoni* were collected each week. Parasitization rates of *T. murgantiae* increased from 8% to 78% over the sample period (Table 1). Although *O. johnsoni* also was present during the entire period, it caused only 1 to 2% mortality.

The increased parasitization rates in 1995 could have been a result of the *Brassica* species that were present the previous year. In 1993, the research plots were planted in corn and the harlequin bug and parasitoids migrated into the research plots from outside the immediate area in 1994. In 1995, the overwintered harlequin bugs from 1994 may have been successful in locating the new *Brassica* crop fields. The earlier colonization may have changed the host egg availability or the initial parasitoid foraging activity, either of which may have changed the parasitization rates.

Our results indicate that the egg parasitoids did not significantly reduce the harlequin bug populations. Mortality of the harlequin bug eggs was due to parasitism or

failure to hatch. The latter accounted for <20% egg mortality in both years. In 1994, except for final sampling date, the percentage of eggs parasitized was lower than the unhatched. In 1995, the percentage of parasitized eggs increased and was greater than the unhatched eggs all 4 wks, with the parasitization rate exceeding 80% by August 29. However, this high rate of parasitization occurred only towards the end of the harlequin bug egg oviposition period and had little effect on its population. Thus, timing is important as the parasitoids are capable of parasitizing a large number of eggs. Ideally, if parasitoid releases are timed to coincide with the start of harlequin bug oviposition, they could be useful in reducing harlequin bug populations. To ensure that augmentative parasitoid releases are synchronized with harlequin bug populations, more information is needed on the reproductive biology, life history, and foraging behavior of the parasitoids.

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