Biology of the Yellowmargined Leaf Beetle (Coleoptera: Chrysomelidae) on Crucifers[1]

Abdullahi O. Ameen and Richard N. Story[2]

Department of Entomology
Louisiana Agricultural Experiment Station
Louisiana State University Agricultural Center
Baton Rouge, LA 70803 U.S.A.

J. Entomol. Sci. 32(4): 478-486 (October 1997)

ABSTRACT Multi-generation survivorship, developmental biology, fecundity, and adult longevity of the yellowmargined leaf beetle, *Microtheca ochroloma* Stål, were studied in the laboratory on cabbage, *Brassica oleracea* var. *capitata* L., collard, *B. oleracea* var. *acephala* L., mustard, *B. juncea* Cosson, turnip, *B. rapa* L., and radish, *Raphanus sativus* L. Host plant significantly affected multi-generation survivorship; survivorship was 0% on cabbage but >70% on the other hosts when tests were terminated in the fourth generation. Duration of development of life stages and total duration of development from oviposition to adult emergence did not vary significantly with host at 20°C. The latter averaged 27 d among hosts. Development averaged 7.8 d for eggs, 10 d for the four larval instars, 3 d for prepupae, and 5.6 d for pupae. Fecundity and adult longevity were significantly affected by host plant. Egg numbers per female were significantly higher on turnip than on collard but did not differ significantly among cabbage, mustard and radish. Sex did not affect longevity, but beetles lived significantly longer on radish than cabbage, collard, mustard, or turnip.

KEY WORDS *Microtheca ochroloma*, Chrysomelidae, survivorship, developmental biology, fecundity, longevity, Cruciferae

The yellowmargined leaf beetle, *Microtheca ochroloma* Stål, is indigenous to South America. It was accidentally introduced into the USA circa 1945 (Chamberlin and Tippins 1948). Both adults and larvae are defoliators of crucifers (Chamberlin and Tippins 1948, Woodfruff 1974, Oliver and Chapin 1983). Most reports on the beetle focused on its geographical distribution in the United States and host associations in the field (Chamberlin and tippins 1948, Haeussler 1951, Oliver 1956, Spink 1959, Balsbaugh 1978). Field infestations have been reported from locations in AL, FL, LA, MS, and TX on cabbage, *Brassica oleracea* var. *capitata* L., collard, *B. oleracea* var. *acephala* L., mustard, *B. juncea* Cosson, turnip, *B. rapa* L., radish, *Raphanus sativus* L., watercress, *Nasturtium officinale* R. Brown (Chamberlin and Tippins 1948, Rohwer et al. 1953, Woodruff 1974, Balsbaugh 1978, Oliver and Chapin 1983).

[1] Received 19 December 1996; Accepted for publication 26 June 1997.
[2] To whom correspondence should be addressed.

There is little information on the biology of this beetle despite its wide distribution in southeastern United States and its potential for damage to crucifers. Oliver and Chapin (1983) reported the biology of the beetle on turnip. Similar information is needed for other crucifer crops on which field populations have been found. These data will be useful in assessing the relative suitability of each crop as a host and, hence, contribute to an assessment of potential beetle populations on field plantings. We report the results of laboratory studies on the multi-generation survivorship, developmental biology, fecundity and adult longevity of *M. ochroloma* on cabbage, collard, mustard, radish and turnip.

Materials and Methods

Insects and host plants. A laboratory colony was initiated from beetles collected on mustard (cv 'Florida Broadleaf') at the St. Gabriel Research Station, Louisiana State University Agricultural Experiment Station, Iberville Parish, LA in the fall of 1992. A total of 291 specimens was collected at five weekly intervals between 23 September and 30 October 1992. To this colony was added a total of 87 beetles collected from a second mustard plot at the same location on 13 November 1992, 18 January, and 25 January 1993.

In the laboratory, specimens were sorted and placed in groups of ten on a moistened white filter paper (90 mm diam) in Petri dishes (100 mm × 15 mm). These paper-lined dishes were used throughout the study as test arenas as well as to maintain colonies. The colony was reared continuously for about 11 generations on mustard foliage obtained from the field. All insects were held in growth chambers maintained at 20°C and a photoperiod of 14:10 (L:D) h. The RH was 50% except in growth rooms used for colony rearing and determination of multi-generation survivorship where RH was 70%.

To study the biology of the beetle on the five crucifer host plants, a source of insecticide and disease-free foliage was established by raising the plants in a greenhouse. The cultivars 'Early Round Dutch' cabbage, 'Georgia' collard, 'Florida Broadleaf' mustard, 'Scarlet Globe' radish, and 'Purple Top White Globe' turnip were used. Plants were raised on a Jiffymix® medium (Jiffy Products of America, Inc., Batavia, IL) in Jiffypots® (about 6.4 cm^2) (Jiffy Products of America, Inc., Batavia, IL) and fertilized on alternate days using Miracle-Gro® (Stern's Miracle-Gro Products, Inc., Port Washington, NY), a 20:20:20 water soluble, NPK fertilizer mixture. New plantings were made every 10 d to ensure that young foliage (3 to 5 wk) was continuously available.

Multi-generation survivorship. Multi-generation survivorship was studied by rearing each of five beetle groups on one of the five host plants through successive generations. The number of larvae (or eggs in the F_1 generation) that survived to pupate and of pupae that emerged as adults were recorded by host plant at each generation. To begin the study, >350 eggs were collected from beetles in the mustard-reared colony when it contained about 500 beetles (with about 60% females). Five groups of forty eggs were randomly selected, transferred into Petri dishes, allowed to hatch, and larvae were maintained on the foliage of assigned plant until pupation. The eclosing F_1 adults were held in mixed-sex pairs and supplied with fresh foliage. To have an adequate number (≥50) of these F_1 adults by host-plant treatment, the rearing process was repeated with a second batch of 200 eggs collected from beetles in the mustard-reared colony. From both groups of F_1 adults, eggs were collected daily, pooled (in dishes provisioned with host foliage), and allowed to hatch until 100 first instars were obtained. Rearing from larva to adult was continued by host-plant treatment until the fourth generation, starting each generation with 100 first instars.

Life cycle and duration of development. To study the life cycle and duration of development from egg to adult emergence on the five crucifer host plants, 500 eggs collected from beetles in the mustard-reared colony ewre randomly divided into five groups and each group randomly assigned to host-plant treatment. Beetles that had been reared on the assigned host plant for one generation were held in mixed-sex pairs (>60 pairs/treatment) and fed foliage until oviposition. All eggs laid during the next 24 h were collected and discarded at which time fresh filter paper and foliage were supplied. After another 24 h, 10 eggs selected at random from each plant group (>100 eggs/group) were transferred to individual dishes. Dishes were arranged by treatment in covered plastic storage containers (10 × 15 × 30 cm) filled with water to a depth of 1 cm to maintain RH above 50%. Dishes in each box were placed on a cardboard platform supported approximately 6 cm above water level. When the larvae eclosed, they were supplied with a leaf disc (15 cm^2) of the appropriate plant. Leaf discs and filter papers were changed daily between 1000 and 1200 h during which beetles were checked for mortality or molting. The presence of an exuvium was used as an indication of larval molting. The number of days between successive molts was used to calculate the duration of life stages. The experiment was replicated three times, although sample size was increased to 20 after the first replication.

Fecundity and longevity. Fecundity and longevity data were collected from beetles that had been preconditioned to host plant for at least two generations in the laboratory. To begin the study, 500 eggs collected from beetles in the mustard-reared colony were divided into five groups, and each group randomly assigned to a host plant, on which they were reared for two generations. As soon as the second-generation adults emerged, 20 1-d-old beetles of each sex were randomly selected by host-plant treatment and transferred in mixed-sex pairs to covered dishes. Dishes were arranged by treatment in plastic storage containers (10 × 15 × 30cm) in a Hotpack® incubator (Hotpack Co., Philadelphia, PA). Pairs were supplied with a leaf disc (15 cm^2) of the appropriate plant, and the eggs oviposited by each female were carefully collected and counted. Fecundity was determined from the total number of eggs oviposited by a female and longevity as days from adult emergence until death per host-plant treatment. Fertility of these eggs was also determined.

Analysis of data. Host plant effects on development time from oviposition to adult emergence were analyzed with analysis of variance appropriate for a randomized complete block design (PROC GLM [SAS Institute 1989]). Analysis of variance also was used to examine host-plant effects on fecundity and adult longevity and included sex as well as host plant effects on longevity, although the design was completely randomized (PROC ANOVA [SAS Institute 1989]). Means were separated using the Tukey test (SAS Institute 1989).

Results

The yellowmargined leaf beetle survived for more than 11 successive generations on mustard and was reared continuously for 4 generations on collard, radish, and turnip (Table 1). On cabbage, however, survivorship was limited to only 3 generations (Table 1).

Duration of life stages was not significantly affected by host plant and averaged 7.8 d for eggs, 10 d for the larval instars, 3 d for prepupae, an 5.6 d for pupae (Table 2). About 5% of larvae exhibited a fifth instar. Duration of development from egg to adult did not vary significantly with host plant ($F = 1.34$; df = 4; $P = 0.3353$), or sex ($F = 0.03$; df = 1; $P = 0.8764$) and averaged 27 d across hosts (Table 2).

Host plant did significantly affect fecundity ($F = 3.90$; df = 4; $P = 0.0057$) and adult longevity ($F = 11.40$; df = 4; $P = 0.0001$). The mean number of eggs oviposited per female was higher by nearly 300 on turnip than on collard but did not otherwise vary significantly with host plant (Fig. 1). Egg number oviposited by an individual female ranged from a high of 1,497 on turnip to a low of 10 on collard. Egg hatch (N) was consistently high, 98.7% (952) on cabbage, 99.1% (934 on collard, 99.0% (1823) on mustard, 99.1% (2722) on radish, and 99.0% (2424) on turnip. Adult longevity was unaffected by sex; no significant main effect ($F = 0.53$; df = 1; $P = 0.4677$), or interaction with host plant was detected ($F = 0.51$; df = 4; $P = 0.7301$). Longevity ranged from a high of 186 d on radish to a low of 16 d on collard (Fig. 2).

Discussion

Our research demonstrated that *M. ochroloma* can survive, complete its life cycle, and oviposit fertile eggs when fed cabbage, collard, mustard, and radish. Oliver and Chapin (1983) reported similar results for turnip. However, we found turnip, mustard, and radish were better hosts for *M. ochroloma* than collard and cabbage. These findings suggest that field plantings of turnip, mustard, and radish may prove more susceptible to beetle infestations than plantings of cabbage and collard. Though there are no quantitative data to support this suggestion, there have been reports of higher population density of *M. ochroloma* on field plantings of turnip and mustard relative to the other crucifers in many locations in southeastern United States (Haeussler 1951, Rohwer et al. 1953, Oliver and Chapin 1983). Chamberlin and Tippins (1948) further reported that a higher population density of the beetle was found in a smaller acreage of turnip though there was a larger acreage of young tender cabbage plants nearby in a vegetable farm at Theodore, AL. In addition, our unpublished data collected from field plots in the East Baton Rouge Parish of Louisiana between 1992 and 1995 revealed a higher population density of the beetle on mustard and turnip relative to cabbage and collard.

We conclude that, though *M. ochroloma* can survive, complete development, and oviposit fertile eggs when fed the foliage of cabbage, collard, mustard, radish, and turnip, these plants differ in their suitability as hosts. Mustard, radish, and turnip are considered better hosts than cabbage and collard because the former yielded higher fecundity or longer survivorship. Further research is needed to assess crop damage from *M. ochroloma* to clarify its pest status in southeastern United States.

Table 1. Multi-generation survivorship of yellowmargined leaf beetle on cabbage, collard, mustard, radish and turnip.

	Percent survivorship by generation							
	F_1		F_2**		F_3**		F_4**	
Plant	Pupa	Adult	Pupa	Adult	Pupa	Adult	Pupa	Adult
Cabbage	85	77	79	71	06†	02	00	00
Collard	90	81	85	78	88	81	80	74
Mustard	96	92	91	88	93	86	89	81
Radish	91	87	89	86	89	80	85	79
Turnip	95	88	90	84	92	81	90	81

*% survivorship starting with 80 eggs per host plant, collected from a mustard-reared colony maintained for >11 generations.
**% survivorship starting with 100 first instars collected from adults of the previous generation by host-plant treatment.
†On cabbage, two separate batches of 100 first instars were reared from the F_2 generation.

Table 2. Life cycle and duration of development of the yellowmargined leaf beetle on cabbage, collard, mustard, radish and turnip, n = 50.

Life Stages*	Mean duration of development (d) (± SE)				
	Cabbage	Collard	Mustard	Radish	Turnip
Egg	7.8 ± 0.1 (48)	7.7 ± 0.1 (49)	7.8 ± 0.1 (47)	7.9 ± 0.1 (49)	7.8 ± 0.1 (48)
1st Instar	3.0 ± 0.1 (47)	2.6 ± 0.1 (48)	2.7 ± 0.1 (47)	2.7 ± 0.1 (49)	3.1 ± 0.1 (48)
2nd instar	2.1 ± 0.1 (47)	2.3 ± 0.1 (48)	1.9 ± 0.1 (47)	2.2 ± 0.1 (48)	1.9 ± 0.1 (47)
3rd instar	2.2 ± 0.1 (47)	2.1 ± 0.1 (48)	2.4 ± 0.1 (47)	2.3 ± 0.1 (48)	2.2 ± 0.1 (47)
4th instar	3.7 ± 0.1 (46)	3.7 ± 0.1 (46)	3.6 ± 0.1 (47)	3.3 ± 0.1 (46)	3.1 ± 0.1 (44)
5th instar	4.0 ± 0.0 (2)	3.7 ± 0.3 (3)	4.0 ± 1.0 (2)	–	3.5 ± 0.5 (2)
	Total larval development				
	11.0 ± 0.2	10.7 ± 0.2	10.6 ± 0.2	10.4 ± 0.3	10.3 ± 0.2
Prepupa	3.1 ± 0.1 (43)	3.1 ± 0.1 (45)	3.0 ± 0.1 (45)	3.2 ± 0.1 (46)	2.9 ± 0.1 (44)
Pupa	5.6 ± 0.1 (43)	5.6 ± 0.1 (43)	5.6 ± 0.1 (44)	5.6 ± 0.1 (46)	5.6 ± 0.2 (44)
	Total duration of development*				
	27.5 ± 0.4	27.1 ± 0.4	27.0 ± 0.4	27.2 ± 0.3	26.6 ± 0.4

Values in parentheses are number of surviving individuals.

*No significant effect of host-plant on duration of development of life stages or on total duration of development (α = 0.05; Tukey test [SAS Institute 1989]).

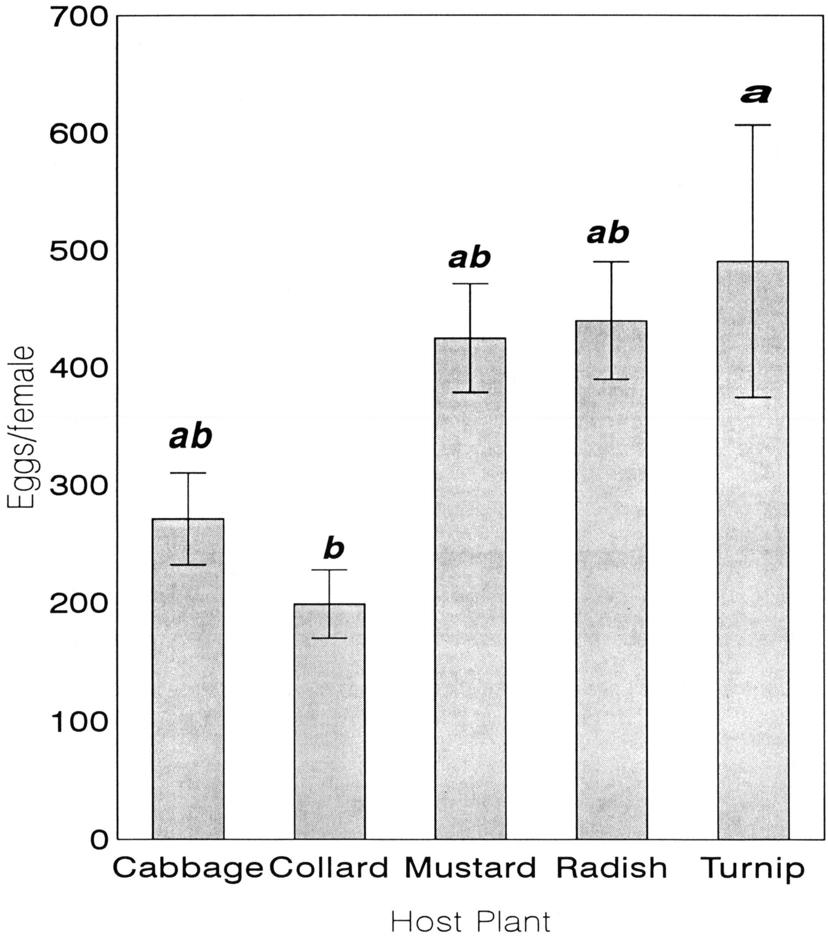

Fig. 1. Fecundity of the yellowmargined leaf beetle on cabbage, collard, mustard, radish and turnip. (Bars reflect x ± SEM). Means having the same letter(s) are not significantly different (Tukey test at ∝ = 0.05).

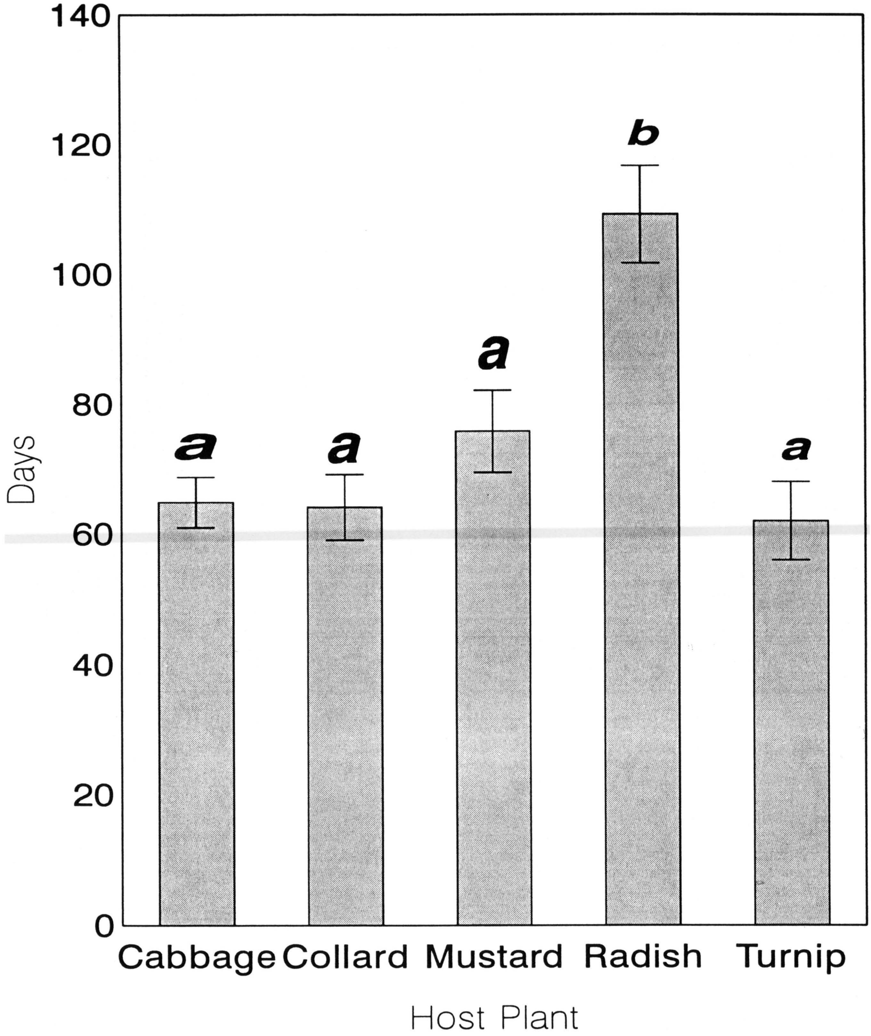

Fig. 2. Longevity of adult yellowmargined leaf beetle on cabbage, collard, mustard, radish and turnip. Pooled data because sex did not significantly affect longevity ($\propto$ = 0.05). (Bars reflect x ± SEM). Means having the same letter are not significantly different (Tukey test at $\propto$ = 0.05).

Acknowledgments

We thank F. S. Guillot, S. J. Johnson, A. M. Hammond, and two anonymous reviewers for their critical review of the manuscript. Approved for publication by the Director, Louisiana Agricultural Experiment Station as Manuscript number 96-17-0173.

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