BIONOMICS OF *SCYMNUS MARGINICOLLIS* (COLEOPTERA: COCCINELLIDAE)[1]

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Abstract

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Scymnus marginicollis Mannerheim was reared on green peach aphids, *Myzus persicae* (Sulzer). At 20°-25°C and a 16-h photoperiod, durations of egg, larval, and pupal stages were about 5, 10, and 7 days, respectively. Adults survived more than 80 days. The ingestion of wax-producing prey was not required for the beetle larvae to produce their woolly wax covering. Larvae fed exclusively by sucking fluids from appendages of the aphid prey. The coccinellid consumed about 16 adult aphids during the larval stage. Adults fed on fluids and tissues of *M. persicae*. Female adults consumed about five aphids per day, nearly twice as many as did males. The beetle populations increased in July and reached peak abundance in August. The seasonal trend of *S. marginicollis* suggests one generation per year.

Résumé

Scymnus marginicollis Mannerheim a été nourrie de puceron vert du pêcher, *Myzus persicae* (Sulzer). A 20°-25°C et sous 16 h de photo-période, la durée des stades œuf, larvaires et nymphal a été d'environ 5, 10 et 7 jours respectivement. Les adultes ont survécu pendant plus de 80 jours. L'ingestion de proies produisant de la cire n'a pas été nécessaire aux larves du coléoptère pour la production de leur propre revêtement cireux. La coccinelle a consommé environ 16 adultes du puceron au cours de sa vie larvaire. Les adultes se sont nourris des tissus et fluides corporels de *M. persicae*. Les femelles adultes ont consommé environ 5 pucerons par jour, soit presque 2 fois plus que les mâles. Les populations du coléoptère ont augmenté en juillet, atteignant leur somme d'abondance en août. La tendance saisonnière de *S. marginicollis* semble indiquer qu'il y a une génération par année.

Scymnus (Pullus) marginicollis Mannerheim is a small, black coccinellid commonly observed feeding on the green peach aphid, *Myzus persicae* (Sulzer), on sugarbeet. Little has been published on this species.

Hatch (1961) reported variability in choice of prey by Scymninae with 62% preferring coccids and 23% preferring aphids. Essig (1913, 1958) reported *S. marginicollis* as a predator of aphids, coccids, and mites. Whitehead (1967), who suggested that Essig may have mistaken *Lindorus lophanthae* (Blaisdell) for *S. marginicollis*, found that *S. marginicollis* is an aphid predator; in his study, adult beetles fed on pea aphids, *Acyrthosiphon pisum* (Harris), from alfalfa, but would not accept cabbage aphids, *Brevicoryne brassicae* (L.).

Two subspecies of *S. marginicollis* were recognized by Hatch (1961): *S. marginicollis borealis* Hatch which is common in Idaho, Oregon, Washington, and British Columbia, and *S. marginicollis marginicollis*, which is rare and confined to Idaho and Oregon. Gordon (1976) considered Hatch's subspecies to be synonymous. With the exception of *S. marginicollis* collected in California by Whitehead (1967), specimens collected outside the Pacific Northwest are attributed to accidental introduction in produce shipments (Gordon 1976).

Most of this study concerns the bionomics of *S. marginicollis* and the construction of a life table. The feeding potential of this predator on *M. persicae* was evaluated and its seasonal abundance on sugarbeet was determined.

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Materials and Methods

Investigations were conducted at the Yakima Agricultural Research Laboratory, Yakima, Washington, during 1976. In June, adult *S. marginicollis* were collected by sweeping untreated alfalfa, red clover, spearmint, and sugarbeet, and used as parental stock for the experiments.

Laboratory experiments were conducted in a growth chamber at 16:8 h photophase:scotophase and 20°–25°C. The daily temperature range was less than 2°C. Relative humidity varied from 50% to 60%.

A continuous supply of *M. persicae* was available from a colony maintained on young sugarbeet plants in a greenhouse.

Individual adult beetles were caged in transparent plastic 0.95-l. containers, 12 cm in diameter with a screw cap. A 7-cm hole in the cap was covered with organdy mesh for air circulation. A sugarbeet leaf was inserted into the hole near the bottom of the cage. The petiole of the leaf was wrapped with soft plastic foam to fill the remainder of the hole to prevent beetles from escaping.

Field-collected adult beetles were sexed, paired, and placed in containers for mating. Males were removed after 1 week. Food was excess numbers of *M. persicae* replenished daily, and a drop of honey on the container cap. Eggs were removed daily and placed on moistened filter paper in separate petri dishes. Incubation periods were recorded. Each neonate larva was placed in a separate petri dish containing a young sugarbeet leaf and five apterous adult *M. persicae*. Wetted cotton wrapped around the petiole supplied moisture to the leaf. After 24 h, dead aphids were removed and new ones added. Twenty petri dishes containing aphids but no predators served as control. Ninety larvae of *S. marginicollis* were observed daily.

Head capsules were measured. Pupation and adult emergence were also recorded.

To determine the amount of feeding by adult *S. marginicollis* on *M. persicae*, 5 ♀ and 5 ♂ newly emerged beetles were each placed in separate containers and supplied daily with 10 apterous adult *M. persicae*. Five containers with aphids but no beetles served as controls. Dead aphids and new nymphs were counted, recorded, and removed daily for 28 days as described above.

Daily sweep-net samples were taken in late June and continued for 65 days. Plots of sugarbeet, red clover, spearmint, and alfalfa were sampled (50 sweeps per plot) daily from 1:00 to 2:30 P.M. Temperature and relative humidity were recorded on an hygrothermograph in a standard weather shelter in a central area.

Intensive daily observations were made on sugarbeet. The presence of aphids and all stages of *S. marginicollis* were noted on five randomly chosen plants. A white drop cloth was placed on the ground around the base of each plant to detect insects dropping from the leaves.

Results and Discussion

Eggs. The pale yellow-green eggs were usually deposited singly but occasionally in clusters of 2 to 4. Dimensions of the eggs were 0.2 by 0.5 mm. Dark pigmentation of the embryonic mandibles and stemmata was visible through the chorion within 4 days of oviposition. Hatch occurred at approximately 5 days.

In the laboratory, most eggs were laid in the pores of the foam around the plant stem rather than on the plant or the container. This suggests that the natural oviposition site is the debris at the base of the plant. Davidson (1923) reported similar behavior in laboratory-reared *Scymnus loewii* Mulsant (= *S. nubes* Casey), although Tawfik *et al.* (1973*a*) found that other *Scymnus* spp. laid eggs on the plant and the container.

Larvae and pupae. At hatching, the chorion split at one end and the halves were forced apart for half the length of the egg. The empty chorion was translucent white. Neonate larvae had no wax covering and were pale yellow-green. Larvae were inactive for 4 to 12 h. Within 24 h of eclosion, white spots of wax emerged from the dorsal pores and soon developed into woolly filaments. Some first instar larvae did not feed until after wax had formed; their wax covering could not have been derived from their food source, as proposed by Brues (1946) and Balduf (1935).

There were four larval instars. Unlike newly hatched larvae, larvae did not rest after molting. The prepupal occupied the latter part of the fourth stadium. Mature larvae became sluggish and fastened their caudal end to the substrate. The body shortened and thickened beneath the protective wax filaments. The cuticle split mid-dorsally at pupation, but the pupa remained within the fourth-instar cuticle. Pupae were inactive. The characteristic thrashing of coccinellid pupae noted by Balduf (1935) was not evident even with teasing.

The durations of immature stages (Table I) are similar to those of other *Scymnus* species (Davidson 1923; Tawfik *et al.* 1973*a*). Development from oviposition to adult eclosion took about 22 days.

The head capsule widths of the larval instars are given in Table II.

S. marginicollis larvae fed by sucking body fluids from the legs, antennae, or cornicles of their prey. Small larvae readily attacked large aphids. If the aphid attempted to escape, the larva maintained its grip and was dragged about until the aphid weakened. Large larvae attached themselves to the substrate by their caudal suctorial disc and were not dislodged. Feeding continued until the prey resembled a cast skin.

First instars occasionally preyed on eggs. According to Brown (1972), cannibalism occurs frequently among coccinellids that lay eggs in clusters. Eggs of *S. marginicollis* are normally laid singly and the cannibalism we observed may have been a laboratory artifact.

First instars did not feed on adult *M. persicae*. The total consumption of 16 aphids during the larval stage (Table III) is substantially smaller than that recorded for other coccinellids. Larger coccinellid species may consume up to 600 aphids

Table I. Duration of immature stages of *Scymnus marginicollis* reared on *Myzus persicae* (at 20°–25°C)

Immature stage	No.	Duration in days (mean ± S.E.)
Egg	600	5.32 ± 0.03
Larva I	70	2.20 ± 0.06
Larva II	61	1.64 ± 0.08
Larva III	65	2.03 ± 0.07
Larva IV	66	3.77 ± 0.10
Pupa	64	6.59 ± 0.17

Table II. Head capsule widths of larval instars of *Scymnus marginicollis* instars

Larval instar	No.	Width in mm (mean ± S.E.)
1	73	0.20 ± 0.05
2	67	0.26 ± 0.04
3	69	0.33 ± 0.02
4	60	0.40 ± 0.05

during their larval stage (Clausen 1916). *S. interruptus* (Goeze) consumes more than 200 *Aphis punicae* Pass. (Tawfik *et al.* 1973*b*). The small size of *S. marginicollis* larvae and their habit of totally consuming the prey's body fluids would account for the low number of aphids they consume. In addition, the average daily consumption by second, third, and fourth instars was 1.25, 2.25, and 2.58 aphids, respectively.

Adults. *S. marginicollis* adults are recognizable as the only black, pubescent *Scymnus* species of their size in the Pacific Northwest (Gordon 1976). Males can be distinguished from females by the presence of a tubercle on the first abdominal sternite.

Adults usually attacked aphid prey from behind and above, removing fluids and tissues and discarding the venter, head, and appendages. Female *S. marginicollis* consumed an average of 5.27 and males 2.74 aphids/day, corrected for the number of aphids dying from other causes.

Life table. The population statistics of *S. marginicollis* (Table IV) were calculated from a life table based on daily observations. The data are graphically represented in Fig. 1. Mortality of eggs was 19%. Mortality of larvae was 8%, most of which was of first instars. On the 23rd day when adult emergence began, generation mortality was 31%. Oviposition began on the 26th day and continued to the 88th day; it reached a maximum on the 42nd day.

The intrinsic rate of increase (r_m) was calculated (Table IV) by combining the reproduction and mortality data for the population, using methods given by Birch (1948) and Krebs (1972). The r_m = .089 applies to a population reared under the conditions of these experiments. A change in the availability of prey, temperature, relative humidity, or other environmental conditions could change the value of r_m.

Field observations. *S. marginicollis* adults were present in the field in early June when observations began and were continuously present on all crops throughout the summer, regardless of food availability, relative humidity, or extremes in temperatures. The majority of beetles were swept from alfalfa and red clover. The combined summary of *S. marginicollis* adults collected daily from two spearmint, three alfalfa, one red clover, and one sugarbeet plots showed peaked adult density occurred in

Table III. Total number of adult *Myzus persicae* consumed by *Scymnus marginicollis*

Larval instar	No. of dead and killed aphids (mean ± S.E.)	Minus no. of dead aphids/control	= No. of aphids consumed	% of total aphids consumed
1	2.20 ± 0.20	2.38	0.00	0.00
2	3.82 ± 0.28	1.77	2.05	12.56
3	6.75 ± 0.07	2.19	4.56	27.94
4	13.78 ± 0.46	4.07	9.71	59.50

Table IV. Population statistics of *Scymnus marginicollis* reared on *Myzus persicae* at 20°-25°C and a 16-h photoperiod

Parameter	Formula	Value
Intrinsic rate of increase (r_m)	$e^{7-r_m x} l_x m_x = 1097$	0.089
Finite rate of increase (λ)	Antilog r_m	1.09
Gross reproduction rate (GRR)	(Σm_x)	75
Net reproduction rate (R_o)	$(\Sigma l_x m_x)$	50

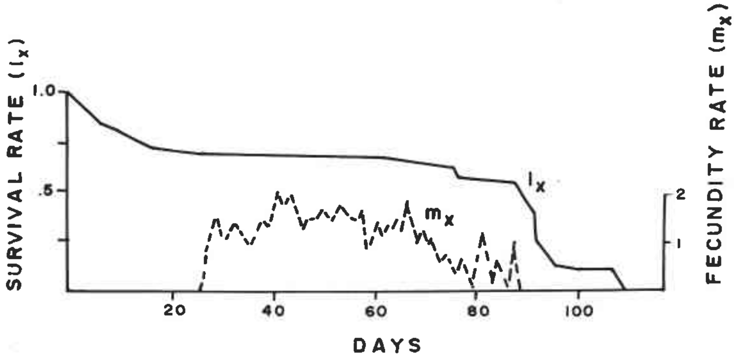

FIG. 1. Survivorship (l_x) and fecundity rate (m_x) of *Scymnus marginicollis* reared on *Myzus persicae*.

August with a high of 31 beetles/100 sweeps with highs of < 5 beetles/100 sweeps for June and July.

Searches of individual sugarbeet plants revealed third and fourth instars in mid-July. No eggs, early larvae, or pupae were found. Adults were most frequently observed on the drop cloth around the plants; they rarely flew when disturbed. Instead, they dropped from the plant and remained motionless for about 30 sec.

The daily observations of *S. marginicollis* larvae and adults on sugarbeet illustrate the seasonal trends in the field (Fig. 2). Eggs must have been deposited in early July for the larvae to have been present during the third and fourth weeks. At the end of July very few larvae and adults, and no pupae were found. Adults were most abundant in August on all crops. Despite favorable conditions in August for production of another brood, no additional larvae were found; this suggests that *S. marginicollis* is univoltine.

Most aphid predators, including coccinellids, leave a crop when aphid populations are very low (Hagen and van den Bosch 1968; Skuhravy and Novak 1966). Many *S. marginicollis* adults and larvae remained on sugarbeets even when aphid density declined to less than one per plant. Its small food requirements may allow *S. marginicollis* to sustain itself on such low prey populations.

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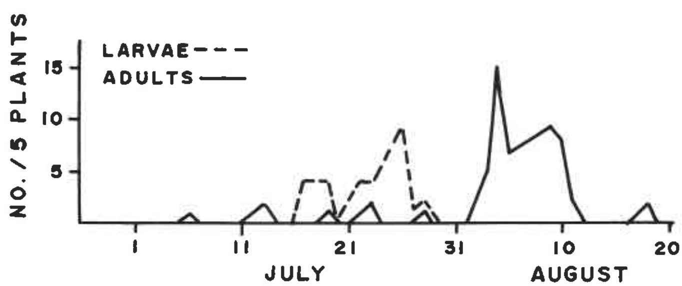

FIG. 2. Total of *Scymnus marginicollis* larvae and adults found by searching five sugarbeet plants per day.

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