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SEASONAL OCCURRENCE OF *COELOPHORE SAUCIA* [COL.; COCCINELLIDAE] AND ITS PREDATION RATE ON APHIDS*

Zhiyi Dai
(*Dept. of Plant Protection, Jiangsu Agricultural College, Yangzhou, Jiangsu*)

Abstract Laboratory studies and field observations on the life history and predation efficacy of *Coelophore saucia* on aphids were carried out from 1980 to 1987 in Yangzhou. *C. saucia* had 5-6 generations a year and overwintered in the adult stage. The accumulative development temperature and the initiating temperature for the development of egg, larva, pupa and a complete life cycle (egg-adult) was found to be 41.1 day-degrees (DD) and 12.4℃, 138.8DD and 8.9℃, 53.6DD and 11.8℃, and 243.3DD and 9.9℃ respectively. The developmental rate varied with the different prey the predator consumed. The duration of larval and pupal stage was 10.4 days when preying on *Aphis pomi*, 11.9 days on *A. glycines*, and 13.9 days on *A. robiniae*. Predation by the adult stage accounted for 92% of the total predation in a generation. The fecundity was 213-1290 eggs per female adult. The occurrence of the predator population was found to be synchronized with the phenology of the prey.

Key words *Coelophore saucia*; Aphid; Control

Coelophore saucia Mulsant is an important natural enemy of aphids on fruit trees, flowers and trees in the Jianghuai area. It is active early in spring and its reversal resistance is strong, which plays an important role in suppressing the aphid population in the early stage. This paper discusses the outbreak regularity and predation efficacy of this ladybird. Partial results are reported as follows.

Materials and methods

1. Source of released *C. saucia*: The overwintering imagoes that had just begun to be active in the middle ten days of April in Yangzhou were picked from peach trees. The imagoes were bred in culture dishes with a diameter of 10cm. Each dish received one egg mass, after hatching until eclosion. In the imago period the larvae were reared in individual dishes. One pair of male and female ladybirds respectively were reared in individual dishes.

* Xuerui Liu, Xinhua Wang and Tongmin Jiang took part in part of the work.

2. Experiment of effective accumulative temperature: Five treatments were set up, viz 18, 21, 24, 27, and 30±0.5℃. There were 20 ladybirds in each treatment, and each treatment was replicated three times. The light was illumintaed for 13 ±0.5 hours. Observations were taken once at 8, 15 and 22 o'clock respectively daily.

3. Influence of different prey species: three prey treatments were set up (*Aphis pome* Degeer, *A. glycines* and *A. robiniae* Macchiati). There were 25 aphids in each treatment, and each treatment was replicated three times. They were fed with enough food every day and observed once at 8, 15 and 22 o'clock respectively daily. They were weighed after eclosion.

4. Experiment of predation function reaction using *Rhopalosiphum nymphaeae* L. as prey. The prey densities of each treatment were 40, 80, 160, 240, 320, 480 and 640 no./200cm^2. And each treatment was repeated ten times. The treatment time was 24 hours. The larvae were starved for 6 hours before treatments, and the imagoes were starved for 12 hours before treatments to make the starvation status consistent among individuals.

5. Outdoor observations: We fed the aphids on wattle of peach trees and hibiscus attached to cages. The aphids were mass cultured. This observation also included the life history of outdoor feeding observations and some related biology characteristics.

Results and analysis

1. The influence of temperature and prey species on growth.

(1) **Growth starting point and effective accumulated temperature** The duration of every ladybird instar was shortened with the increase of temperature in the range of 18~30℃. The durations of ladybird instar are presented in Table 1. The growth starting point and effective accumulated temperature of *C. saucia* in different periods were calculated according to the least squares method. The results are presented in Table 2.

(2) **Survival rate under different temperatures** The survival rate of *C. saucia* was very different under different temperatures. The survival rate was the highest at 24~27℃ and decreased at above or below this range of temperatures (Table 3).

The relationship between the survival rate (S) and temperature (T) is binomial. The equation is as follows:

$$S = 28.7872T - 0.5877T^2 - 256.981 \quad (R=0.9634^*)$$

(3) **Influence of different prey species on growth:** The food habit and prey range of *C. saucia* was broad, but their preference was varied. According to observations in Yangzhou, the ladybirds showed the highest preference for *Hyalopterus amygdali* B1anchard, *Myzu-s persicae* (Sulzer), *Aphis pomi* Deg. and *Myzus tropicalis* Tamehashi etc. Secondly, the preference was moderate on *Rhopalosiphum nymphaeae* L., *A. glycines* Mats., *A. gossypii* Glov. and *Schizaphis graminum* (Rond.) etc. In cases where food was lacking, ladybirds consumed *A. robiniae* Macchiati, which was least preferred.

Table 1. The periods of each C. saucia status under different temperature (day)

Temperature (℃)	Status of C. saucia							
	Egg	1st instar	2nd instar	3rd instar	4th instar	Larva period	Pupae	Egg-imago
18	6.2	4.0	2.3	3.2	6.8	16.2	8.5	30.8
21	5.7	3.1	1.9	1.8	4.4	11.2	5.0	21.8
24	3.5	2.3	1.5	1.6	3.6	9.0	4.2	16.6
27	2.9	1.6	1.2	1.4	3.2	7.3	4.0	14.1
30	2.3	1.6	1.3	1.3	2.9	7.0	2.9	12.2

Table 2. The growth start point and effective accumulated temperature of C. saucia

Item	Status of C. saucia			
	Egg	Larva	Pupae	Egg-imago
Growth start point (℃)	12.4	8.9	11.8	9.9
Effective accumulated temperature (day-degrees, DD)	41.4	138.8	53.6	243.3

Table 3. The survival rate of C. saucia under different temperature Yangzhou 1986

Item	Temperature (℃)				
	18	21	24	27	30
No. of C. saucia observed	75	74	75	75	75
Survival rate	72.0	83.8	96.0	94.7	76.4

C. saucia preyed on different, and the developmental rates of its larvae, pupae and the weight of primary eclosion to imago had obvious differences. The results of the study that used the *Aphis pome* Degeer, *A. glycines* and *A. robiniae* Macchiati to feed the third generation of *C. saucia* respectively are presented in Table 4.

Table 4. The influence of different quarries on the period of C. saucia larvae and pupae and the weight of

imago (Yangzhou, 1981)			
Prey species	Average larval period (day)	Average pupal period (day)	Weight of imago (mg/no.)
Aphis pome Degeer	6.3	4.1	21
A. glycines	7.1	4.8	20
Acacia aphid	8.1	5.8	13

Among the above results, with the exception that the imago weight difference of *Aphis pome* Degeer and *A. glycines* was not significant, the imago weight differences among the periods of other larvae and pupae, treated by *A. robiniae* Macchiati and between the other two treatments were all above $\alpha = 0.01$ level, and the difference was significant.

2. Predation effect in different aphid periods

(1) **Comsumption** *A. gossypii* Glov. were used as food to feed *C. saucia*. Each larva ate 524.1 aphids on average, each imago ate 6557.5 aphids on average, taking up about 92% of the total eating amount. Because not only the amount of food that imagoes ate per day was large, but also the adult longerity was long, it was at the potential stage to suppress aphid damage.

The consumption in 7~15 days of imago early eclosion was small, preying on 36.9 aphids on average. After mating, the consumption increased rapidly with the development of ovary until egg laying period, preying on 94.1 aphids per day on average. After the egg laying period, the predation amount decreased continuously, preying on 15~20 aphids per day on average. But according to outdoor observations with cages, the average predation amount made up only 53~75% of that fed indoors.

(2) **Predation function reaction**

The predation amount of *C. saucia* under different prey densities followed the Holling II equation ($Na=aNT/1+aT_hN$). The experiment results are presented in Table 5.

Table 5. The reactive equation parameters of C. saucia's predation quantity and predation function under different prey densities (Yangzhou, 1981)

Status of C. saucia	Quantity of predation (no./ C. saucia) under different prey densities (no./cm^2)							Instant attack rate, a	Treatment time, Th	r
	40	80	160	240	320	480	640			
1st instar larva	4.4	4.9	9.5	11.0	12.0	12.8	15.1	0.1371	0.0649	0.94**
2nd instar	4.2	3.9	9.3	12.1	13.6	14.2	15.1	0.1166	0.0609	0.87**

larva 3rd instar	6.7	12.0	12.8	14.1	16.0	22.4	23.3	0.2428	0.0437	0.97**
larva 4th instar	21.0	34.6	33.0	44.5	64.4	65.3	70.3	1.3472	0.0079	0.95**
larva Imago	35.0	48.2	50.8	67.1	68.4	81.0	98.3	1.4215	0.0118	0.95**

3. Yearly life history and important biological characters

C. saucia lived through winter as imagoes in the bark crevices and the sun-facing sides of buildings, and it had a certain aggregation character. The imagos that overwintered usually began to be active in the last ten days of April, occurring in 5~6 generations per year. Because the egg laying period of imagoes was long, the generations overlapped and the aphid status intermixed after the second generation.

The imago that was newly eclosed with immature reproduction organs could not mate at once and needed a pre-mating period of 8~16 days. It could mate for many times in its whole life, usually 4~5 times, or up to 12~16 times. The female aphid that did not mate did not usually lay eggs, and those eggs laid did not hatch.

The imago laid 6~20 eggs at once, and it spent about half a minute to lay each egg. The period of egg laying was some days during a span of 27~129 days. Each female imago laid 213~1290 eggs, 454.2 eggs on average, which differed significantly with each individual. The peak of egg laying often appeared between the 16~40 days after egg laying began, which was also the period of highest predation amount (Fig. 1).

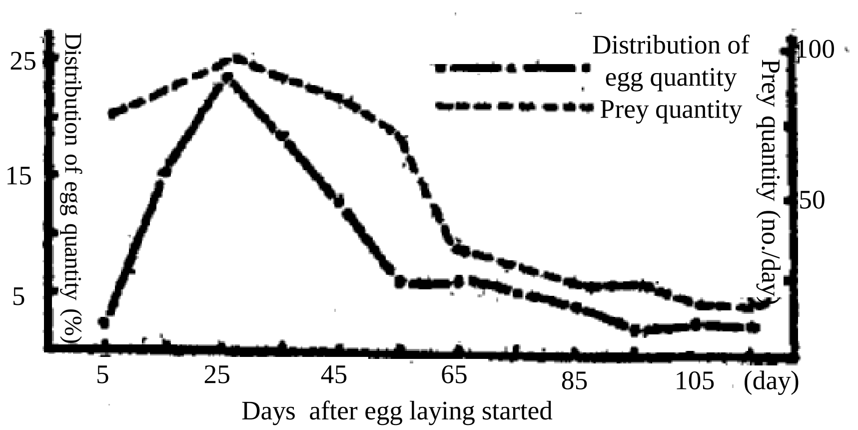

Fig. 1 The distribution of egg quantity and predation quantity of C. saucia

The sex ratio was about 1:1. Its tolerance of starvation was strong; the newly emerged imago could tolerate starvation for 4.5 days. And imago in the egg laying period could tolerate starvation for about 11 days.

The development of eggs was influenced by temperature, but the influence of sunshine and humidity was very low. Under the average temperature of 27.5℃, three kinds of treatments were applied - illumination for 24 hours, darkness for 24 hours and illumination for 12 hours. The developmental rate and the hatching rate of eggs had no obvious change. Under the condition of 30℃, five kinds of relative humidity treatments were treated - 52%, 73%, 80%, 91%, and 100%. The hatching rate and the developing rate of eggs had no obvious change either.

C. saucia had obvious seasonal synchronized phenomena to its hosts. For example, the main hosts were peach, pear, apple and hibiscus in spring, and they would switch to legume, cotton, pearleaf and crabapple etc. in summer, then migrate back to peach, pear and hibiscus etc. plants in autumn. This was mainly influenced by the distribution of prey species. For instance, the density of *Hyalopterus amygdale* Blanchard on peaches in spring was high, but the alate aphids migrated to cattail and reed etc. plants in moldy rain seasons, and the population number decreased significantly. Then they would migrate back to peach trees again and cause damage and reproduce by October. Thus, the population distribution of this aphid on peach trees was perennially represented by the “saddle” distribution.