EFFECT OF TEMPERATURE ON THE LIFE CYCLE AND PREDATORY CAPACITY OF LADYBIRD BEETLE *MICRASPIS DISCOLOR* FABRICIUS (COLEOPTERA: COCCINELLIDAE)

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ABSTRACT: The effects of temperature on the development and the predatory capacity of *Micraspis discolor* larvae were studied in laboratory. Two temperature levels 23.50°C and 30.71°C on average, were used to assess the life cycle and developmental stages of the ladybird beetle *M. discolor*. The life cycle of *M. discolor* was 27.38 days at 23.50°C and reduced to 19.77 days at 30.71°C, the total larval period was 13.42 and 9.9 days, respectively. The pre-oviposition period of the ladybird beetle *M. discolor* was 4.95 days at 23.50°C and 5.23 days at 30.71°C. The female beetles laid 282 eggs and the hatching percentage of egg was 81.03 at 30.71°C and 179 eggs and the hatching percentage of egg was 88.73 at 23.50°C. At temperature 30.71°C and 23.50°C, the pupal periods were 4.91 and 2.92 days, respectively. The longevity of adult ladybird beetles was slightly prolonged when they were reared at 30.71°C compared with that when they were reared at 23.50°C. Feeding on the second insturs of *B. brassicae* the predatory capacity of *M. discolor* larvae consumed an average 206.28 prey per day at 30.71°C and 161.84 prey per day at 23.50°C.

Keywords: Micraspis discolor, life cycle, longevity, predatory beetle.

INTRODUCTION

The ladybird beetle have been known worldwide as a predator of a number of insects. They are distributed in many countries of Asia [6]. This beetle, often called ladybug or coccinellid, is the most commonly known of all beneficial insects.

In Europe these beetles are called ladybirds [16]. They are of great economic important as predaceous both in their larval and adult stages on various important crop pests such as aphids, coccids and other soft bodied insects including aphids [5, 7], while the species *M. discolor* feed on many inscet pests such as aphids, brown plant hopper, corn borer, Lepidopteron insects, mealybug, white flies [13]. This predaceous coccinellids is also found in association with those insects infesting cruciferous vegetables**,** cabbage, bean, chilli, tobacco, cotton, maize, potato, soyabean and sweet potato [4].

In Vietnam, the aphid is one of the most destructive pests and its distribution is field wide. The aphids that attack cruciferae plants and other crops in the surrounding of Hanoi city. At the time of infestation plants fail to give planting resulting in 20- 40% yield loss [12]. In balanced ecosystems, insect pests are kept in check by their natural enemies (predators and parasitoids). They are considered as beneficial agents in agricultural systems. Coccinellid predators play an important role in keeping aphid densities low in cruciferous vegetables and other field crops.

The study of the biology of *M. discolor* would help to use this insect of proper biological control. So, the present study was undertaken to observe the biology and the effect of temperature to the life cycle and predatory capacity of *M. discolor*.

MATERIALS AND METHODS

Collection and mass culture

All experiments were done in the Faculty of Biology, Hanoi National University of Education, Vietnam, at room temperature to observe the biology of ladybird beetle. The temperature was measured in the morning and afternoon of the day by electronic thermometers humidity.

M. discolor were collected from various cruciferous crops, such as *Brassica oleracea var. capitata, Brassica chinensis* L, *Brassica oleracea* var. *botrytis* L, *Brassica oleracea var. gongylodes* in Gia Lam, Thanh Tri and Dong Anh districts, Vietnam.

Several males and females of the *Micrapis discolor* were collected by sweep net from the crucifer field and were confined in cages. These beetles were paired and capulated in cages (18 × 13.5 × 6.5 cm). The bottom of the cages was covered with blotting paper.

Brevicoryne brassicae collected from cruciferous plants in the fields. After that they have reared in cruciferous plants place in rearing sheft boxes until the second instars emerged.

Effects of temperatures on the developmental stages of *M. discolor*

The larvae and predator adults of *Micrapis discolor* were reared in the laboratory in order to supply necessary insects for the experiments, Several males and females of the *Micrapis discolor* were collected by sweep net from the crucifer field and were confined in cages. These beetles were paired and copulated in cages (18 × 13.5 × 6.5 cm). The bottom of the cages was covered with blotting paper. Immediately after hatching, larvae were transfered to the rearing cages (18 × 13.5 × 6.5 cm) and the second instars of *Brevicoryne brassicae* were provided as food on leaf cuttings of cruciferous crops with rearing method.

Brevicoryne brassicae collected from cruciferous plants in the fields. After that they were reared in cruciferous plants placed in rearing sheft boxes until the second instars emerged. The number of aphids was counted everyday in order to additional food for larvae and predator adult of *Micrapis discolor* until pupation. Temperatures for rearing were room temperature, with 80% relative humidity.

Eggs were observed daily for eclosion, larvae were observed in Petri dishes, the feeding process of 30 larvae and fresh cruciferous leaves provided daily until pupation. Pupae were observed daily for adult emergence and sex ratio was determined. Eggs, larvae, pupae were also collected daily and preserved in 70% ethanol solution.

Effects of temperatures on the longevity of adult

After emerged from pupae adults were transfered to the rearing cages. Two experiments were carried out and randomly triplicate: Experiment 1: at 30.71ºC (room temperature), experiment 2: 23.50ºC (room temperature).

Each experiment was tracking 30 individual adults, food was provided daily and testing laboratory until adults died. Time tracking of adult life in each experimental plot were recorded.

Feeding capacity of *M. discolor* larvae on *B. brassicae*

Immediately after hatching, the larvae and predator adults of *M. discolor* were taken and reared individualy in Petri dishes (6.0 × 1.0 cm). The predator larva of *M. discolor* were tracking 15 individuals and candomly triplicate 3. Each predator larva of *M. discolor* was offered 150 second instar larvae of *Brevicoryne brassicae* every day. The number of prey eaten daily and the development time of the predator larva of *M. discolor* were recorded.

Statistical analysis

The Data were analyzed by Analysis of Variance (ANOVA) and the mean values were separated by Duncan's Multiple Range Test (DMRT). All analyses were performed using Descriptive statistics.

RESULTS AND DISCUSSION

Effects of temperatures on the developmental stages of *M. discolor*

Effects of two temperature levels 23.50°C and 30.71°C used on the life cycle and developmental stages of the ladybird beetle *M. discolor* were showed in table 1.

First instar

The development of newly hatched larvae was 1.44 ± 0.16 days at 30.71°C and 1.89 ± 0.17 day at 23.50°C. Chowdhury et al. (2008) [3] found that the newly hatched larval period was from 1 to 3 days and on an average of 1.71 ± 0.20 days using bean aphid as food, which is similar to the results of our findings at 23.50°C.

Prodhan et al. (1995) [11] reported that this period of *M. discolor* was 2 to 3 days using bean aphid, which is higher than our findings.

Table 1. Effects of temperatures on the developmental stages of *M. discolor* on *B. brassicae*

Developmental stage	Duration (days) at two levels of temperature (°C)	
	30.71	23.50
Egg	2.00 ± 0.00	3.82 ± 0.06
First instar	1.44 ± 0.16	1.89 ± 0.17
Second instar	2.04 ± 0.24	2.32 ± 0.18
Third instar	2.52 ± 0.26	3.54 ± 0.17
Fourth instar	3.90 ± 0.24	5.67 ± 0.24
Total larval period	9.9 ± 0.23	13.42 ± 0.19
Pupa	2.92 ± 0.25	4.91 ± 0.12
Pre-Oviposition	4.95 ± 0.15	5.23 ± 0.14
Total life cycle	19.77 ± 0.44	27. 38 ± 0.15

Second instar

The duration of the 2nd instar larvae was 2.04 ± 0.24 days at 30.71°C and 2.32 ± 0.18 day at 23.50°C (table 1). Nasiruddin & Islam (1979) [8] found that the duration of the 2nd instar larvae of *M. discolor* was 2.4 to 3.1 days on different aphid. Prodhan et al. (1995) [11] found that the duration of 2nd instar of *M. discolor* varied from 1 to 2 days using bean aphid using cabbage aphid as a host, which is comparatively similar to the results of the present findings.

Chowdhury et al. (2008) [3] reported that the duration of the 2nd instar larvae of *M. discolor* varied from 1.50 to 3 days and the mean duration was 2.20 ± 0.16 days using bean aphid.

Third instar

The result indicated that the duration of the 3rd instar larvae was 2.52 ± 0.26 days (30.71°C) and 3.54 ± 0.17 days (23.50°C) (table 1). Nasiruddin and Islam (1979) [8] reported that the duration of the 3rd instar larvae of *M. discolor* varied from 3.1 to 3.8 days on maize, bean and chilli aphids as host. Chowdhury et al. (2008) [3] found that the duration of the 3rd instar larvae lasted from 2 to 4 days. The mean duration of 3rd instar larvae was 3.10 ± 0.17 days.

Fourth instar

Observation made on the larval duration of the 4th instar larvae on an average 3.90 ± 0.24 days with temperature 30.71 and 5.67 ± 0.24 days with temperature 23.50 (table 1). Prodhan et al. (1995) [11] reported that the duration of final instar larvae of *M. discolor* was 3 days. Nasiruddin & Islam (1979) [8] recorded that the duration of the 4th instar larvae of *M. discolor* varied from 3.8 to 4.2 days on maize, bean and chilli aphids.

Duration of larval stages

The total larval period (1st instar to 4th instar) was 9.9 ± 0.23 days at 30.71°C and 13.42 ± 0.19 days at 23.50°C (table 1). Nasiruddin & Islam (1979) [8] observed that the total period of *M. discolor* was 11.8 to 12.5 days, which is simillar to the present findings. Prodhan et al. (1995) [11] observed that the total larval period of *M. discolor* varied from 7 to 9 days on bean aphid. This result was lower than the present study.

However, Sakurai et al. (1991) [14] reported that the quality of food and environmental factors like temperature, humidity also play an important role on different aspects of the biology of coccinellid beetles. So, this variation may be due to the quality of food and environmental factors like temperature and humidity.

Pupal period

The pupal period was 2.92 ± 0.25 days at 30.71°C and 4.91 ± 0.12 days at 23.50°C (table 1). Nagammuang (1987) [9] recorded that the mean pupal duration of *M. discolor* was 3.43 ± 0.57 days when larvae reared on *A. craccivora.* Different findings revealed that the pupal period of coccinellid beetles varied with the different of food and it was correlated with the temperature [14]

Pre-Oviposition

The time between the date of adult emergence and the first egg deposition was considered as pre-oviposition period. The pre-ovipositon period of *M. discolor* was 4.95 ± 0.15 days at 30.71°C and 5.23 ± 0.14 days at 23.50°C (table 1).

Agarwala et al. (1988) [1] observed that the pre-oviposition period was 6 to 10.33 days on *A. craccivora* at 16-26°C. Prodhan et al. (1995) [11] studied that the pre-oviposition preiod of *M. discolor* was 3 to7 days.

Adult longevity

The longevity of adult ladybird beetles was counted from the emergence of the adult to its death. At 30.71°C, the longevity of the ladybird beetles was 32 ± 0.15 days, and at 23.50°C the longevity of the ladybird beetles was 22 ± 0.14 days (table 2).

Table 2. Effects of temperatures on the longevity of adult

Average temperature (°C)	The longevity of adult (days)
30.71	32 ± 0.15
23.50	22 ± 0.14

It showed that the longevity of the ladybird beetle at 23.50°C was shorter than that at 30.71°C.

Samal & Misra (1985) [15] reported that the adult of *M. discolor* fed on Nilaparvata lugens lived for 24 to 40 days in September-November. Ngammuang (1987) [9] found that the longevity of male and female were 37.8 ± 15.24 and 59.53 ± 23.53 days when fed on *A. craccivora*, in the laboratory at temperature of 28 ± 2°C with 74% RH.

Fecundity and hatching rate of *M. discolor*

In the laboratory, the number of eggs laid per female were 348. The mean hatching percentage were 83.03 at temperature of 30.71°C and the number of eggs laid per female were 222. The mean hatching percentage were 88.73 at temperature of 23.50°C (table 3).

Table 3. Effects of temperatures on the fecundity and hatching rate of *M. discolor*

No. of observation	Average temperature (°C)	
	30.71	23.50
No. of egg laid	348	222
No. of egg hatched	282	197
% of egg hatching	81.03	88.73

Ngammuang (1987) [9] reported that the number of eggs deposited by on female of *M. discolor* was 181.07 ± 6.37 on *A. craccivora*, and 70.15% eggs were hatched. Prodhan et al. (1995) [11] observed that the facundity of female varied form 200-300 eggs with mean of 270.5 and with average 70.15% eggs were hatched. These results seem to be close with our findings.

Omkar & Pervez (2002) [10] reported that the oviposition peak tended to shift towards younger females and the oviposition rate increased with increase in temperature from 20 to 27°C. The maximum fecundity and percent egg viability was 750 eggs and 95% at 27°C and minimum 385 eggs and 65% at 20°C, respectively, that is higher than the present findings.

Feeding capacity of *M. discolor* larvae on *B. brassicae*

The results presented in table 4 show the predatory capacity of *M. discolor* larvae of each stage on *B. brassicae* was assessed at two rearing temperatures.

The predatory capacity of first instar larvae was lowest, eating an average 16.89 prey per day at 30.71°C and 14.54 prey per day at 23.50°C. The capacity of the second instar larvae was eating an average 33.82 prey per day at 30.71°C and 27.23 prey per day at 23.50°C.

Table 4. Feeding capacity of *M. discolor* larvae on *B. brassicae*

Developmental stage	Average temperature (°C)	Predatory capacity of different instars of *M. discolor* (prey/day)
First instar	30.71	16.89 ± 1.15
Second instar		33.82 ± 0.78
Third instar		63.40 ± 1.22
Fourth instar		92.17 ± 1.50
Total preys eaten		206.28 ± 1.66
First instar	23.50	14.54 ± 0.19
Second instar		27.23 ± 0.26
Third instar		47.90 ± 0.28
Fourth instar		72.17 ± 1.50
Total preys eaten		161.84 ± 0.62

The capacity of the third instar larvae was slightly higher, eating an average 63.40 prey per day at 30.71°C and 47.90 prey per day at 23.50°C. At the fourth instar stage, the larvae had the highest predatory capacity, eating an average of 92.17 prey per day at 30.71°C and 72.17 prey per day at 23.50°C. In total, each lavrae can eat an average 206.28 prey per day at 30.71°C and 161.84 prey per day at 23.50°C.

Begum et al. (2002) [2] reported that each larva of *M. discolor* consumed an average of 47.6 third instar brown plant hopper.

CONCLUSION

Rearing temperature affected both growth and development of *M. Discolor*, the cycle of this species was prolonged at low temperature.

The feeding capacity of *M. discolor* larvae was significantly greater at 30.71°C than at 23.50°C. The data from this work also provided further evidence that temperature has affected adult longevity and fecundity and hatching rate of *M. discolor*.

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ẢNH HƯỞNG CỦA NHIỆT ĐỘ ĐẾN VÒNG ĐỜI VÀ KHẢ NĂNG ĂN MỒI CỦA BỌ RÙA ĐỎ *MICRASPIS DISCOLOR* FABRICIUS (COLEOPTERA: COCCINELLIDAE)

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TÓM TẮT

Ảnh hưởng của 2 ngưỡng nhiệt độ 23,50°C và 30,71°C đến vòng đời và khả năng ăn của sâu non bọ rùa đỏ *Micraspis discolor* trong phòng thí nghiệm đã được nghiên cứu với con mồi là rệp xám.

Ở điều kiện nhiệt độ 23,50°C, thời gian hoàn thành vòng đời của bọ rùa đỏ là 27,38 ngày, giai đoạn sâu non hoàn thành pha phát dục là 13,42 ngày, giai đoạn nhộng là 4,91 ngày; giai đoạn trước đẻ trứng của bọ rùa đỏ là 5,23 ngày, con cái đẻ 179 quả trứng và tỷ lệ trứng nở 88,73%; khả năng ăn rệp *B. brassicae* là 161,84 con rệp/ngày.

Ở điều kiện nhiệt độ 30,71°C, thời gian hoàn thành vòng đời của bọ rùa đỏ là 19,77 ngày, giai đoạn sâu non hoàn thành pha phát dục là 9,9 ngày; giai đoạn nhộng là 2,9 ngày; giai đoạn trước đẻ trứng là 4,95 ngày; con cái đẻ 288 quả trứng và tỷ lệ trứng nở 81,03%; khả năng ăn rệp *B. brassicae* của sâu non là 206,28 con rệp/ngày.

Từ khóa: Micraspis discolors, khả năng ăn, nhiệt độ, vòng đời, thời gian sống.

Ngày nhận bài: 13-12-2012