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INFLUENCE OF CONSTANT TEMPERATURE DEGREES ON THE BIOLOGICAL CHARACTERS AND PREDACEOUS EFFICIENCY OF THE PREDATOR *Rodolia cardinalis* (MULSANT)

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ABSTRACT

Laboratory experiments were carried out to study the influence of different constant temperature in the insectary of the economic entomology Department, Faculty of Agriculture, Mansoura University.

The larval stage of the predator *Rodolia cardinalis* (Mulsant) when reared on the third nymphal instar of *Icerya aegyptiaca* Douglas under three constant temperature 20±1, 24±1 and 28±1˚c lasted an average of 20.7±0.34, 11.8±0.34 and 7.3±0.49 days, respectively.

The average of the total consumption for larval stage when reared on *I. aegyptiaca* at 20, 24 and 28˚c reached 28.80±2.18; 60.50±2.48 and 53.45±3.27 individuals/ larva. Meanwhile, results showed that, the highest total consumption for larva during its four larval instars when reared at 24˚c followed by 28˚c with highly significant differences.

The calculated biomass from (Carbohydrates, Lipids and protein) consumed by one predator larva during its larval stage at 20, 24 and 28˚c reached an average of (38.30, 36.86 and 21.89 mg.), (80.47, 77.44 and 45.98 mg.) and (71.09, 68.42 and 40.62 mg.), respectively.

Longevity for female and male when fed on the third nymphal instar of *I. aegyptiaca* as preys under different constant temperature of 20, 24 and 28˚c lasted an average of (50.4±2.16 and 33.4±2.20), (46.4±2.12 and 29.0±2.09) and (22.4±1.29 and 15.1±0.82 days), respectively.

The average of the total consumption for adult female fed on *I. aegyptiaca* reached 140.6±5.72, 328.2±10.90 and 218.3±9.14 individuals/ female when reared under 20, 24 and 28˚c, respectively, with highly significant differences. Also, for adult male reached 50.3±4.95, 145.8±6.84 and 107.8±7.14 individuals/ male, respectively, with highly significant differences.

The highest total consumption for adult female was recorded during the oviposition period especially, under 24˚c (289.0±10.53 individuals/ female) and resulting, the number of deposited eggs/ female was the highest (354.30±19.90 egg/ female), it could be concluded that the temperature degree of 24˚c was the best for mass rearing of *R. cardinalis* because the female layed the highest eggs on this degree

INTRODUCTION

Rodolia cardinalis (Mulsant) (Coleoptera: Coccinellidae) is an important coccinellid predator feeding on mealybug species (Hamed and Saad 1989, Lehane 1998, Ibrahim 2005 and Awadalla 2010). The effect of

temperature and mealybug species as prey types on the developmental time, fecundity and the other biological characters were studied by several investigators in different parts of the world (Khalaf 1987, Ragab 1995, Causton *et al.* 2004, Grafton *et al.* 2005, Ghanim *et al.* 2006 and Awadalla 2010).

For integrated pest management program needs the evaluation of the definite role of the natural enemies of these insect pests and knowledge of the population relationships of the insect host and their natural more ecological and biological informations.

A few information is available on the influence of different temperature degrees on the biological aspects and on predaceous efficiency of the coccinellid predator *R. cardinalis*.

Therefore, the aim of the present work is to study Influence of constant temperature degrees on the biological characters and predaceous efficiency of the predator *Rodolia cardinalis*

MATERIALS AND METHODS

Laboratory experiments were carried out to study the effect of different constant temperature on the biological characters as well as the predaceous efficiency of the coccinellid predator *Rodolia cardinalis* (Mulsant). The experiments were carried out in the insectary of the Economic Entomology Department, Faculty of Agriculture, Mansoura University in the incubator under three constant temperature degrees of 20±1˚c , 24±1˚c and 28±1˚c.

To obtain a culture from the predator *R. cardinalis* a large numbers in the pupal stage were collected from ficus, *Ficus nitida* thunb., guava, *Psidium guava* L., persimmon, *Diospyros kaki* L. and citrus trees which were found to be a heavily infested with *Icerya aegyptiaca* (Douglas) (westwood) and transferred to the laboratory until emergence of the adults.

To explain the difference in various biological characters of the predator *R. cardinalis*, chemical analysis was carried out by using one gram of living insects of *I. purchasi, I. aegyptiaca* and *I. seychellarum* to determine the total carbohydrates, protein and lipids by using the method of Hedge and Hofreiter (1962), Jones *et al.,* (1991) and A.O.A.C. (1984), respectively.

The total carbohydrates, protein and lipids per individual from the different preys were obtained by dividing these amounts per gram by the individual number representing this gram from *I. aegyptiaca*. Then the average consumption from these components by the different larval instars and the adult stage of the predator were calculated.

RESULTS AND DISCUSSION

As shown in Table (1) the larval stage of the predator *R. cardinalis* when reared on the third nymphal instar of *I. aegyptiaca* under three constant temperature 20, 24 and 28˚c lasted an average 20.7±0.34, 11.8±0.34 and 7.3±0.49 days, respectively. Statistical analysis showed a highly significant

differences on the larval stage of the predator under the three constant temperature degrees.

Data represented in Table (1) showed that the average of the total consumption during the larval instars under the different temperature as well as the calculated biomass from carbohydrates, lipids and protein consumed by one predator larvae during its larval instars.

As a conclusion, the average of the total consumption for the total larval instars on *I. aegyptiaca* as preys at 20, 24 and 28˚c reached 28.80±2.18, 60.50±2.48 and 53.45±3.27 individuals/ predator larva. Meanwhile, results showed that, the highest total consumption for the predator larvae during its four larval instars when reared at 24˚c (60.50±2.48 indiv.) followed by 28˚c (53.45±3.27 indiv.) with highly significant differences. The calculated biomass from (Carbohydrates, Lipids and protein) consumed by one predator larva under 20, 24 and 28˚c reached an average of (38.30, 36.86 and 21.89 mg.), (80.47, 77.44 and 45.98 mg.) and (71.09, 68.42 and 40.62 mg.), respectively.

Table (1): Influence of constant temperature degrees on the duration of larval instars and predaceous efficiency of *R. cardinalis* when fed on the third nymphal instar of the mealybug *I. agyptiaca*

Larval instars	Temp.	Average duration (days)	Daily average consumption	Total mean consumption	Av. Weight of the main components consumed / larvae (mg.)		
					Carbohydrates	Lipids	protein
1st	20	5.9± 0.23a	0.67	3.95± 0.18b	5.25	5.06	3.00
	24	3.3± 0.31b	2.58	8.4± 0.68a	11.17	10.75	6.38
	28	2.4± 0.23c	3.21	7.55± 0.47a	10.04	9.66	5.74
2nd	20	4.8± 0.24a	1.15	5.45± 0.25c	7.25	6.98	4.14
	24	3.1± 0.23b	3.46	10.55± 0.64a	14.03	13.50	8.02
	28	1.3± 0.13c	5.85	7.60± 0.77b	10.11	9.73	5.78
3rd	20	4.2± 0.28a	1.48	6.15± 0.55c	8.18	7.87	4.67
	24	2.3± 0.22b	5.62	12.65± 0.74a	16.82	16.19	9.61
	28	1.2± 0.13c	8.38	10.05± 0.47b	13.37	12.86	7.64
4th	20	5.9± 0.33a	2.26	13.25± 1.12b	17.62	16.96	10.07
	24	3.2± 0.35b	9.03	28.9± 1.91a	38.44	36.99	21.96
	28	2.5± 0.17c	11.53	28.25± 1.28a	37.57	36.16	21.47
Total	20	20.7± 0.45a	1.39	28.80± 2.18c	38.30	36.86	21.89
	24	11.8± 0.34b	5.15	60.50± 2.48a	80.47	77.44	45.98
	28	7.3± 0.49c	7.32	53.45± 3.27b	71.09	68.42	40.62

Means followed by the same letters in a column for each larval instar are not significantly differences at 0.05 level of probability (Duncan's Multiple Range Test).

Data illustrated in Fig. (1) showed that the percentage of the total consumption during the four larval instars when fed on the third nymphal instar of *I. aegyptiaca* under different temperature degrees. It can be noticed that, the fourth larval instar was the highest percentage of the total consumption and reached 46.0, 47.77 and 52.85% under 20, 24 and 28˚c, respectively.

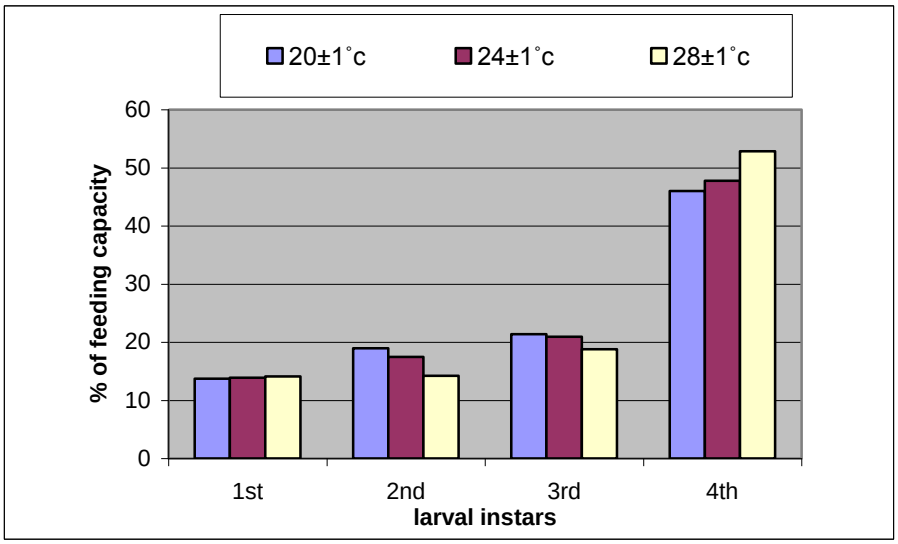

Fig. (1): The percentage of the total consumption during four larval instars when the third nymphal instars of *I.aegyptiaca* under three constant temperature.

The obtained results in Table (2) cleared that the longevity for female and male when fed on the third nymphal instar of *I. aegyptiaca* as preys under different constant temperature of 20, 24 and 28˚c lasted an average of (50.4±2.16 and 33.4±2.20), (46.4±2.12 and 29.0±2.09) and (22.4±1.29 and 15.1±0.82 days), respectively. Statistical analysis showed significant differences between the ovipositional period as well as the adult longevity for female and male under the constant temperature degrees.

Data illustrated in Table (2) showed that the average of the total consumption during the ovipostional period, the number of deposited eggs per female and also, the total consumption for adult male. Moreover, the calculated biomass from carbohydrates, lipids and protein consumed by one adult female during its ovipostional period or one adult male during its longevity.

As a conclusion, the average of the total consumption for adult female fed on *I. aegyptiaca* reached 140.6±5.72, 328.2±10.90 and 218.3±9.14 individuals/ female when reared under 20, 24 and 28˚c, respectively, with highly significant differences. Also, for adult male reached 50.3±4.95, 145.8±6.84 and 107.8±7.14 individuals/ male, respectively, with highly significant differences. On the other hand, results showed that, the highest total consumption for adult female was recorded during the

oviposition period especially, under 24˚c (289.0±10.53 individuals/ female) and resulting, the number of deposited eggs/ female was the highest (354.30±19.90 egg/ female). Meanwhile, the calculated biomass from (carbohydrates, lipids and protein) consumed by one predator female during its longevity reached (186.00, 179.97 and 106.86 mg), (436.51, 420.10 and 249.43 mg) and (290.34, 279.42 and 165.91 mg) under 20, 24 and 28˚c, respectively, where for the adult male were (66.9, 64.38 and 38.23 mg), (193.91, 186.62 and 110.81mg) and (143.37, 137.98 and 81.93 mg), respectively.

Table (2): Influence of three constant temperature degrees on the ovipositional periods, predator's efficiency and fecundity of *R. cardinalis* adults reared on the third nymphal instar of *I. agyptiaca.*

Biological aspects	Temp.	Period (days)	Daily average consumption	Total consumption	Fecundity	Average weight of the main components consumed / adult (mg.)		
						Carbohydrates	Lipids	protein
Pre-oviposition period	20	7.1± 0.69a	3.14	22.3± 0.78a		29.66	28.54	16.95
	24	3.1± 0.31b	8.26	25.6± 1.54a		34.05	32.77	19.46
	28	2.6± 0.31b	10.19	26.5± 2.20a		35.25	33.92	20.14
Oviposition period	20	32.9± 2.24a	3.02	99.3± 5.60c	109.0±12.17	132.07	127.10	75.47
	24	40.3± 2.04a	7.17	289.0± 10.83a	354.30±19.90	384.37	369.92	219.64
	28	17.8± 1.14b	10.08	179.4± 7.65b	336.6±25.34	238.60	229.63	136.34
Inter-oviposition	20	10.4± 0.86a	1.83	19.0± 1.52a		25.27	24.32	14.44
	24	3.0± 0.38b	4.53	13.6± 1.34b		18.09	17.41	10.34
	28	2.0± 0.31b	6.20	12.4± 1.43b		16.49	15.87	9.42
Adult longevity female	20	50.4± 2.16a	2.79	140.6± 5.72c		186.00	179.97	106.86
	24	46.4± 2.12a	7.07	328.2± 10.90a		436.51	420.10	249.43
	28	22.4± 1.29b	9.75	218.3± 9.14b		290.34	279.42	165.91
Adult longevity male	20	33.4± 2.20a	1.51	50.3± 4.95c		66.9	64.38	38.23
	24	29.0± 2.09a	5.03	145.8± 6.84a		193.91	186.62	110.81
	28	15.1± 0.82b	7.14	107.8± 7.14b		143.37	137.98	81.93

Means followed by the same letters in a column for each period are not significantly differences at 0.05 level of probability (Duncan's Multiple Range Test).

Data illustrated in Fig. (2) showed that the percentage of the total consumption during the female ovipositional periods when fed on the third nymphal instar of *I. aegyptiaca* under 20, 24 and 28˚c. It can be noticed that, the highest percentage of consumption recorded during the oviposition period and reached 70.63, 88.05 and 82.18% at 20, 24 and 28˚c, respectively.

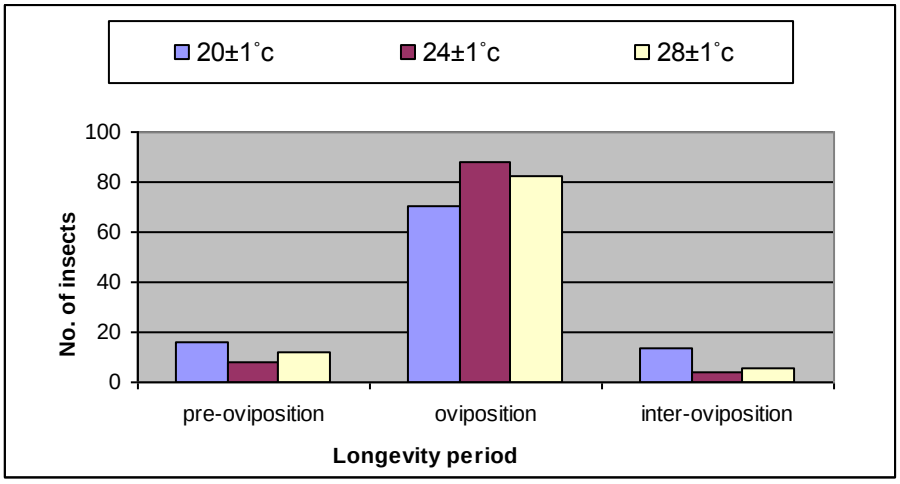

Fig. (2): The percentage of total consumption during female longivity periods when fed on the third nymphal instar of *I. aegyptiaca* under three constant temperatures.

The obtained results are in agreement with those by of Omkar and Pervez (2004) and Grafton *et al.* (2005). The survival of the various life stages, first instar larvae were most susceptible to mortality at temperatures between 20 and 30ºC of *Propylea dissecta* (Mulsant), while, pre-pupa suffered least mortality. Egg-mortality was maximum at 35 ºC. Female biased sex ratios were obtained at all five temperatures tested with higher proportion of females at the extremes of temperature, thus suggesting that females are more thermal-tolerant. Lowest mortality of immature stages with maximum larval survival and adult emergence was recorded at 27 ºC, while reverse was the case at 35 ºC. Thus, 27 ºC may be considered best for the laboratory rearing of *P. dissecta* (Omkar and Pervez 2004). While, Grafton *et al.* (2005) studied the effect of temperature on the development of *R. cardinalis* when fed on *I. purchasi* under controlled laboratory conditions. Adult exposed to temperature of 25, 28, 31, 34, and 37°C for 72 h showed 95-100% survival, however eggs production was significantly reduced at 34 and 37°C. Eggs maintained at 34°C showed reduced hatch and survival of larvae, and eggs held at 37°C failed to hatch. There was no egg eclosion at 10°C. Ibrahim (2005) who evaluated the effect of different constant temperature on the biological characters of *R. cardinalis.* The optimum temperature for rearing this predators was 25 ◌̊C because the number of eggs, hatchability percentage and female longevity were the highest in comparison with the other temperature degrees. While, Hamed and Chemsedine (2001) noticed

that the fecundity of females at different temperatures ranged between 1.7 eggs at 15ºC and 601.86 eggs at 30ºC. The pre-oviposition period ranged between 23.75 days at 15ºC and 3.47 at 35ºC. Awadalla (2010) mentioned that, The total developmental times of the immature stages for *R. cardinalis* were 62.30, 41.10, 26.85, 18.85 and 12.7 days with significant differences when reared on *I. purchasi* at 16, 20, 24, 28 and 32ºC, respectively.

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تأثير درجة الحرارة الثابتة على الصفات البيولوجية والكفاءة الافتراسية لمفترس ابو العيد فيداليا

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* أجريت التجارب المعملية لدراسة تأثير درجات الحرارة بمربى الحشرات بقسم الحشرات الإقتصادية- كلية الزراعة- جامعة المنصورة بالحضان.
* متوسط فترة الطور اليرقى للمفترس عند تربيته على الحوريات فى العمر الثالث على درجات 20، 24، 28ْم كانت 20.7 ±0.34 ، 11.8 ± 0.34 ، 7.3 ± 0.49 يوم على التوالى .
* متوسط الإستهلاك الكلى للأعمار اليرقية للمفترس على درجات الحرارة 20، 24، 28ْم بلغت 28.80 ± 2.18، 60.50 ± 2.48، 53.45 ± 3.27 فرد/ يرقة مفترس وقد أشارت النتائج إلى أن أعلى إستهلاك كلى خلال الطور اليرقى للمفترس عندما تم تربيته على درجة حرارة 24ْم مع وجود إختلافات عالية المعنوية .
* وجد أن الكتلة الحيوية المحسوبة من الكربوهيدرات والدهون والبروتين المستهلك بواسطة يرقة واحدة من المفترس خلال الطور اليرقى كانت (38.30، 36.86، 21.89 مجم) ، (80.30، 77.44، 45.98) ، (71.09، 68.42، 40.62 مجم) على درجات الحرارة 20، 24، 28ْم على التوالى .
* متوسط فترة حياة الحشرة الكاملة الأنثى والذكر عند تربيتها على البق الدقيقي المصرى تحت درجات حرارة 20، 24، 28 أستغرقت (50.4 ± 2.16، 33.4±2.20)، (46.4 ± 2.12، 29.0 ± 2.09)، (22.4 ± 1.29، 15.1 ± 0.82 يوم) على التوالى .
* متوسط الإستهلاك الكلى للأنثى عند تغذيتها على البق الدقيقي المصرى بلغت 140.6 ± 5.72، 328.2 ± 10.90، 218.3 ± 9.14 فرد/ أنثى على درجات حرارة 20، 24، 28ْم على التوالى مع وجود إختلافات عالية المعنوية. أيضاً بالنسبة للذكر بلغت 50.3 ± 4.95، 145.8 ± 6.84، 107.8 ± 7.14 فرد/ ذكر مع وجود فروق عالية المعنوية .
* سجل أعلى معدل إستهلاك للأنثى خلال فترة وضع البيض خصوصاً تحت درجة حرارة 24ْم (289.0 ± 10.53 فرد/ أنثى) ونتيجة ذلك كانت الأعلى فى كمية البيض الموضوع (354.30 ± 19.90 بيضة/ أنثى). وخلاصة ذلك أن أفضل درجة حرارة لتربية أبو العيد فيداليا كانت 24ْم لأن الإناث وضعت أعلى عدد من البيض على هذه الدرجة.

قام بتحكيم البحث

أ.د / هاله احمد كامل الصيرفى	**كلية الزراعة – جامعة المنصورة**
أ.د / محمود رمزى شريف	**مركز البحوث الزراعيه**