

## BIOLOGICAL ASPECTS OF THE TRUE SPIDER *KOCHIURA AULICA* (ARANEIDA: THERIDIIDAE) REARED ON THE FIRST LARVAL STAGE OF *SPODOPTERA LITTORALIS* IN EGYPT

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**ABSTRACT:** *Specimens of Kochiura aulica spider were collected from cotton crops in Qalyubia governorate during season 2017. Spiders were associated with the leaf cotton worm, Spodoptera littoralis (Boisduval, 1833) larvae. The spider Kochiura aulica (C.L. Koch, 1838) had 5 spiderlings for female and male. Individuals of the spider K. aulica were reared on the first larval stage of S. littoralis under laboratory conditions at three constant temperatures (20, 25 and 30°C and 60-70% R.H). The first spiderling recorded the longest duration compared to other spiderlings of female and male when fed on 1<sup>st</sup> larval stage of S. littoralis at three constant temperatures. Results indicate that individuals of K. aulica which were reared at 30 °C developed faster than those reared at 20 and 25 °C. The life cycle of K. aulica was the shortest when the spider reared at 30°C averaged 79.3 and 76.2 days followed by 25°C averaged 103 and 98.3 days and the longest values was 123.7 and 118.2 days at 20°C for female and male, respectively with significant differences among the three constant temperatures. Prey consumption was calculated for different stages. Effect of constant temperatures on longevity, life span and fecundity of the spider were studied. The number of consumed preys was the highest at 30 °C and the lowest at 20 °C. Also, the number of egg sacs per female was the highest at 30 °C and the lowest at 20 °C.*

**Key words:** *Theridiidae, biology, food consumption, Spodoptera littoralis, spider.*

### INTRODUCTION

Spiders are one of the more diverse arthropod taxa, ranking 7<sup>th</sup> class in global diversity, which makes them a fascinating group to study (Coddington and Levi, 1991). True spiders are worldwide distributed and occupy many ecological environments. Taxonomists documented about 117 families, 4128 genera and 48086 species (World Spider Catalog, 2019).

Spiders are the most widespread of the predators, often they exist in any place, in particular in the agricultural ecosystem where they are beneficial in the reduction of the population density of the pests (Ghabbour *et al.*, 1999); they devour any small arthropods. Thus they can play an important role in the control of the pests. Spiders consider from the

biocontrol agents they fed on most of pests of vegetables, crops, ornamental and orchard trees (Jeppson *et al.*, 1975).

*Kochiura aulica* was primarily described as *Theridion aulicum* by C.L. Koch in 1838, transferred to *Kochiura* by Archer in 1950, then to *Anelosimus* by Levi in 1956, and restored to *Kochiura* again by Agnarsson (2004). This spider was recorded from different governorates of Egypt (El-Hennawy, 2002 and Sallam, 2002).

*Spodoptera littoralis* (Boisduval, 1833) (Lepidoptera: Noctuidae), is one of the most destructive agricultural lepidopteron pests within its subtropical and tropical range. It is attacking plants belonging to 44 different families including grasses, vegetables, crops and deciduous fruit trees all containing



species of highly economic importance (Abdel-Megeed, 1975). Many researchers studied the biological aspects of some spiders as biological control agents for many pests (Rahil and Hanna, 2001; El-Erksousy *et al.*, 2002; Hussein *et al.*, 2003; Abdel-Karim, *et al.*, 2006; Ahmad *et al.*, 2009; Abdel-Azim, 2014; Ahmad and Heikal, 2016).

This study conducted to investigate the potential and biological parameters of spider *K. aulica* reared on the first larval stage of *S. littoralis* under laboratory conditions.

## MATERIAL AND METHODS

### Rearing of prey insect *S. littoralis*:

Cotton leaf worm, *S. littoralis* was reared in the laboratory using a method described by Mostafa (1988). Field-collected egg batches of *S. littoralis* were cultured on castor bean leaves *Ricinus communis* L., in glass jars, 20 cm diameter and 15 cm height, which were washed in running water and dried before being placed in rearing jars. The jars were covered with muslin cloth held in position by rubber bands and kept in an incubator at 25°C and 60-70 % R.H. The jars were daily examined. Adult moths were confined in glass chimneys as oviposition cages. These oviposition cages were provided with pieces of cotton soaked in 10% sugar solution for adult nourishment. The obtained eggs were re-cultured as mentioned above. The batches were left until hatch and the first larval instars were taken as preys to the spider.

### Stock culture and mass rearing of *K. aulica*:

Ten adult females of *K. aulica* were collected on 10 June 2017 from cotton crop, Kaha city, Qalyubia governorate, Egypt. It was reared individually inside a plastic vials, fed until laid egg sacs and observed till hatching. Every female laid

an egg sac, the newly hatched spiderlings were feed on 1<sup>st</sup> larva of *S. littoralis*. Each spiderling was supplied with a known number of the prey and observed till reached maturity. These experiments were carried out in an incubator at three constant temperatures (20, 25, 30°C and 60-70% R.H.) Spider individuals were examined every two days and the numbers of consumed prey individuals were recorded and replaced by another live one.

### Biological aspects:

Biological aspects of *K. aulica* were studied as follows: feeding behavior, spiderling duration (days), food consumption (preys/spider/day), mating, life cycle, longevity and life span of spider females and males. Also, the pre-oviposition, oviposition and post-oviposition periods (in days), number of egg sac/female and total number of eggs/sac of the spider females were estimated.

Statistical analysis: One way Anova was calculated by using SAS statistical software (SAS Institute, 2010). In addition, LSD (Fisher's Significant Difference Test) was chosen to identify the significant difference within group.

## RESULTS AND DISCUSSION

### Behavior of mating:

The adult female of *Kochiura aulica* was fed about 24 hours before introducing the male into the same glass container. The male moved towards female's web jerking his pedipalps until reaching it. Then, he touched the tips of the female's legs and pedipalps. A preparatory period preceded copulation.

### Behavior of feeding:

The spider *K. aulica* attacked *S. littoralis* larva from the inter-secutar

membrane between head and thorax, then sucked its contents.

#### **Duration of *K. aulica* Incubation period:**

The egg sac was spherical in shape, pale white and became dark before hatching. As shown in Table (1) the incubation period of *K. aulica* eggs lasted 24.7, 19.7 and 15.3 days for the females and males which fed on 1<sup>st</sup> instars larva of *S. littoralis* at temperatures 20, 25 and 30°C, respectively. These data are confirmed by that of Abdel-Azim (2014) who indicated that the incubation period of *Theridion melanostictum* eggs was averaged as 24.5 days. In addition, Abdel-Karim *et al.* (2006) found that the incubation period was lasted 13 days in individual and group rearing, moreover there were significant differences among the three constant temperatures on the egg hatchability.

#### **Spiderling duration:**

The obtained results in Table (1) revealed that *K. aulica* has 5 spiderlings for female and male. The first spiderling of *K. aulica* fed on 1<sup>st</sup> instars of *S. littoralis* lasted 22.3, 18.7 and 14.7 days for female and 19.7, 18.3 and 14.2 days for male at temperatures 20, 25 and 30°C, respectively. The 2<sup>nd</sup> spiderling averaged 19.3, 16.7 and 13.7 days for female and averaged 18.3, 16 and 13.7 days for male at temperatures 20, 25 and 30°C, respectively. In the same vein the 5<sup>th</sup> spiderling lasted 18.7, 15.7 and 11.3 days for female and 18.8, 14.3 and 11 days for male at temperatures 20, 25 and 30°C, respectively.

Thus, the total immature stages lasted 99, 83.3, 64 days for female and 93.5, 78.7 and 60.8 days for male at the same constant temperatures. Statistical analysis of data showed that, when the individuals fed on 1<sup>st</sup> instars larva of *S. littoralis* the duration of spiderling and

the life cycle was affected by the degree of temperature, where high significant differences were recorded. The shortest period was recorded with the individuals fed on prey at 30°C while the longest period was recorded at 20°C.

The life cycle duration at temperatures 20, 25 and 30°C, recorded 123.7, 103 and 79.3 days for female; moreover it recorded 118.2, 98.3 and 76.2 days for male, respectively. Generally, there were significant differences among the three constant temperatures on all stages of spider duration.

The obtained results are in harmony with that detected by El-Erksousy *et al.* (2002) who demonstrated that total duration of male life cycle was shorter than that of female, when studied the biological aspects of the spider *A. aulicus* Koch on *S. littoralis*. Total spiderlings of male and females lasted 51.1±1.6 and 57.5±2.7 days for males and females, respectively when *Theridion melanostictum* fed on *S. littoralis* (Abdel-Azim, 2014). Also, Abdel-Karim *et al.* (2006) indicated that life cycle of the same species in individual rearing was 36.83 & 39.78 days for female and male, respectively feeding on *S. littoralis*. Also he added that the constant temperature and humidity during rearing had an evident effect on life cycle duration. Also, the kind of prey affected life cycle duration.

#### **Longevity and life span:**

The longest life span of *Kochiura aulica* lasted 240.3 and 144.8 days at 20°C while, it recorded the shortest period as 164.8 and 99.8 days 30°C, with significant differences among the three constant temperatures (Table 1). These results are in accordance with that of Abdel-Karim *et al.*, (2006) who observed that the constant temperature and

Table (1): Duration of the true spider *Kochiura aulica* stages when fed on first larval stage of *Spodoptera littoralis* at three constant temperatures

Biological aspects	Duration of female stages (Mean $\pm$ SD.) (days)			L.S.D at 0.05	Duration of male stages (Mean $\pm$ SD.) (days)			L.S.D at 0.05
	20°C	25°C	30°C		20°C	25°C	30°C	
Incubation period	24.7 $\pm$ 0.52 a	19.7 $\pm$ 0.52 b	15.3 $\pm$ 0.52 c	0.63	24.7 $\pm$ 0.82 a	19.7 $\pm$ 0.82 b	15.3 $\pm$ 0.82 c	1.00
1 <sup>st</sup> spiderling	22.3 $\pm$ 2.25 a	18.7 $\pm$ 0.52 b	14.7 $\pm$ 0.82 c	1.74	19.7 $\pm$ 0.52 a	18.3 $\pm$ 0.52 b	14.2 $\pm$ 1.17 c	0.97
2 <sup>nd</sup> spiderling	19.3 $\pm$ 0.52 a	16.7 $\pm$ 0.82 b	13.7 $\pm$ 1.03 c	1.00	18.3 $\pm$ 0.82 a	16.0 $\pm$ 0.89 b	13.7 $\pm$ 0.82 c	1.00
3 <sup>rd</sup> spiderling	19.7 $\pm$ 0.82 a	16.3 $\pm$ 0.52 b	11.7 $\pm$ 1.21 c	1.10	18.3 $\pm$ 0.52 a	15.3 $\pm$ 0.52 b	11.3 $\pm$ 0.82 c	0.77
4 <sup>th</sup> spiderling	19.0 $\pm$ 0.89 a	16.0 $\pm$ 0.89 b	12.7 $\pm$ 1.37 c	1.32	18.3 $\pm$ 0.82 a	14.7 $\pm$ 1.37 b	10.7 $\pm$ 0.52 c	1.18
5 <sup>th</sup> spiderling	18.7 $\pm$ 0.52 a	15.7 $\pm$ 0.52 b	11.3 $\pm$ 0.52 c	0.63	18.8 $\pm$ 0.41 a	14.3 $\pm$ 0.52 b	11.0 $\pm$ 0.63 c	0.64
Total spiderling	99.0 $\pm$ 1.67 a	83.3 $\pm$ 2.07 b	64.0 $\pm$ 3.58 c	3.16	93.5 $\pm$ 0.84 a	78.7 $\pm$ 2.25 b	60.8 $\pm$ 2.14 c	2.28
Life cycle	123.7 $\pm$ 1.37 a	103.0 $\pm$ 2.53 b	79.3 $\pm$ 4.08 c	3.54	118.2 $\pm$ 1.17 a	98.3 $\pm$ 2.94 b	76.2 $\pm$ 2.40 c	2.82
Longevity	116.7 $\pm$ 9.31 a	93.7 $\pm$ 3.61 b	85.5 $\pm$ 0.84 c	7.12	26.7 $\pm$ 2.58 b	31.7 $\pm$ 1.37 a	23.7 $\pm$ 1.80 c	2.50
Life span	240.3 $\pm$ 10.58 a	196.7 $\pm$ 6.06 b	164.8 $\pm$ 4.26 c	9.17	144.8 $\pm$ 3.06 a	130.0 $\pm$ 4.29 b	99.8 $\pm$ 0.75 c	3.78

The means with the same letters at the same row are not significantly different at 0.05% level.

humidity during rearing had an evident effect on life cycle duration. Also, the kind of prey affected life cycle and life span duration. While, Ahmad and Heikal (2016) indicated that the life span lasted on  $160.17 \pm 2.04$  and  $155.27 \pm 8.88$  days for male and female, respectively.

The longest female pre-oviposition, oviposition and post-oviposition periods averaged 26.7, 63.3 and 26.7 days at 20°C, whereas, it averaged shortest period as 15.8, 50 and 19.7 days at 30°C. Applying the same tests as shown in (Table 2), it was shown that the shortest period of female longevity lasted 85.5 days when reared at 30 °C, while longest period lasted 116.7 days, at 20°C. Whereas the shortest period of male longevity as 23.7 days at 30°C and longest period as 31.7 days at 25°C, with significant different between the three constant temperatures (Table 1). These results run with that published by Hussein *et al.* (2003) who revealed that adult male and female lived for longer period when reared on *Tetranychus urticae* Koch, *Aphis craccivora* Koch diets in spring-summer it averaged 73.10 & 144.00 days compared by 60.00 & 122.00 days when only fed on aphids.

**Fecundity of the females:**

The results in Table (2) indicated that, the average number of egg sac per female of *Kochiura aulica* fed on *S littoralis* larvae, was  $2.5 \pm 0.55$  when reared at 20°C and  $3.5 \pm 0.55$  when reared at 25°C, whereas the highest values was record at 30°C as 4.2 egg sac per female. In addition, the average number of individuals emerged from the egg sac was 14.7, 22.7 and 28.3 when fed at 20, 25 and 30°C, respectively with significant differences among the three constant temperatures.

This is comparable to that achieved by Rahil and Hanna (2001) who show that the adult females of *K. aulicus* Koch spider consumed large number of prey than males. Also, the same authors indicated that the oviposition period of *K. aulicus* was 28-96 days for female that mated more than once. The pre-and post-oviposition periods were 9-16 and 51-210 days, respectively. However, Abdel-Karim *et al.*, (2006) reported that egg sacs per female per day during the first 20 days of oviposition period in individual rearing was 3.00 egg sacs while in group rearing it was 0.91 egg sacs, feeding on *S. littoralis*.

**Table (2): Longevity and fecundity of female spider *Kochiura aulica* when fed on first larval stage of *Spodoptera littoralis* at three constant temperatures**

Biological aspects	Duration of different stages (days) (Mean ± SD.)			L.S.D at 0.05
	20°C	25°C	30°C	
Pre-oviposition period	26.7 ±2.58 a	19.0 ±0.89 b	15.8 ±0.75 c	2.01
Oviposition period	63.3 ±6.83 a	55.0 ±4.47 b	50.0 ±0.89 b	5.83
Post-oviposition period	26.7 ±2.85 a	19.7 ±0.52 b	19.7 ±1.03 b	2.0
Longevity	116.7 ±9.31 a	93.7 ±3.61 b	85.5 ±0.84 c	7.12
Total number of eggs/sac	2.5 ±0.55 b	3.5 ±0.55 a	4.2 ±1.17 a	0.99
Number of eggs sac/ female	14.74.03 c	22.74.93 b	28.32.66 a	4.9

The means with the same letters at the same row are not significantly different at 0.05% level.

**Table (3): Food consumption of female spider *Kochiura aulica* when fed on first larval stage of *Spodoptera littoralis* at three constant temperatures**

Biological aspects	No. of prey consumed/ spider (Mean ± SD.)			L.S.D at 0.05	Daily No. of prey consumed /spider/day (Mean ± SD.)			L.S.D at 0.05
	20°C	25°C	30°C		20°C	25°C	30°C	
1 <sup>st</sup> spiderling	51.7±9.31 b	68.3±2.58 a	51.8±2.48 b	7.08	2.3±0.24 b	3.7±0.21 a	3.5±0.13 a	0.25
2 <sup>nd</sup> spiderling	45.0±4.47 c	66.7±5.16 b	87.7±4.08 a	5.65	2.3±0.18 c	4.0±0.25 b	6.5±0.73 a	0.56
3 <sup>rd</sup> spiderling	49.7±7.50 c	68.3±6.83 b	97.3±3.93 a	7.70	2.5±0.33 c	4.2±0.54 b	8.4±1.11 a	0.91
4 <sup>th</sup> spiderling	45.0±4.29 c	88.3±9.31 b	115.8±3.92 a	7.70	2.4±0.34 c	5.6±0.86 b	9.2±1.02 a	0.98
5 <sup>th</sup> spiderling	43.3±2.58 c	96.7±5.16 b	126.2±3.76 a	4.89	2.3±0.18 c	6.2±0.13 b	11.2±0.72 a	0.53
Total spiderling	234.7±27.25 c	388.3±5.16 b	478.8±14.70 a	22.30	11.9±1.21 c	23.6±0.73 b	38.8±3.53 a	2.71
Pre-oviposition	55.0±4.47 c	88.3±2.58 b	98.3±2.58 a	4.10	2.1±0.26 c	4.7±0.27 b	6.2±0.29 a	0.34
Oviposition	136.7±13.66 a	91.7±2.58 c	109.7±0.52 b	9.88	2.2± 0.02 a	1.7±0.14 b	2.2±0.03 a	0.1
Post-oviposition	58.3±6.83 b	103.7±4.93 a	110.0±8.94 a	8.72	2.2±0.18 b	5.3±0.23 a	5.6±0.69 a	0.53
Longevity	250.0±24.90 c	283.7±4.93 b	318.0±11.73 a	19.86	6.4± 0.24 c	11.6±0.32 b	14.0±0.70 a	0.57
Life span	484.7±52.04c	672.0±5.44 b	796.8±10.67 a	37.94	18.3± 1.43 c	35.2± 0.42 b	52.9±2.89 a	2.31

The means with the same letters at the same row are not significantly different at 0.05% level.

Table (4): Food consumption of male spider *Kochiura aulica* when fed on first larval stage of *Spodoptera littoralis* at three constant temperatures

Biological aspects	No. of prey consumed/ spider (Mean $\pm$ SD.)			L.S.D at 0.05	Daily No. of prey consumed /spider/day (Mean $\pm$ SD.)			L.S.D at 0.05
	20°C	25°C	30°C		20°C	25°C	30°C	
1 <sup>st</sup> spiderling	49.0 $\pm$ 2.24 b	68.8 $\pm$ 1.64 a	50.00 $\pm$ 4.47 b	3.90	2.46 $\pm$ 0.07b	3.73 $\pm$ 0.12 a	3.54 $\pm$ 0.27 a	0.21
2 <sup>nd</sup> spiderling	40.8 $\pm$ 1.10 c	68.0 $\pm$ 7.58 b	78.33 $\pm$ 6.83 a	7.25	2.22 $\pm$ 0.11 c	4.19 $\pm$ 0.66 b	5.75 $\pm$ 0.66 a	0.65
3 <sup>rd</sup> spiderling	44.0 $\pm$ 2.24 c	67.0 $\pm$ 6.71 b	94.17 $\pm$ 4.92 a	6.25	2.37 $\pm$ 0.20 c	4.47 $\pm$ 0.58 b	8.36 $\pm$ 0.99 a	0.82
4 <sup>th</sup> spiderling	46.0 $\pm$ 4.18 c	88.0 $\pm$ 4.47 b	93.33 $\pm$ 5.16 a	6.08	2.46 $\pm$ 0.24 c	5.93 $\pm$ 0.24 b	8.76 $\pm$ 0.45 a	0.4
5 <sup>th</sup> spiderling	44.2 $\pm$ 0.45 b	94.0 $\pm$ 5.48 a	96.67 $\pm$ 5.48 a	5.20	2.35 $\pm$ 0.05c	6.51 $\pm$ 0.12 b	8.80 $\pm$ 0.42 a	0.32
Total spiderling	224.0 $\pm$ 8.57 c	385.8 $\pm$ 10.06 b	412.50 $\pm$ 9.08 a	11.81	11.86 $\pm$ 0.44 c	24.83 $\pm$ 0.60b	35.21 $\pm$ 1.20a	1.01
Longevity	64.4 $\pm$ 2.51 b	88.0 $\pm$ 2.74 a	88.33 $\pm$ 2.74 a	3.30	2.41 $\pm$ 0.32 c	2.79 $\pm$ 0.16 b	3.76 $\pm$ 0.41 a	0.38
Life span	288.4 $\pm$ 10.71 c	473.8 $\pm$ 8.23 b	500.83 $\pm$ 7.07 a	11.75	14.27 $\pm$ 0.76 c	27.62 $\pm$ 0.63 b	38.97 $\pm$ 0.83a	0.91

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## المظاهر البيولوجية للعنكبوت *Kochiura aulica* (Araneida: Theridiidae) عند تغذيته على الطور اليرقى الأول لدودة ورق القطن في مصر

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### الملخص العربي

تم جمع عينات العنكبوت من حقول القطن بمحافظة القليوبية خلال موسم ٢٠١٧ مرتبطاً بالاطوار اليرقية لدودة ورق القطن. وجد ان العنكبوت (*Kochiura aulica* (C.L. Koch, 1838) له خمسة أعمار يرقية للذكور والإناث. تم تربية العنكبوت *K. aulica* على الطور اليرقى الأول لدودة ورق القطن تحت الظروف المعملية تحت ثلاث درجات حرارة ٢٠، ٢٥، ٣٠م° ورطوبة نسبية ٦٠-٧٠%. كان للعمر اليرقى الأول للعنكبوت أطول فترة تطور عن باقي الأعمار اليرقية بالنسبة للذكور والإناث عند تغذيتها على الطور اليرقى الأول لدودة ورق القطن على الثلاثة درجات حرارة. وأشارت النتائج أن أفراد العنكبوت *K. aulica* التي تم تربيتها على درجة حرارة ٣٠م° تطورت بسرعة عن التي تم تربيتها على درجتي حرارة ٢٠، ٢٥م°. سجلت أقصر دورة حياة للعنكبوت عند التربية على درجة حرارة ٣٠م° بمتوسط ٧٩,٣، ٧٦,٢ يوماً، يليها درجة حرارة ٢٥م° بمتوسط ١٠٣، ٩٨,٣ يوماً بينما اقصر فترة كانت ١٢٣,٧، ١١٨,٢ يوماً على درجه حرارة ٢٠م° للإناث والذكور على التوالي مع وجود فروق معنوية بين الثلاثة درجات حرارة. تم حساب عدد الفرائس المستهلكة للأطوار المختلفة. وتم دراسة تأثير درجات الحرارة على طول فترة حياة الطور الكامل للعنكبوت وطول فترة الحياة والخصوبة. كان أعلى استهلاك للفرائس على درجة حرارة ٣٠م° واقلها على درجة حرارة ٢٠م°، وكان أعلى عدد من أكياس البيض التي وضعتها الأنثى على درجة حرارة ٣٠م° واقلها على درجة ٢٠م°.

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