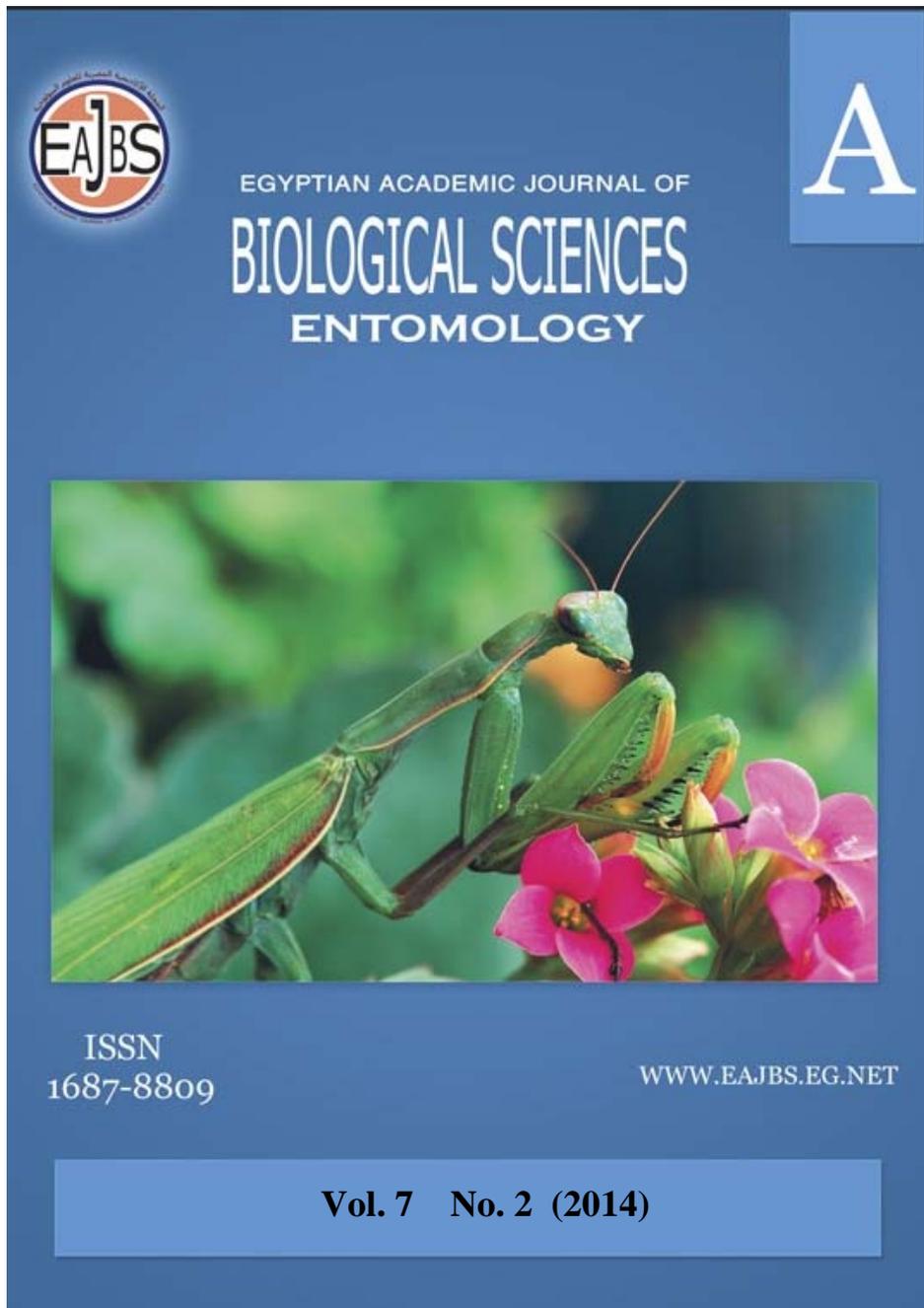


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Biological Aspects of the Spider *Theridion incanescens* (Araneae: Theridiidae) Feeding on *Tetranychus urticae* and *Ceratitis capitata* With Notes on its Mating Behaviour

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ABSTRACT

The life history of *Theridion incanescens* Simon, 1890 is studied for the first time in Egypt. *T. incanescens* was first recorded from Egypt in 2012. It was collected from *Aloe vera* cultivated in Giza, mango, citrus and grape trees at El-Sharqia & Ismailia. The individuals were reared under laboratory conditions and were fed every two days on motile stages of *Tetranychus urticae* (Koch, 1836) until reaching to subadults, after that they were fed on *Ceratitis capitata* (Wiedemann). The males and females reached maturity in the fifth instar after 41–47 & 34–52 days respectively. Adult longevity, life span, fecundity of female and food consumption were studied too. The mating behaviour of *T. incanescens* was described. It began with courtship followed by four copulatory sequences. Total duration of the mating behaviour was 3:05 hour.

Keywords: *Theridion incanescens*, life cycle, feeding, mating behaviour, spiders, *Ceratitis capitata*, *Tetranychus urticae*, life history, Theridiidae, Egypt.

INTRODUCTION

Theridion Walckenaer, 1805 is the type genus of Family Therididae Sundell, 1833, as defined by Levi (1957, 1959, 1963). *Theridion* has more than 570 species worldwide distributed (Platnick, 2013). In Egypt, there are 8 species recorded of genus *Theridion*: *Theridion melanostictum* O.P.-Cambridge, 1876, *T. musivum* Simon, 1873, *T. nigrovariegatum* Simon, 1873, *T. spinitarse* O.P.-Cambridge, 1876, *Theridion varians* Hahn, 1833 (El-Hennawy, 2006), *T. cairoense* (Wunderlich, 2011), *T. incanescens* Simon, 1890 and *T. jordanense* Levy & Amitai, 1982 (Thaler-Knoflach, & El-Hennawy 2012). Genus *Theridion* is widely distributed in Egypt: Cairo, Alexandria, Nile Delta, Ismailia, Suez, Sinai and Upper Egypt (El-Hennawy 2006).

Theridion melanostictum was reared in laboratory by Abo-Taka *et al* (2004) who studied its life history, fecundity, feeding behaviour, mating behaviour, sex ratio and rate of food consumption. Spiders are thought to be obligatory predators that feed on a wide variety of prey (Foelix, 1996). The Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera : Tephritidae), is one of the most polyphagous and important pests of edible fruits worldwide (Weems, 1981; Liquido *et al.*, 1991). Its host range includes

more than 350 species of fruits and vegetables (Liquidó *et al.*, 1991). In Egypt, *C. capitata* attacks several fruits which are available all over the year causing considerable damage which inflicts significantly economic losses to peach, apricot, guava, mango, fig and citrus all over governorates (Saafan, 1986). Some spiders were observed to attract to traps containing the parapheromone trimedlure and males of *Ceratitis capitata* (Kaspi, 2000). *T. incanescens* was first recorded from Egypt by Thaler-Knoflach & El-Hennawy (2012), found on cultivated *Aloe vera*. Also it was collected from some fruit trees. This work studies its life history and behaviour.

MATERIAL AND METHODS

Spiders rearing:

Adult females of *T. incanescens* were collected from *Aloe vera* cultivated in Giza and from mango, citrus and grapes at El-Sharqia & Ismailia Governorates. Specimens were reared under laboratory conditions, 28-30°C and 60-70% R.H in plastic vials (3cm diameter x 5cm height). Two females laid egg sacs. Hatched spiderlings were individually reared and fed, every two days, on motile stages of *Tetranychus urticae* mites picked up by camelhair brush until reached to subadults, after that they were fed on adults of *C. capitata* picked up by glass tubes, then transferred to the spiders' vials.

Mating behaviour

More than ten couples of *T. incanescens* were observed with a stereo microscope and videotaped with a Nikon P510. The behaviour was described by terminology cited after Knoflach (1998).

Production of *Tetranychus urticae*

A colony of *T. urticae* was reared in the laboratory on twigs of sweet potato (*Ipomoea batatas* Lam.) inserted in conical flask full of water.

Production of *Ceratitis capitata*

A culture of *C. capitata* (Wied.) was obtained from the established culture in the fruit flies rearing laboratory, Plant Protection Research Institute. Adult flies were reared in wooden cage (30×30×30cm) where three sides were covered with wire screen and the fourth was covered with muslin cloth for laying eggs. Deposited eggs were received in a plastic tray filled with water put at the bottom of the cage side covered with the muslin cloth. The flies were fed on the mixture of enzymatic yeast hydrolyzate and sugar placed in Petri dishes. The flies were supplied with water through a piece of sponge. The females deposit their eggs through the muslin side of the cage. Eggs were collected daily, measured volume, transferred to the surface of the artificial rearing medium in trays and kept in laboratory at a constant temperature (25± 1°C). The full grown larvae jump outside the rearing trays and allowed to pupate in a layer of fine sand. The sand containing the pupae was sieved to separate the pupae. The pupae were transferred to plastic containers which were placed in the adult rearing cages until emergence.

RESULTS AND DISCUSSION

Incubation period, sex ratio and spiderlings

White egg sacs were laid, became dark yellow before hatching. The incubation period was 6 days under laboratory conditions, 28°C ±2 and 60-70% R.H.

After hatching the 59 spiderlings were reared. Seven individuals escaped before reaching maturity and 18 individuals died before adulthood. Only 34 individuals reached adult stage (15 males and 19 females). Sex ratio (male: female) was 1: 1.3

Maturity was as reached in the fifth instars for males and females. *Anelosimus aulicus* developed and molting 5th time through five spiderlings before reaching adulthood for both male and female (Hussein *et al*, 2003).

T. melanostictum reached maturity in the fifth instar for females and fourth one for males (Abo-Taka *et al*, 2004).

The duration of the different stages of *T. incanescens* varied among instars. The longest duration was that of the first and fifth instars in males and females (Table 1). The duration of other instars were similar.

Table 1: Duration of different stages of *Theridion incanescens* Simon, 1890.

Developmental Stage	Duration (days)					
	Male			Female		
	Mean	S.D.	Range	Mean	S.D.	Range
Incubation period	6	0	6	6	0	6
1st instar	11.57	1.09	9 - 12	11.60	1.06	9 - 12
2nd instar	6.29	0.73	6 - 8	6.07	1.10	6 - 8
3rd instar	5.00	0.00	5	5.80	2.57	5 - 12
4th instar	6.07	3.47	5 - 18	5.13	0.35	5 - 6
5th instar	8.43	2.77	5 - 13	10.20	3.88	7 - 18
Total spiderling instars	36.92	2.84	35 - 41	38.80	5.17	28 - 46
Life cycle	42.92	2.84	41 - 47	44.80	5.17	34 - 52
Adult longevity	33.83	16.45	16 - 60	124.25	54.99	62 - 172
Life span	76.75	18.91	57 - 107	170.25	58.81	103 - 223
Unmated female longevity	--	--	--	171.86	27.47	151-192

Adult longevity and Life span

The adult longevity duration of *T. incanescens* differed according to the sex. Males lived shorter than females whereas the virgin female had longest adult longevity duration (Table 1). Adult longevity on *T. melanostictum* also differed according to sex and food type (Abo-Ttaka *et al*, 2004).

Developmental period of female

The oviposition duration of *T. incanescens* proximately equal the post-oviposition duration while it was twice of the pre-oviposition duration (Table 2).

During oviposition period, the female laid 3-5 egg sacs; every egg sac contained 20-35 eggs.

Table 2: Fecundity of *Theridion incanescens* Simon, 1890 female.

	Mean	S.D.	Range
Pre-oviposition duration (days)	20.50	11.21	7 - 32
Oviposition duration (days)	53.50	21.06	25 - 73
Post-oviposition duration (days)	50.25	25.85	21 - 72
Number of eggs / egg sac	28	7.21	20- 35
Number of egg sacs / female	4.2	0.84	3 - 5

T. melanostictum female constructed 2-5 egg sacs during her oviposition period of 9 to 27 days when fed on *T. urticae* and constructed 4-5 egg sacs during 19-25 days when fed on *Brevicoryne brassicae*. The number of eggs/egg sac was 13-37 in the first case and 17-37 in the second one (Abo-Taka *et al*, 2004).

Food consumption

Obtained results of *T. incanescens* fed on *T. urticae* during first, second and third instars. Fourth, fifth instars and adults fed on *C. capitata* as presented in Table (3).

The average number and daily rate of consumed *T. urticae* gradually increased according to males and females' development. Average number and daily rate of consumed prey per female were more than those of males (Table 3).

Similar results were observed for consumed *C. capitata* which gradually increased during the fourth, fifth and adult stages. Average number of consumed prey per the female was more than for the male (Table 3).

Table 3: Food consumption of *Theridion incanescens* different stages.

Developmental Stage	Prey	Male				Female			
		Total			Daily rate	Total			Daily rate
		Mean	S.D.	Range		Mean	S.D.	Range	
1 st instar	<i>T. urticae</i>	192.79	16.38	170- 222	16.84	199.47	31.54	123 - 240	17.42
2 nd instar		344.64	32.67	299- 397	55.57	385.20	70.72	299 - 512	65.87
3 rd instar		459.50	26.25	428 -489	91.90	482.60	43.82	433 - 577	93.59
4 th instar	<i>C. capitata</i>	7.43	1.70	6- 11	1.40	10.60	2.03	8 - 15	2.06
5 th instar		13.29	0.91	12- 14	1.71	20.80	7.92	10 -36	2.26
Adult longevity		61.57	36.68	16- 130	2.01	304.73	112.01	124 - 546	2.33

Mating behaviour of *Theridion incanescens*

The mating behaviour of *T. incanescens* began with a courtship followed by four copulatory sequences. The first one is a "Pseudocopulation" without sperm induction and the last one was with "mating plug". Total duration of the mating behaviour was 3:05 hour.

Courtship

After 4:45 minutes of inserting the male inside the female's container, the male contacted the female's web. He was plucking and turned to another direction repeating plucking during movement against the female. He touched her abdomen and rapidly returned to the first position within 1:30 minutes. Plucking and other acts were almost repeated in a similar manner and courtship persisted 12 minutes.

Pseudocopulation

Pseudocopulation means no sperm transferred during copulation sequence (Helsdingen, 1965). The male and female were palpating for 7 seconds; after that they contacted by I & II legs. The male inserted left palp simultaneously with abdomen pulsating of the female alternately 13 times within 18 seconds. The acts and rest times were repeated and the pseudocopulation persisted 4.30 minutes.

Copulation

During copulation the male copulated his female by 3 sequences, pre each one he constructed sperm web followed by sperm induction.

Sperm web building

The male left the female and went to make a horizontal thread linked to the female's web. He began spinning in a vertical line, to end at another point and went back to make two parallel threads, equal and close together to stand upon them by his last pair of legs. Among the claws of the third pair of legs, the male has built his sperm web within 45 seconds.

Sperm induction

After that, the male flexed his abdomen between the body and the legs to approach epigastric furrow 4 times to sperm web to put a sperm drop. The male up took sperms by dipping movements with exchange of his two palps. The number of palpal dips was 22, 36 and 40 times during 36, 44 and 95 seconds in the first, second and third copulatory sequences.

The true copulatory sequences:**The first true copulatory sequences**

After sperm induction the male rubbed his palps while the female moved around herself twice during 0.25 seconds and stopped. Then the male approached towards her to stop in the middle of the distance between them to lick his tarsi of legs I & II. After that he moved around himself once (for 55 seconds). The male moved towards the female and began direct contact to interplay their palps and legs quickly up and down for 5 seconds.

The male became slightly distant and moved again around himself once and licked the tarsi of his four legs then moved towards the female again to directly contact and interplay. He repeated that 3 times (during 1.2 minutes) before inserting his left and right palps alternately. During all insertions, the palps of male had haematodochal swelling and his abdomen was pulsating. The number of palps insertion were 7 times per each, the mean of insertion duration was 20:14 seconds, the maximum and minimum duration were 22 and 18 seconds respectively. The total insertion time was 7:8 minutes.

After that, the male left the female to build the next sperm web to start another copulatory sequence.

The second true copulatory sequences

The total number of palps' insertions was 34 times, 17 per each.

The mean of the first 14 insertion durations of palps is proximate to the first copulatory sequence (22.43 seconds), the maximum and minimum duration were 31 and 19 seconds respectively. While the mean of the 20 remained insertion durations was 8.1 seconds, and the maximum and minimum durations were 19 and 3 seconds respectively.

The last copulatory sequences

After the male ended palps' insertions, he licked his palps for 2:25 minutes.

Total number of palps' insertions was 10 times (5 per each), but the insertion for each palp partite in twice alternately not equal duration followed by the another palp excepted the first insertion.

The first insertion durations were 26 and 20 seconds for the left and right palps respectively. While the mean of the 8 remained insertion durations was 18.3 seconds, and the maximum and minimum durations were 33 and 11 seconds respectively. After that, the male formation of the mating plug. The duration of the last copulatory sequences was about 45 minutes.

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