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BIOLOGY AND LIFE TABLE PARAMETERS OF THE COCCINELLID PREDATORY INSECT *Stethorus gilvifrons* (MULSANT) FED ON IMMATURES OF *Tetranychus urticae* (KOCH)

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ABSTRACT

Biological aspects of the predatory insect *Stethorus gilvifrons* (Mulsant) fed on nymphs of the two – spotted spider mite *Tetranychus urticae* Koch were studied in laboratory at 25 ± 1 ºC and 70 ± 5 % RH., Egg incubation period of eggs lasted 3.87 and 4.07 days for male and female, respectively. The first female larval instar was active stage lived for about 2.93 days, during which it consumed and 7.73 *T. urticae* individuals with a daily rate of 2.64 preys / day. The same trend was noticed within the second larval instar that lived for a shorter time 2.00 days and consumed 14.80 preys with a daily 7.40 preys. The third larval instar lived for 2.33 and consumed 25.46 with a daily rate of 10.92 preys / day. The fourth instar lasted 4.13 days during which it consumed 69.40 with daily rate of 16.80 prey individuals. Pupal stage lasted for 3.73 and 4.47 days for male and female, respectively. Life cycle durated 17.70 and 19.90 days for male and female , respectively.

Average male and female longivety was 24.33 and 36.46 days, respectively. Data showed that adult female of *S .gilvifrons*, which lived 36.46 days, consumed a total number of *T. urticae* nymphs 2267.13 prey nymphs / female .

Thus, adult female consumed during its oviposition period and longevity nearly 77.0 % and 95 % of the total consumed prey during its whole life span. The mean generation time (T) averaged 30.41days. Net reproductive rate (R_o) was 49.53 and the intrinsic rate of natural increase (r^m) was 0.12 , the finite rate of increase e^{rm} (λ) was 1.13.

Keywords : *Tetranychus urticae* - *Stethorus gilvifrons* – biology – life table

INTRODUCTION

The two – spotted spider mite *Tetranychus urticae* Koch is considered to be the most dangerous species of the family of tetranychidae. It is difficult to manage this group of mite pests by chemical compounds because a kind of resistance can be developed within a few years (Geoghiou, 1990). Therefore, it was necessary to develop some other control tactics such the use of biological control agents.Predatory mites especially the mesostigmatid mites are considered to be among the most promising bioagent of spider mites. Apart from the predatory mites, some insects are also known to have the ability to be natural enemies of spider mites. Predatory thrips, lady bugs and staphylinid species have been recognized as promising predators of spider mites (Gilstrap, 1995; Kishimoto, 2003 and Roy *et al.* 2003). The predaceous insects such as Stethorus species Weise (Coccinellidae: Coleoptera) are acariphagous where they feed successfully on spider mites (Kishimoto, 2003). All known species of this genus have been suggested to have potentiality as biological control agents of spider mites

(Baily and Caon, 1986; Felland and Hull, 1996; Rott and Ponsonby, 2000 and Ragkou *et al.*, 2004). However, given that this genus may have certain advantages as a potential biocontrol agent, further experiments are essential, in order to assess the feasibility of their use for mite control under the Egyptian local conditions. Therefore the present work aims to study all biological aspects during the whole life span of *Stethorus gilvifrons* Mulsant

MATERIAL AND METHODS

the predaceous coccinellid *Stethorus gilvifrons* (Mulsant) were colleted from leaves and twigs of castor plants *Ricinus communis* growing at the farm of the Faculty of Agriculture, Mansoura University, Mansoura district. Samples of plant leaves and twigs were collected in Polyethylene bags, with small pieces of cotton wool soaked in ether and brought to the laboratory for direct examination using a stereoscopic binocular microscope.

The adults of predaceous coccinellid *S. gilvifrons* were kept in plastic boxes 20 cm × 10 cm × 5 cm coverd with muslin on the top and the bottom covered with filter paper as shown in Fig.1. The box was provided with pieces of leaves of castor plants *Ricinus communis* which heavily infested with the spider mites *Tetranychus urticae* Koch as a source of sufficient food.

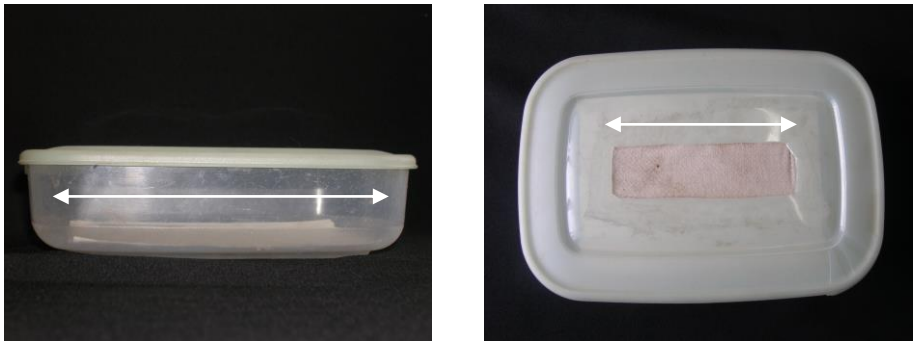

Fig. (1): Mass rearing unit for the predatory insects *Stethorus gilvifrons* preying immature of *T. urticae*.

Biological studies of *Stethorus gilvifrons* (Mulsant)

The predaceous coccinellid *Stethorus gilvifrons* (Mulsant) was colleted from leaves of castor plants *R. communis* and provided with nymphs of *Tetranychus urticae* as a source of food. Tetranychid mites were collected from leaves of castor plants at Mansoura district.

Predaceous coccinellid *S. gilvifrons* was kept in an incubator at 25 ± 1 ^{o}C and 70 ± 5 % RH., where the newly emerged females deposited its eggs.

The newly deposited eggs were singly transferred to small plant leaf discs of *Hibiscus mutabilis* (1 inch each) placed on moist cotton pad in Petri dishes (15cm in diameter). The cotton pad was supplied with moisture to keep leaf discs fresh and also to prevent immature individuals of coccinellid from escaping. Pupae were kept separately in plastic tubes (2 × 10 cm) Fig. 2, its

opening covered with pieces of muslin and a small piece of the tube wall (1 × 1 cm) was cut and covered with piece of muslin to keep suitable humidity. After emergance of the adult insects, they were coupled (♀ & ♂) and each kept in a tube provided with pieces of castor plant leaves heavily infested with the immature of spider mites ***T. urticae*** as a source of food.

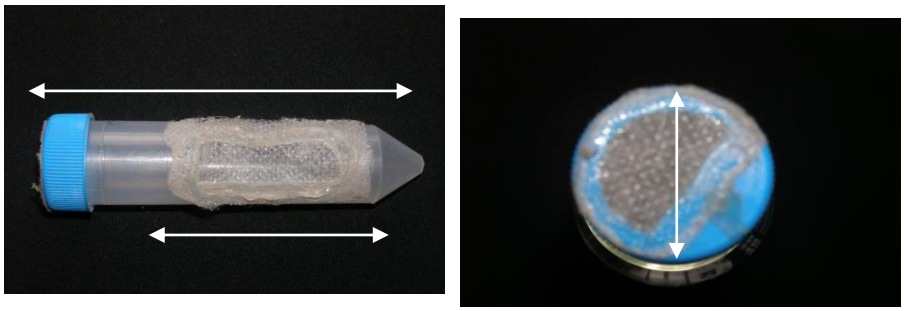

Fig. (2): Rearing unit for the predatory insect adult *Stethorus gilvifrons* preying immature of *T. urticae* with opening on upper and lateral side of the tube covered with muslin for aeration.

Data were recorded for the whole life span, where observations were noted twice daily. The rearing experiment was started with 20 newly hatched larvae.

Individual development, survival and egg production of adult females were observed where life table parameters were calculated according to Birch (1948), Laing (1968) and using the Basic Computer Program of Abou – Setta and Childers (1986), where:-

L_x : Number of females alive.
X : Actual female age.
M_x : Femal progeny / female.
L_x : Rate of survival (survivorship).
R_o : The net reproductive rate.
T : The mean generation time.
R_m : Interinsic rate of natural increase.
e^{rm} : Finite rate of increase.

RESULTS AND DISCUSSION

In a preliminarily study, it was found that *Stethorus gilvifrons* failed to develop when kept at 20 ^{0}C under laboratory conditions and provided with its common prey *Tetranychus urticae*. Therefore, individuals of this predatory insect species were reared at the most suitable temperature for most arthropods, 25 ^{0}C in an incubator to know as much as we can about its biology.

Similarly, Roy *et al.*, (2003) failed to get a good development from *S. punctillum* Weise, which was provided with *Tetranychus mcdanieli* McGregor kept at 16 – 18 ^{0}C.

However, data listed in Table (1) showed that egg incubation period averaged 3.87 and 4.07 days for male and female, respectively. The first female larval instar was an active stage that lived for about 2.93 days, during which it consumed 7.73 *T.urticae* nymphs with a daily rate of 2.64 preys / day as shown it Tables 1, 2 and Figs 3, 4.

The second larval instar lived for a shorter time 2.00 days and consumed 14.80 prey individuals with a daily rate of 7.40 nymphs. The third larval instar lived for 2.33 and consumed 25.46 with a daily rate of 10.92 mite nymphs / day (Tables 1, 2).

Data also showed that the fourth larval instar lived for a longer time and consumed more prey than former ones. It lasted 4.13 days during which consumed 69.40 with a daily rate of 16.80 nymphs as shown in Figs (3 & 4) and (Tables 1,2) .

When full grown, larvae of *S .gilvifrons* stopped moving and eating and a pupal stage took place which lasted for 3.73 and 4.47 days as male and female pupae, respectively (Table 1).

In general, male immatures completed its life cycle before female immatures where the life cycle averaged 17.70 and 19.90 days for male and female, respectively.

Similar results were obtained by Janardan and Ray (1977) who found the life cycle of an unidentified species of the genus *Stethorus* durated 14 days at 30 ^{0}C, while Puttaswamy and Channa (1977) found that *S. pauperculus* (Weise) larvae lasted 7.63 days and had 4 larval instar.

Also, Mridul and Badal (2002) noticed that there were 4 larval instars for *S .gilvifrons* fed on *Oligonychus coffee* Neither where it completed its life cycle in 16.33 days under laboratory conditions. Moreover, Ragkou *et al*. (2004), found that the first, second, third and fourth larval instars of *S. punctillum* fed voraciously on an average of 19.56, 14.43, 21.90 and 18.40 *T. urticae* nymphs, respectively.

From the previous results it can be concluded that immature stages of Stethorus species have the ability to feed successfully and consume a considerable number of Tetranychus mite individuals. Accordingly, Khan *et al.*, (2002) stated that the predatory ladybird beetle *S. vagana* (Blackbourn) is one of the best biological agents of *T. urticae* which should be produced commercially.

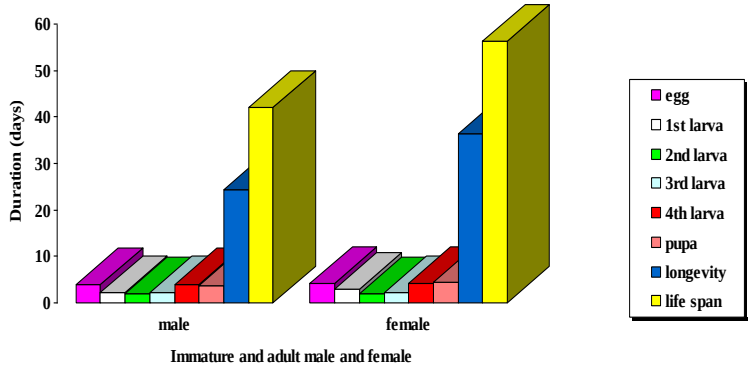

Fig 3 : Duration (days) of immatures and adult male and female of *Stethorus gilvifrons* fed on Tetranychus urticae nymphs at 25 C.

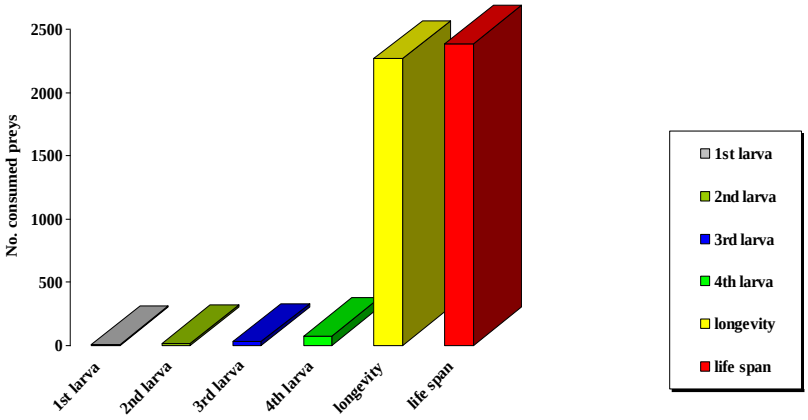

Fig 4 : Total number of *Tetranychus urticae* nymphs consumed by larval instars and adult females of *Stethorus gilviforns* at 25 oC

Concerning adulthood, data in Table 1 and Fig 3 showed that male lived for a shorter time than female. Male and female longevity were 24.33 and 36.46 days, respectively. Female insect passed through a preoviposition period of about 3.46 days, during which it consumed 161.66 prey nymphs with a daily rate of 46.22 individuals before starting to lay eggs. During an average of 25.20 of oviposition period, adult female attacked more prey (1744.53 prey) needed for egg deposition, Table (2) showed that adult female

of *S .gilvifrons*, which lived 36.46 days, consumed a total number of 2267.13 *T. urticae* nymphs / female (Fig 4). This meant that adult female consumed nearly 95 % of the total number of consumed prey individuals during its whole life span. Also, ovipositing female needed about 76.95 % from the total number of consumed prey in its adulthood.

Similar results were obtained by Roy *et al*., (2003) who reared *S. punctillum* on *T. mcdanicli* and found that its oviposition period lasted 21.10 days at 28 ^{0}C. On the other hand, Kasap and Aktung (2003) found that adult female and male of *S. punctillum* fed on *T. viennesis* lived for 50.63 and 34.87 days at 25 ^{0}C and 60 % RH., respectively.

Concerning life table parameters of the predatory lady bird beetle *S .gilvifrons*, data in Table (3) and (Fig 5) clearly indicated that the survivorship curve showed that L_X value followed I pattern in which survival rate at 25 ^{0}Cwas nearly 100 % Fig. (5). Kishimoto (2003) mentioned that survivorship of *Stethorus* species was mainly affected by prey species. He found that *Amphitetranychus viennensis* was the most favorable prey for *S. japnicus* in Japan. In particularly, most predatory larvae reared on *Panonychus mori* eggs died during the first larval instar and only 10 % of these larvae developed to pupae.

The mean generation time (T) of *S .gilvifrons* averaged 30.41days. Also, Kasap and Aktug (2003) found that (T) time of *S. punctillum* fed on *T. viennesis* was 30.8 days when reared at 25 ^{0}C and 60 % RH.

Concerning egg production, data showed that the net reproductive rate (R_o) was 49.53 and the intrinsic rate of natural increase (r^m) was 0.12 (Table 8), the finite rate of increase e^{rm} (λ) was 1.13 .

Similar results were previously obtained by Roy *et al.*, (2003) who found that (r^m) value of *S. punctillum* was 1.19, while it was 0.15 for the same species fed on *T. viennensis* (Kasap and Aktug. 2003).

On the other hand, Mori *et al.,* (2005) found that (r^m) value of *S. japonicus* fed on *T. urticae* eggs was 0.15 at 25 ^{0}C. and (R_o) value was 270.49, (T) time was 51.10 days and the finite rate of increase e^{rm} (λ) was 1.169.

From the previous results it can be concluded that the ladybird beetles belonging to the genus Stethorus are obligate predators of tetranychid mites. Therefore, it is highly recommended to know more information about its biology and ecology in order to broaden over options for its potential use as a biocontrol agent.

Table (3) : Life table parameters of S*tethorus gilvifrons* fed on immature of *T. urticae* at 25 ^{0} C and 70 % RH.

Mean Total Fecundity	Mean Generation Time (T)	Net Reproductive Rate (R_0)	Intrinsic Rate of Increase (r^m)	Finite Rate of Increase (e^{rm})
115.26	30.41	49.53	0.12	1.13

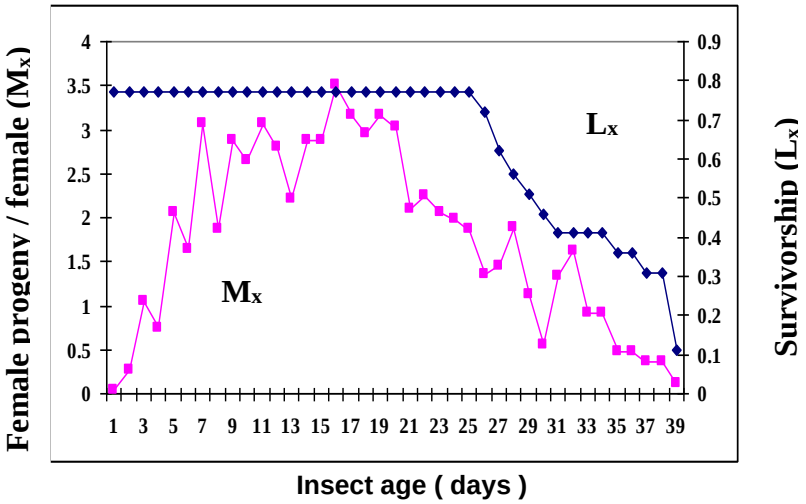

Fig. (5): Age – specific fecundity (M_x) and survivorship (L_x) of *Stethorus gilvifrons* provided with of *T. urticae* immature at 25 ^{0}C.

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بيولوجى وجدول الحياة للمفترس الحشرى *Stethorus gilvifrons* عند تربيته على الأطوار المتحركة العنكبوت الأحمر *T. urticae* .

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تمت تربية المفترس الحشرى *Stethorus gilvifrons* على حوريات العنكبوت الأحمر ذو البقعتين *T. urticae* على درجة حرارة ٢٥ م٠ و ٧٠ % رطوبة نسبية وقد أظهرت النتائج أن دورة حياة الأنثى والذكر كانت ١٩,٩٠ و ١٧,٧٠ يوم على التوالى بينما كانت فترة Longevity كانت ٣٦,٤٦ للأنثى و ٢٤,٣٣ للذكر بينما كانت Life span للأنثى ٥٦,٤٠ وللذكر كانت ٤٢,٠٦ . وقد تم حساب ماتستهلكه أنثى المفترس الحشرى خلال دورة الحياة و Longevity, Life span وقد كان ١١٧,٣٩ و ٢٢٦٧,١٣ و ٢٣٨٤,٥٣ على التوالى .وقد كان متوسط فترة الجيل ٣٠,٤١ أما قيمة R_0 فقد كانت ٤٩,٥٣ وقد كانت r_m ٠,١٢ بينما كانت e^{rm} ١,١٣.

Table (1): Duration (in days) of developmental stages and adult of *Stethorus gilvifrons* fed on immature of *Tetranychus urticae* (koch) at 25 ºC and 70 % RH..

Sex	Egg	developmental stages					Life cycle
		1 st. larva	2 nd. Larva	3 th. Larva	4 th. Larva	Pupa	
♂	3.87 ± 0.19	2.2 ± 0.10	1.87 ± 0.09	2.20 ± 0.11	3.87 ± 0.19	3.73 ± 0.15	17.70 ± 0.28
♀	4.07 ± 0.11	2.93 ± 0.18	2.00 ± 0.14	2.33 ± 0.13	4.13 ± 0.21	4.47 ± 0.21	19.90 ± 0.31

Sex	Adults					Total no. eggs	Daily rate
	Preoviposition	Oviposition	Postoviposition	Longevity	Life span		
♂	----------	----------	----------	24.33 ± 0.90	42.06 ± 1.04		
♀	3.46 ± 0.29	25.20± 1.52	7.80 ± 1.14	36.46 ± 2.30	56.40 ± 2.29	115.26 ± 4.23	4.57

± SE : Standard errors.

Table (2) : Number of consumed *Tetranychus urticae* (koch) immature preyed by larva and adult females of *Stethorus gilvifrons* at 25 ºC and 70 % RH. .

Developmental stages											
1 st. larva		2 nd. Larva		3 th. Larva		4 th. Larva		Pupa		T	D
T	D	T	D	T	D	T	D	T	D		
7.73 ± 0.58	2.64	14.8 ± 1.28	7.40	25.46 ± 1.38	10.92	69.40 ± 5.79	16.80	------	------	117.39 ± 14.09	5.89

Adult stages									
Preoviposition		Oviposition		Postoviposition		Longevity		Life span	
T	D	T	D	T	D	T	D	T	D
161.66 ± 14.09	46.72	1744.53 ± 96.98	69.22	360.933 ± 50.28	46.27	2267.13 ± 126.37	62.18	2384.53 ± 128.54	42.27

± SE : Standard errors.
T : Total number of prey consumed /immature or adult female.
D : Daily mean of prey consumed /immature or adult female.