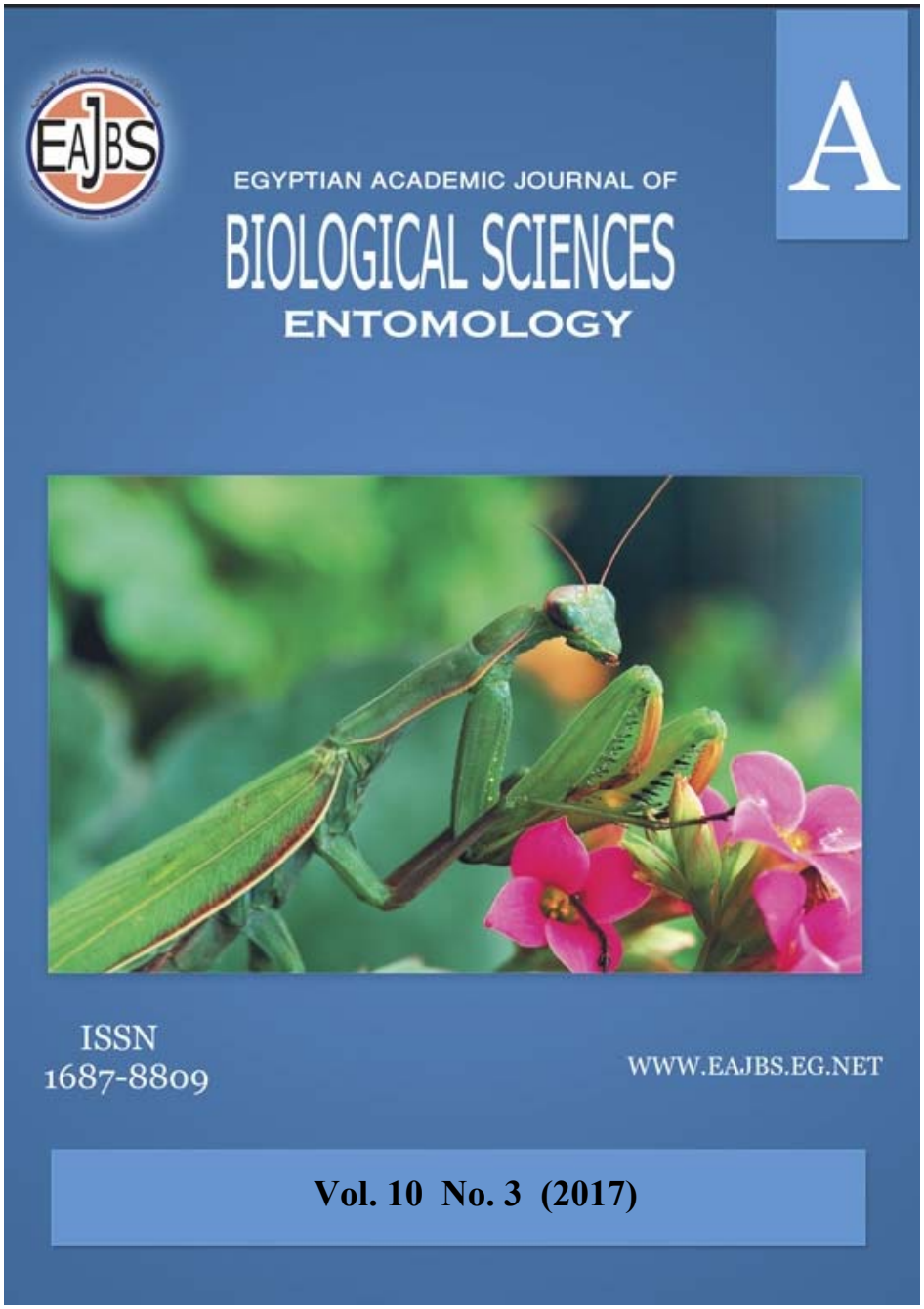

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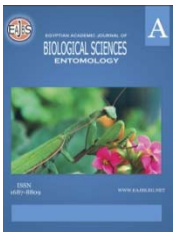

Studies on Biology of Ascid mite, *Blattisocius keegani* (Acari: Gamasida: Ascidae) When Fed on Two Astigmatid Mites at Different Laboratory Conditions

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ABSTRACT

Blattisocius keegani (Mesostigmata: Ascidae) is a predatory mite that has traditionally been studied as a biological control agent in stored products. The developmental time (incubation period, life cycle and longevity), fecundity and food consumption of the predatory mite *B. keegani* (Fox) (Ascidae) were investigated at 25 and 35°C and 75% R.H when fed on the two astigmatid mites, *Rhizoglyphus echinopus* and *Lepidoglyphus destructor*. The incubation period of *B. keegani* was not affected when fed on the preys at tested temperature. The duration of life cycle for both sexes of *B. keegani* was obviously affected by the type of food employed at different temperature. The longest period lasted 12.6 days when predatory females fed on *R. echinopus* larvae at 25ºC, but the shortest period recorded on *L. destructor* larvae at 35ºC for predator males was 10.22 days. The female longevity of *B. keegani* was also affected when the predator fed on the two tested preys at two temperature, as the maximum longevity was 26.7 days for female at 25ºC on *R. echinopus* larvae, and the minimum corresponding period was 16.54 days for male on *L. destructor* at 25ºC. The adult female of *B. keegani* laid the highest number of eggs (41.6) when fed on *R. echinopus* at 35ºC, while the lowest number of eggs was observed when fed on *L. destructor* larvae (35.4 eggs) at 25ºC. The food consumption of the different predator stages increased with its growth. The larval stage of both female and male had the least prey consumption than the other stages (protonymph and deutonymph) and the predator male individuals consumed lower number of introduced prey than the female individuals. The total amount of consumed prey individuals during the whole life span was 88.9 larvae of *R. echinopus* at 25ºC, changed to record 98.0 preys at 35ºC, while, the number of devoured *L. destructor* was 81.6 and 87.2 prey at 25 and 35ºC, respectively. The *B. keegani* male devoured 80.0 & 85.0 larvae of *R. echinopus* and 74.8 & 80.7 larvae of *L. destructor* at 25 and 35ºC., respectively.

INTRODUCTION

Damage by insects, mites, fungi, and sprouting causes hundreds of millions of dollars of economic losses to grain producers, merchandisers, and processors each year (Harein and Meronuck, 1995). Large numbers of mites are known to infest many of grains and stored products throughout the world. These mites attack damaged and undamaged grains devouring the embryos and other surrounding tissues (El-Sayed and Ghallab, 2007), prevents germination, and reduces the nutritive values. Mites of the genus *Rhizoglyphus* (Claparede) are commonly associated with plants with bulbs, corms and tubers. *Rhizoglyphus echinopus* (Fumouze and Robin) is one of the most important mite of this genus, and is known to cause damage to a variety of crops

(e.g. onions, garlic and other vegetables) and ornamentals (lily and other flower bulbs) in greenhouses and in the field around the world (Lesna *et al*., 1995). Majority of members of the glycyphagid mites (Glycyphagidae) are cosmopolitan, commonly known as synanthropic mite species. Of them, the mite, *Lepidoglyphus destructor* (Schrank) is one of the commonest species of stored product mites and is frequently found in association with stacks of grain, straw, and hay standing in the open field or in a permanent stackyard (Griffith, 1960), linseed, rice, dried fruits, sugar beet seed (Chmielewski, 1969), dried calves stomachs, dead insects, dried mammal skins, rodent and bumble bee nests (Hughes, 1976) and Post-harvest sweepings (hay, straw) from barn (Chmielewski, 2001). Predatory mites are among the natural enemies considered for use in agricultural areas, mainly for the control of damaging mites and insects. Mites of the family Ascidae (Mesostigmata) are considered the main predators of stored product mites and of some small insects. Previous studies recorded the presence of *Blattisocius* species in different stored foodstuff: bean (Saleh, 1980), wheat bran (Saleh *et al*., 1985), bran (Baker, 2000; Athanassiou *et al*., 2001), rice and barley (Al-Nasser, 2007), maize, wheat flour, wheat, broad bean and rice (El-Sayed and Ghallab, 2007). Some *Blattisocius* species found in stored foods have been studied to determine their potential as predators of pest arthropods (Halliday *et al*., 1998; Thind and Ford, 2006; Britto *et al*., 2012). Studies conducted by Riudavets *et al*., (2002) on *Blattisocius tarsalis* (Berlese) when fed on several stored product pests under controlled laboratory conditions showed that adult individuals were able to prey on eggs of the mould mite *Tyrophagus putrescentiae* (Schrank), the Indian meal moth *Plodia interpunctella* (Hübner), the Mediterranean flour moth (*Ephestia kuehniella* Zeller), the cigarette beetle, *Lasioderma serricorne* (Fabricius), the rusty grain beetle, *Cryptolestes ferrugineus* (Stephens), the rust-red flour beetle, *Tribolium castaneum* (Herbst), the bean weevil *Acanthoscelides obtectus* (Say), and first instar nymphs of the booklouse *Liposcelis bostrychophila* (Badonnel). Therefore the scope of this work was to introduce details of biological study of the ascid predacious mite, *Blattisocius keegani* when fed on the larvae of the astigmatid mites, *Rhizoglyphus echinopus* and *Lepidoglyphus destructor* at different temperature.

MATERIALS AND METHODS

The predacious mite, *Blattisocius keegani* (Fox) (Ascidae) and the acarid mites *Rhizoglyphus echinopus* (Fumouze and Robin) (Acaridae) and *Lepidoglyphus destructor* (Schrank) (Glycyphagidae) were extracted from stored onion bulbs at Ashmoun region, El-Menofia Governorate by using modified Tullgren funnels. Cultures of the predatory mite *B. keegani* was maintained on the acarid bulb mite, *R. echinopus*. For preparing pure culture of the astigmatid mites, *R. echinopus* and *L. destructor*, plastic cups of 1.5 cm high x 2.5 cm in diameter were filled up to 0.5 cm with plaster of Paris and activated charcoal in the rate of 8: 2, respectively. One adult female and male of each prey were placed in the prepared cup, supplied with dried yeast as food and drops of water added to maintain suitable relative humidity and kept in an incubator at 25ºC. The larval stages of *R. echinopus* and *L. destructor* were introduced as food source for rearing the predatory mite *B. keegani*. The predatory mite individuals were reared singly in similar cages used for rearing the astigmatid mites. Observations were made daily, incubation period, life cycle, longevity of adults of males and females and fecundity of adult female. The food consumption of *B. keegani* males and females were determined under 25 and 35±2°C and 75±5%

R.H. on the same preys. Observation was terminated when all predatory mites had died. All presented data were subjected to one way analysis of variance (ANOVA) and means were separated by Duncan´s multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

In this study, the different biological aspects of the predacious mite, *B. keegani* on two different astigmatid mites, *L. destructor* and *R. echinopus* larval stages were conducted under the laboratory conditions at 25 and 35°C and 75% R.H. Both females and males of *B. keegani* were found to pass through one larval and two nymphal stages (protonymph and deutonymph) before reaching adulthood.

Incubation period:

As shown in Table (1), the incubation period of *B. keegani* was not obviously affected when fed on the preys at tested temperature. The highest incubation period of *B. keegani* was noticed about 2.5 days when female members fed on *R. echinopus* at 25˚C, but the shortest period was recorded for male individuals at 35˚C when reared on *L. destructor* and durated 1.8 days. The statistical analysis of obtained data showed that L.S.D. at 0.05 = 0.05 and 0.08 for females and males, respectively.

Table 1: Biological aspects of predator mite, *Blattisocius keegani* when fed on two astigmatid mites at 25 and 35 ˚C and 75 % RH.

Biological aspects		25 ˚C		35 ˚C		L.S.D. at 0.05
		R. echinopus	*L. destructor*	*R. echinopus*	*L. destructor*	
Incubation period	♀	2.5±0.0.07 (2.4-2.6)	2.24±0.05 (2.2-2.3)	2.21±0.01 (2.20-2.22)	2.2±0.07 (2.1-2.3)	0.05
	♂	2.26±0.11 (2.1-2.4)	2.1±0.07 (2-2.2)	2.0±0.07 (1.9-2.1)	1.8±0.07 (1.7-1.9)	0.08
Life cycle	♀	12.6±0.07 (12.5-12.7)	11.52±0.04 (11.5-11.6)	11.8±0.1 (11.7-11.9)	10.5±0.1 (10.4-10.6)	0.06
	♂	11.42±0.08 (11.3-11.5)	10.52±0.22 (10.2-10.8)	11.0±0.21 (10.7-11.3)	10.22±0.28 (9.8-10.6)	0.20
Longevity	♀	26.7±0.4 (26.0-27.0)	22.72±0.08 (22.6-22.8)	22.76±0.53 (22-23.5)	21.64±0.32 (21.2-22.0)	0.35
	♂	22.54±0.36 (22.0-23.0)	16.54±0.36 (16.0-17.0)	20.48±0.36 (20.0-21.0)	18.68±0.35 (18.2-19.2)	0.34
Life span	♀	39.3±0.35 (38.7-39.6)	34.24±0.05 (34.2-34.6)	34.56±0.50 (33.9-35.3)	32.14±0.32 (31.7-32.5)	0.33
	♂	34.04±0.71 (33.0-35.0)	26.0±0.7 (25.0-27.0)	31.6±0.89 (31.0-33.0)	28.76±0.5 (28.0-29.4)	0.68
Fecundity / ♀		38.0±0.71 (37.0-39.0)	35.4±0.89 (34.0-36.0)	41.6±1.14 (40.0-43.0)	37.2±0.83 (36.0-38.0)	0.86
Pre-oviposition period /♀		3.22±0.08 (3.1-3.3)	3.08±0.08 (3.0-3.2)	3.02±0.4 (3.0-3.1)	2.84±0.11 (2.7-3)	0.08
Oviposition period /♀		17.74±0.37 (17.1-18.0)	14.38±0.04 (14.3-14.4)	14.54±0.7 (13.8-15.5)	14.06±0.42 (13.6-14.7)	0.43
Post-oviposition period /♀		5.74±0.13 (5.6-5.9)	5.26±0.05 (5.2-5.3)	5.06±0.08 (5-5.2)	4.74±0.08 (4.6-4.8)	0.09

± S.D.

Life cycle:

From the tabulated data in Table (1), it could be observed that the duration of life cycle for both sexes of *B. keegani* was obviously affected by the type of food employed at different temperature. This period averaged 12.6 and 11.52 days for females fed on *R. echinopus* and *L. destructor* at 25ºC, respectively, changed to last 11.8 and 10.5 days for the same individuals when fed on the same prey types but at

35ºC, respectively, however, the male predatory mite averaged 11.42, 10.52 & 11.0, 10.22 days at the same conditions, respectively. L.S.D. at 0.05 recorded 0.06 and 0.20 for females and males, respectively.

Longevity and life span:

Adult female longevity and life span of *B. keegani* are presented in Table (1). The maximum longevity was 26.7 days at 25ºC when the predatory mite fed on *R. echinopus* larvae, and the minimum corresponding figures was 16.54 days for male individuals reared on *L. destructor* at 25ºC. Total life span followed a similar trend as longevity; these were 39.3 days (the longest period) when female fed on *R. echinopus* at 25ºC, and 26.0 days (the shortest one) when males fed on *L. destructor* at 25ºC.

Fecundity:

The adult female of *B.* keegani as shown in Table (1) laid the highest number of eggs (41.6) when the individuals fed on *R. echinopus* at 35ºC, while the lowest number of eggs was observed when the predatory mite fed on *L. destructor* larvae (35.4 eggs) at 25ºC. The statistical analysis of obtained data indicated that L.S.D. at 0.05 level = 0.86.

Food consumption of *B. keegani* when fed on *R. echinopus* and *L. destructor*.

The food consumption of *B. echinopus* males and females was noticed and recorded in Table (2).

Table 2: Food consumption of *Blattisocius keegani* when fed on immatures of astigmatid mite, *Rhizoglyphus echinopus* and *Lepidoglyphus destructor* at 25 and 35 ˚C and 75% R.H**.**

Biological aspect of the predator ascid mite stage		No. of devoured preys ± S.D				
		R. echinopus larvae		*L. destructor* larvae		L.S.D. at 0.05
		25 ˚C	35 ˚C	25 ˚C	35 ˚C	
Larva	♀	2.4±0.16 (2.2-2.6)	2.82±0.13 (2.6-2.9)	2.2±0.07 (2.1-2.3)	2.4±0.07 (2.3-2.5)	0.11
	♂	2.38±0.08 (2.3-2.5)	2.56±0.11 (2.4-2.7)	2.26±0.15 (2.1-2.5)	2.4±0.11 (2.3-2.6)	0.11
Protonymph	♀	4.4±0.07 (4.3-4.5)	5.0±0.14 (4.8-5.2)	3.98±0.15 (3.8-4.2)	4.48±0.18 (4.2-4.7)	0.13
	♂	4.0±0.07 (3.9-4.1)	4.26±0.17 (4-4.4)	3.8±0.12 (3.6-3.9)	4.0±0.14 (3.8-4.2)	0.12
Deutonymph	♀	5.0±0.14 (4.8-5.2)	5.5±0.14 (5.3-5.7)	4.54±0.22 (4.2-4.8)	5.02±0.11 (4.9-5.2)	0.15
	♂	4.2±0.14 (4-4.4)	4.56±0.19 (4.3-4.8)	4.0±0.14 (3.8-4.2)	4.8±0.07 (4.7-4.9)	0.14
Immature stages	♀	11.88±0.16 (11.6-12)	13.3±0.21 (13-13.6)	10.78±0.18 (10.5-11.0)	11.62±0.33 (11.3-12.0)	0.22
	♂	10.6±0.21 (10.3-10.9)	11.4±0.14 (11.2-11.6)	10.02±0.15 (9.8-10.2)	11.3±0.21 (11-11.6)	0.17
Longevity	♀	77.0±1.4 (75-79)	85.0±1.87 (83-88)	71.2±1.1 (70-73)	76.0±2.12 (73-79)	1.59
	♂	70.2±1.48 (68-72)	75.0±1.58 (73-77)	64.8±1.92 (62-67)	70.2±1.3 (69-72)	1.51
Preoviposition		4.0±0.1 (3.8-4.2)	4.42±0.11 (4.3-4.5)	3.8±0.12 (3.6-3.9)	3.98±0.25 (3.6-4.3)	0.16
Oviposition		60.0±1.41 (58-62)	66.0±1.4 (64-68)	55.8±1.1 (54-57)	60.0±1.4 (58-62)	1.27
Postoviposition		13.0±0.35 (12.5-13.5)	14.2±0.45 (13.5-14.5)	11.1±0.14 (11-11.3)	12.0±0.35 (11.5-12.5)	0.32
Life span	♀	88.9±1.15 (87-90)	98.0±0.71 (97-99)	81.6±0.54 (81-82)	87.2±1.09 (86-89)	0.87
	♂	80.0±1.4 (78-82)	85.8±0.84 (85-87)	74.8±2.3 (72-78)	80.7±0.84 (80-82)	1.39

± S.D.

Immature stages of *B. keegani*.

The food consumption of the different predator stages increased with its growth. The larval stage of female and male had the least prey consumption than the other stages (protonymph and deutonymph) and the predator male consumed lower number of introduced prey than the female. During the all immature stages of *B. keegani* females, the number of consumed *R. echinopus* was 11.88 and 13.3 larval stages at 25 and 35ºC, respectively. On the other hand the number of devoured larval stages of *L. destructor* during the predator immature stages (female) was 10.78 and 11.62 larvae. However, the number of devoured larvae of each prey was lower in the predatory male individuals than those consumed in case of females, as *B. keegani* male consumed 10.6 & 11.4 of *R. echinopus* and 10.02 & 11.3 of *L. destructor* at 25 and 35ºC, respectively.

Longevity of *B. keegani*.

Adult of *B. keegani* started prey consumption after emergence at the two tested temperatures. During the preoviposition period of predator adult female devoured an average of 4.0, 4.42, 3.8 and 3.98 prey of *R. echinopus* and *L. destructor* at 25 and 35ºC, respectively. The maximum means of total food consumption of the predator was recorded during the oviposition period, as it consumes an average of 60, 66, 55.8 and 60.0 of the previously mentioned prey at the same conditions, respectively. The highest values for the mean prey consumption by postoviposited females were observed at 25ºC (13.0 days) on *R. echinopus* larvae, while the lowest value was 11.1 prey of *L. destructor* at 25ºC.

Life span of *B. keegani*.

Data presented in Table (2) revealed that temperature significantly affected amount of consumed prey for the predatory mite life span. When *B. keegani* female fed on *R. echinopus* larval stages, the total amount of consumed prey individuals was 88.9 at 25ºC, changed to record 98.0 preys at 35ºC, while the number of devoured larvae of *L. destructor* was 81.6 and 87.2 prey individuals at 25 and 35ºC, respectively. On the other hand, the predatory mite *B. keegani* male devoured 80.0 & 85.0 larvae of *R. echinopus* and 74.8 & 80.7 larvae of *L. destructor* at 25 and 35ºC, respectively. Similar results were obtained by Taha *et al*., (2007) when reared B. keegani on the acrid mite, *T. putrescentiae*. The life cycle lasted 10.9 days but the female pre-oviposition, oviposition and postoviposition periods durated 2.1, 30.0 and 5.0 days and deposited an average of 29.3 eggs with a daily rate of 0.9 eggs for the predator, respectively. Female of the predator destroyed an average number of prey (97.5) during life span with a daily rate of 7.4 prey at the same trend. Fawzy (1996) reared B. keegani on two stored grain pests: *Suidasia nesbitti* (Hughes) and *Grammolichus aegypticus* Shereef and Fawzy. The authors noticed that the adult female lived for 25.3 and 26.0 days and deposited averages of 24.9 and 14.1 eggs when fed on the two aforementioned preys, respectively. The adult female consumed 31 and 25 individuals of *S. nesbitti* and *G. aegypticus* respectively during its life span. Also, El-Sanady (2005) reared the same predator on the larval stages of *T. putrescentiae* and *R. robini* and decided that the adult consumed 31.3 and 28.5 individuals of the two prementioned preys, respectively during its life span. On the other hand, the effect of *B.* keegani as biological control agent on two date mites, *T. putrescentiae* and *B. freemani* was examined by Rezk (2016). The data showed that the daily mean numbers of consumed mites by *B. keegani* were 2.65 and1.83.The total mean numbers of consumed mites were 40.7 and 35.9 mites/female when fed on *B. freemani* and *T. putrescentiae*, respectively. The total mean longevity values were 15.3 and 19.7 days/female when fed on the same diets, respectively.

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ARABIC SUMMERY

دراسات على بيولوجيا الاكاروس *Blattisocius keegani* المنتمى لعائلة Ascidae عند تغذيته على اثنين من الاكاروسات عديمة الثغر عند ظروف معملية مختلفة

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فى هذه الدراسة تم استخدام يرقات الاكاروسات عديمة الثغر *Rhizoglyphus echinopus* والمنتمى لعائلة Acaridae و *Lepidoglyphus destructor* المنتمى لعائلة Glycyphagidae لدراسة المظاهر البيولوجية للاكاروس المفترس *Blattisocius keegani* والمنتمى لعائلة Ascidae وذلك عند درجتى الحرارة ٢٥ و ٣٥ مº ورطوبة نسبية مقدارها ٧٥ %. فى هذه الدراسة لم تتأثر فترة حضانة البيض Incubation period للمفترس بنوع الغذاء أو درجة الحرارة المستخدمة. وتاثرت فترة دورة الحياة Life cycle بهذه العوامل حيث سجلت أعلى فترة ١٢.٦ يوم عند تغذية اناث المفترس *B. keegani* على يرقات الاكاروس *R. echinopus* عند ٢٥ مº والتى قلت لتسجل أقل قيمة لها عند تغذية الافراد الذكور على يرقات الاكاروس *L. destructor* مسجلة زمنا مقداره ١٠.٢٢ يوما عند ٣٥ مº. ولقد تأثرت فترة حياة الافراد البالغة Longevity ايضا بنوع الغذاء ودرجة الحرارة حيث سجلت الدراسة أعلى فترة ممكنة لها عند تغذية الاناث على يرقات الاكاروس الاكاريدى *R. echinopus* مسجلة زمنا مقداره ٢٦.٧ يوما عند ٢٥ مº واقل فترة مسجلة كانت للافراد الذكور للمفترس عند التغذية على يرقات الاكاروس *L. destructor* مسجلة فترة مقدارها (16.54 يوما) عند نفس درجة الحرارة وقامت الافر اد الاناث طول حياتها بوضع اكبر عدد من البيض Fecundity عند التغذية على يرقات الاكاروس *R. echinopus* (41.6 بيضة) عند ٣٥ مº واقل عدد من البيض كان عند التغذية على يرقات الاكاروس *L. destructor* (35.4 بيضة) عند ٢٥مº. ولقد اتضح من الدراسة ان معدل الاستهلاك الغذائى للاكاروس المفترس تاثر بصورة واضحة بنوع الغذاء المستخدم ودرجة الحرارة التى تعرض لها الاكاروس *B. keegani* حيث تشير النتائج الى ان عدد ما تم استهلاكه بواسطة اناث المفترس من يرقات الاكاروس *R. echinopus* كان ٨٨.٩ يرقة عند درجة الحرارة ٢٥ مº تغير الى ٩٨.٠ يرقة من نفس الفريسة عند ٣٥ مº بينما ما تم استهلاكه من يرقات الاكاروس *L. destructor* طول فترة حياة انثى المفترس كان ٨١.٦ يرقة عند ٢٥ مº و ٨٧.٢ يرقة عند ٣٥مº. واثبتت الدراسة ان عدد اليرقات التى استهلكت عند تغذية ذكور المفترس كان ٨٠.٠ و ٨٥ من يرقات الاكاروس *R. echinopus* و ٧٤.٨ و ٨٠.٧ من يرقات الاكاروس *L. destructor* وذلك عند درجتى الحرارة ٢٥ و ٣٥ مº على الترتيب.