Egyptian Veterinary Medical Society of Parasitology Journal

Original Article

Biology of Blattisocius mali (Oudemans) (Acari: Gamasida: Ascidae) feeding on different diets under laboratory conditions

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Abstract:

The mite, Blattisocius mali (Oudemans) (Acari: Ascidae) was reared at 25 ± 1 °C and 75 ± 5 % R.H. on the immatures of the Astigmatid mite, Rhizoglyphus robini Claparede and the free-living nematodes (FLN), Rhabditis sccanica Allgen. The mean incubation period of B. mali was 1.85 and 1.55 days when fed on immature stages of R. robini and 1.84 and 1.54 days when fed on R. sccanica for females and males, respectively. The duration of the life cycle for both sexes of B. mali was significantly affected by the kind of food used and took 8.68 and 7.73 days when fed on R. sccanica of females and males, However this duration lasted longest times for B. mali averaged 9.89 and 8.91days when fed on R. robini, female and male individuals, respectively. Adult longevity of B .mali was influenced by the type of food employed, this period lasted 27.87 and 21.8 days on R. sccanica. This period was 29.46 and 24.22days on R. robini females and males individuals, respectively. The current study indicated that the free living nematode proved to be the most favorable diets as it gave the highest fecundity rate (86.5 eggs). On the contrary, the least number of eggs were deposited by B. mali during feeding on immature of R. robini (37.7eggs). During the development time of life span B.mali, the total number of the tested consumed prey was significantly differed. It was 138.7and 90.4 preys when the B. mali males and females fed on R. robini, respectively.

Keywords: *Mites, Blattisocius mali, Biocontrol, Acaridae, Nematoda.*

INTRODUCTION

Ascid mites are important predators in many soil ecosystems (Walter and Lindquist, 1989). Most of mite species of the family Ascidae are free-living predators which live in the higher layers of soil, plants and stored products, where they feed on nematodes and small arthropods. Many other species are fungivorous while others are probably pollen feeders or predators on young saprophytic mites, insects and nematodes (Afifi et al., 1984; Abou-Awad and Nasr, 1984).

Within the Ascidae family, the *Blattisocius* genus contains a group of cosmopolitan species. They feed on eggs and young larvae of arthropods, as well as on different mite species (Hagstrum et al. 2013). Some of the species belonging to this genus have been highlighted due to their potential as biological control agents of stored products (Athanassious and Rumbos 2018). However, the biology of most *Blattisocius* spp. remains poorly researched (Thomas et al. 2011).

Members of Acaridae are widely distributed living on organic matter and usually infest

stored seeds, stored products, flour and other food stuffs. Species of Ascidae are candidate as natural enemies for control of *Rhizoglyphus robini* which is one of the most important acarid species, and is known to cause loss to a different crops (e.g. garlic,onions and other vegetables) and ornamentals (lily and other flower bulbs) in greenhouses and in the field around the world (Lesna et al., 1995).

The feeding habits and food preferences of species belonging to family Ascidae feeding on nematodes have been reported by (Muraoka and Ishibashi 1976; Rockett and Woodring 1966; Rodriquez et al.,1962 and Afifi et al., 1986).

Therefore the scope of this work was to introduce a clear study of the predacious mite, *Blattisocius mali* when fed on immature stages of the astigmatid mites, *Rhizoglyphus robini* and free-living nematodes, *Rhabditis sccanica*.

MATERIALS AND METHODS

Predacious mite, *Blattisocius mali* (Oudemans) rearing:

For studying the biological aspects of *B. mali*, samples were collected from soil of corn crop from Diarb-Nigm Region, Sharkia Governorate. Two types of plastic cups were used for rearing individuals. The first for culturing mites (measuring 5.0cm. diam. and 5.0 cm. deep), and the second for individual rearing (measuring 2.0 cm. diam. and 5.0 cm. deep). Each cup was filled up to 2.0 cm high with mixture of (Paris: clay: charcoal) (7: 2: 1), respectively. Drops of water were added to maintain suitable relative humidity.

Several adult females and males of the *B. mali* were placed in the large plastic cups supplied with prey individuals and every cups was tightly closed. Many females from the culture of *B. mali* were taken and transferred to another cup for rearing units. Females were left 24 hours for oviposition. Thereafter, when a sufficient number of eggs were laid, the adult females were removed and thus eggs from the same age were obtained to start the experiment. Each egg was transferred to a small cup to start biological aspects. A 50 replicates were used in each test conditions. The predatory mite individuals were reared singly in similar cages used for rearing the astigmatid mites and free- living nematodes. Observations were recorded daily, incubation period, life cycle, longevity, fecundity and food consumption were determined under 25 ± 1◦C and 70 ± 5% R.H.

Source of food:

The acarid mite, *Rhizoglphus robini* was collected from bran and maintained at the laboratory in large plastic cups. One adult female and male of prey were placed in the prepared cup, supplied with dried yeast as food and drops of water were added to maintain suitable relative humidity and kept in an incubator at 25ºC.

The free-living nematodes, *Rhabditis. sccanica,* were extracted from samples of organic manure using Baermann's funnel for 24 hrs. The extraction was added to a petri dish containing slices of potatoes as food source for nematode. The petri dish was left for one week in natural condition. By using a camel brush, drops of this feeding were put in rearing cells of mites as a main source of food (Gomaa,1992). To follow up *B.mali* development, fifly individuals from each stage were singly mounted in Hoyer's medium with a droplet of Nesbitt's clearing agent. Specimens were inspected under a binocular microscope to fine the developmental stages and subsequently to measure their periods.

RESULTS

Habitat and behavior:

The predator, *B. mali* is very active species usually searching for its prey. Great numbers of the mite were collected from soil under corn associated with eggs and immature stages of acarid species and nematodes. Cannibalism was not observed in this species. Females deposit their eggs in groups or singly in protected places.

Hatching and moulting:

Hatching occurred through a longitudinal median slit about to third of egg length and extending from egg narrowed. Hatched larvae crawled outside, and then kept quiet for few minutes beside the translucent egg shell. Larvae and nymphs when full grown entered a semiquiescent period during which the individual stopped feeding but could move especially when disturbed. This period lasted 5-60 minutes after which individual kept quiet. Just before moulting, individual made some successive movements beginning from propodosoma and end in opisthosoma, a dorsal transverse slit occurred between the propodosoma and hysterosoma. The mite tried to free itself from the old exuvium through twisting movements and subsequently withdrew the fore-legs and anterior part of the body outside. Afterwards, it crawled forwardly trying to get rid of the rest of the old skin. Newly emerged individuals kept quiet beside its old skin for a short period, and then started to move actively searching for its prey.

Mating:

Mating took place soon after emergence of both sexes. Male approached the female anteriorly, and both viberated their palps and fore legs. The male moved around the female to reach her opisthosomal end crawled underneath her, and clasped her body with his third and fourth pairs of legs while male and the ventral surface of female were facing each other. Nearly half body of the male projected behind the female and copulation occurred lasting about 10 minutes, after that both sexes separated and female showed some rapid classic movements.

Biological aspects:

Incubation period:

Data in Table (1) reveal that *B. mali* developed from egg to adult stage when fed on immature stage of the acarid mites *R. robini* and free living nematode, *R. scanica*. Incubation period of the *B. mali* was not obviously affected when fed on two preys at tested temperature. The average period of incubation was 1.84 ± 0.031 and 1.85 ± 0.018 days for females of predatory mites, *B. mali* when fed on free living nematode and acarid mites and it was1. 54 ± 0.014 and 1.55 ± 0.014days for males when fed on free living nematode and acarid mites, *R. robini,* respectively.

Larval stage

The duration of larval stage for both sexes was affected by the type of food employed. Result indicated that larval period of *B. mali* females was very high significant when they fed on free living nematode and bulb mite, it was averaged 1.63 ± 0.01&1.93 ± 0.014 days, respectively. This period of *B. mali* male was significant when reared on free living nematode and bulb mite and it averaged 1.58 ± 0.014 & 1.66 ± 0.014 days, respectively.

Protonymphal stage:

Table (1) shows that protonymphal stage was influenced by kind of prey. It was very high significant for females and males *B. mali*. It was 2.26 ± 0.06 & 2.89 ± 0.015 days in case of females when fed on free living nematode and *R. robini* , respectively. While it was

averaged 1.91± 0.06 & 2.71 ± 0.014 days in case of male when fed on free living nematode, respectively.

Deutonymphal stage:

Table (1) explicates that the both sexes of deutonymphal stage of *B. mali* were highly affected by the kind of food employed of females and males. Deutonymphal stage period was 2.85 ± 0.027 & 3.095±0.076 days when females fed on free living nematode and *R. robini*, respectively. but this period was recorded 2.69 ± 0.022 & 3.012± 0.014 days when male were reared on free living nematode and *R. robini*, respectively.

Life cycle:

Data given in table (1) indicated that there was a high significant effect of food types on the life cycle of females and males of *B. mali*. The life cycle for female of *B. mali*. It was 8.68 ± 0.08 and 9.89 ± 0.042 days when fed on free living nematode and bulb mites, *R. robini*, respectively , while it was recorded 7.73 ± 0.034 and 8.91 ± 0.027 days when males reared on free living nematode and bulb mites, *R. robini*, respectively.

Preoviposition, oviposition and postoviposition :

Data in table (2) shows preoviposition, oviposition and postoviposition periods of adult female *B. mali* adult females. These periods were very high significantly according to the kind of food submitted. Preoviposition, oviposition and postoviposition periods averaged 1.78 ± 0.05, 17.72 ± 0.5 and 8.4 ± 0.05 days,respectively, when fed on free living nematode. Those periods were 2.81 ± 0.05, 22.6 ± 0.05 and 4.04 ± 0.05 days, respectively when fed on acarid mites, *R. robini.*

Longevity:

Type of introduced food showed high significantly effects on longevity of predacious mites, *B. mali*. This period was 27.87±0.55 and 29.46 ± 0.042 days when female of *B. mali* fed on free living nematode and bulb mites, *R. robini*, respectively. while it was to 21.82 ± 0.21 and 24.22±0.18 days for male *B. mali* when reared on free living nematode and bulb mites, *R. robini*, respectively.

Life span:

From data in Table (1) indicated that kinds of food significantly affected the length of the life span period female and male of *B. mali* when females fed on free living nematode and acarid mites, *R. robini*, respectively. This period averaged 36.53 ± 0.4 and 39.28 ± 0.55 days, and it was 29.54 ± 0.22 and 33.19 ± 0.17 day when the males of *B. mali* fed on free living nematode and acarid mites, *R. robini*, respectively.

Fucundity:

Egg production by the ascid mite, *B. mali* was influenced by the type of food ingested. Fecundity was very high significantly when the adult female reared on the free living nematode where it deposited 86.5 ± 1.98 eggs, while the adult female deposited 37.7 ± 0.79 eggs when fed on astigmatid mites, *R. robini.*

Food consumption:

The number of devoured preys of *R. robini* immature stages (larvae, protonymphs, deutonymphs, total immature stages and longevity) was 2.6 ± 0.16, 4.1 ± 0.23, 6.3 ± 0.15, 13 ± 0.30 and 112.7 ± 1.35 individuals for *B. mali* males. These numbers were differed recording 2.6±0.16, 4.5±0.17, 5.6 ± 0.22, 12.9 ± 0.31 and 64.8±0.57 individuals for the predator females at 25±1ºC and 70% R. H. (Table 3).

Table 1: Developmental times of *B. mali* when reared on two types at 25 ± 1°C and 70 ± 5% R.H.

Predator stage	Sex	Average periods in days		L.S.D	F	P
		R. sccanica	*R. robini*			
Incubation period	♀	**1.84±0.031a**	**1.85±0.018a**	**0.0316**	**0.027**	**0.871ns**
	♂	**1.54±0.014b**	**1.55±0.014b**	0.0412	0.023	0.880ns
Larva	♀	**1.66±0.024b**	**1.93±0.014a**	**0.05**83	**92.200**	**0.0000*****
	♂	**1.58±0.014^{b}**	**1.6 3±0.014^{a}**	0.0400	8.002	0.0111*
Protonymph	♀	**2.26±0.057^{b}**	**2.89±0.015^{a}**	**0.123**	**115.4**	**0.0000*****
	♂	**1.91±0.015^{b}**	**2.71±0.014^{a}**	0.0427	1550.66	0.0000***
Deutonymph	♀	**2.85±0.027^{b}**	**3.095±0.076^{a}**	**0.170**	**9.2**04	**0.0071 ****
	♂	**2.69±0.022^{b}**	**3.012±0.014^{a}**	0.0549	155.7355	0.000***
Immature stages	♀	**6.81±0.058^{b}**	**8.039±0.045^{a}**	**0.153**	**281.892**	**0.0000 *****
	♂	**6.18±0.029^{b}**	**7.36±0.031^{a}**	0.0889	781.641	0.0000***
Life cycle	♀	**8.68±0.08^{b}**	**9.89±0.042^{a}**	**0.191**	**179.38**	**0.0000 *****
	♂	**7.73±0.034^{b}**	**8.91±0.027^{a}**	0.0908	753.211	0.0000***
Longevity	♀	**27.87±0.08 ^{b}**	**29.46±0.042^{a}**	**1.542**	**4.707**	**0.0437 ***
	♂	**21.82±0.21^{b}**	**24.22±0.18^{a}**	0.5877	73.841	0.0000***
Life span	♀	**36.53±0.47^{b}**	**39.28±0.55^{a}**	**1.527**	**14.231**	**0.0014 ****
	♂	**29.54±0.22^{b}**	**33.19±0.17^{a}**	0.5862	170.794	0.0000***

Table 2: Effect of prey types on female longevity and fecundity of *B. mali* at 25 ± 1°C and 70±5% R.H

Biological parameters	Average periods in days		L.S.D	F	P
	R. sccanica	*R. robini*			
Pre-oviposition	**1.78±0.049[b]**	**2.81±0.046[a]**	**0.14**	**234.2**	**0.0000 *****
Oviposition	**17.72±0.45[b]**	**22.6±0.52[a]**	**1.5**	**75.63**	**0.0000 *****
Post-oviposition	**8.49±0.049[a]**	**4.04±0.046[b]**	**0.56**	**274.42**	**0.0000 *****
Longevity	**27.87±0.48[b]**	**29.46±0.55[a]**	**1.12**	**77.63**	**0.0000 *****
Fecundity (Total average)	**86.5±1.98[a]**	**37.7±0.79[b]**	**4.47**	**524.54**	**0.0000 *****
Daily oviposition rate	**3.11±0.06[a]**	**1.28±0.016[b]**	**0.14**	**751.39**	**0.0000 *****

Table3: Food consumption of *B. mali* when fed on *R. robini* at 25 ± 1°C and 70±5% R.H.

Predator stage	Sex	No. of devoured prey individuals		L.S.D	F	P
		Daily rate	Total average			
Larva	♀	1.33	2.56±0.091[a]	0.349	3.41	0.0813 ns
	♂	1.643	2.68±0.138[a]			
Protonymph	♀	1.33	3.84±0.09[a]	0.201	6.0548	0.0242*
	♂	1.41±	4.940.076[b]			
Deutonymph	♀	1.855	5.74±0.0768[a]	0.196	0.115	0.7382ns
	♂	1.823	5.49±0.0536[a]			
Immature stages	♀	1.614	14.35±0.034[b]	0.1116	6.171	0.023*
	♂	1.746	12.85±0.04[a]			
Longevity	♀	3.829	112.80±0.0943[a]	0.202	147.61	0.0000***
	♂	2.658	64.38±0.019[b]			
Life span	♀	3.515	138.07±0.069[a]	0.1503	273.33	0.0000***
	♂	2.332	77.40±0.0181[b]			
Pre-oviposition		3.20	8.99±0.0156[b]			
Oviposition		4.21	95.15±0.0135[b]			
Post-oviposition		2.22	8.97±0.0121[b]			

DISCUSSION

The present study, the biology of predatory mite, *Blattisocius mali* was showed when reared on *R. robini* and free living nematode at 25±1ºC and 70% R. H. Incubation period of B. mali could not influenced by the type of diets at the same of temperature .Lowest incubation period was found during feeding the male on free living nematode. The life cycle, longevity and life span of the predator were affected by kind of food. The predacious mite had longer developmental period of the life cycle, longevity and life span during feeding on R. *robini*. Daily oviposition rate and fecundity of females were also affected by the type of food. They have higher fecundity when females were fed on free living nematode, *R. sccanica* than feeding on *R. robini*. The present agrees with obtained results by Britto et al., (2012), they found that the fecundity of Lasioseius floridensis Berlese was 3 times higher when fed on the free living nematode rather than *Tyrophagus putrescentiae* (Schrank). Somespecies of Ascidae and Macrochelidae are so reliant on nematodes as food. They did not deposit eggs without first feeding nematodes Walter et al., (1987). Kaid (1998) described adult male, female and immature stages of an *Androlaelaps* sp., in addition to its biological aspects and feeding habits when feed on three kinds of diet (*Caloglyphus* sp., *Tyrophagus putrescentiae* and free living nematode, *R.scanica*). He recorded that acarid mites, the developmental times of predatory mites, *Androlaelaps* sp., was higher significantly on *T. putrescentiae* compared with free living nematode.

The predator *B.mali* passed through one larval and two nymphal stages before being adult (female and male). Each moving immature stage followed by quiescent one, these results coincided with those mentioned by Yassin et al. (2017), Enas (2019) and Mohamed (2013). Afifi et al., (1986) reported that Protogamasellus minutus (Ascidae) was developed and reproduce on the acarid mites *R. robini*.

Hughes (1976) found that *B. mali* is predator of the acarid species *Carpoglyphus lactis* (L.), *Acarus siro* and *T. putrescentiae*. Azevedo et al., (2019) declared that species of soil predatory mites feed on a diverse diet making them excellent bio-control candidates for conservation biocontrol programs. Free-living nematodes are commonly found in soils and serve as prey for many soil predatory mites, but, have never been used as alternative prey to enhance the efficacy of soil predatory mites for conservation biological control. *Enas (2019)* noted that *Blattisocius tarsalis* (Berlese) is candidate as a predatory mite, for potential biological control of astigmatid stored product mites. She investigated the performance of B. tarsalis on immature stages of the astigmatid mites*, T. putrescentiae* and *R. robini.*

Yassin et al.,(2017) reported that *Blattisocius keegani* (Fox) is a predatory mite and has traditionally been as a biological control agent in stored products.

They studied the developmental time (incubation period, life cycle and longevity), fecundity and food consumption of the predatory mite *B. keegani* were investigated at 25°C and 35°C and 75% R.H when fed on the acarid mites, *R. robini* showing similar results with the present study. Also, Mohamed (2013) reared *Blattisocius dentriticus* (Berlese) at 30 ± 2 °C and 80 ± 5 % R.H. on *R. robini* resulting similar results to the present investigation. Gallego et al., (2019) studied the possibility of using *Blattisocius mali* as a potential biological control agent of the Potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), and went to that the mite is an

active predator to that insect pest.

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الملخص العربي

بيولوجى الأكاروس(*Blattisocius mali* (Oudemans) (أكاري ، جامسيدا ، أسكيدي) متغذيا علي بيئات مختلفة تحت ظروف المعمل

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تمت تربية الأكاروس(*Blattisocius mali* (Oudemans (فصيلة Ascidae) على نوعين مختلفين من الغذاء هما الأطوار غير الكاملة للحلم الأكاريد (فصيلة *Rhizoglyphus robini Claparede*(Acaridae والنيماتود حرة المعيشة *Rhabditis sccanica Allgen* وذلك تحت ظروف المعمل (25±1 م^{O} و5 ± 75 % رطوبة نسبية). كان متوسط فترة حضانة البيض 1.84 incubation periodو 1.54 يوما عند التغذية على النيماتودا *R. sccanica* للإناث والذكور على التوالى، اما عند التغذية على الأطوار غير الكاملة للحلم *R. robini* كانت1.85 و1.55 يوما للاناث والذكور على التوالى. و لوحظ أن دورة الحياة لكل من الذكر والأنثي قد تأثرت بنوع الغذاء المقدم للمفترس الاكاروسى تأثيرا معنويا فكانت 8.68 و 7.73يوما عند التغذية على النيماتودا, بينما كانت أطول 9.89و 8.91 يوما عند التغذية على *R. robini* للذكور والاناث , على التوالى .و تأثرت فترة طول العمربنوع الغذاء , استمرت هذه الفترة 21.8و27.87 يوما على عند التغذية علي النيماتودا لكل من الاناث والذكور على التوالى. وتغيرت هذه الفترة إلى 29.46و 24.22 يوما عند التغذية على الحلم لكل من الاناث والذكور, على التوالى . أوضحت الدراسة أن النوع *B. mali* يفضل النيماتود كغذاء حيث أعطت أعلى معدل خصوبة (86.5 بيضة) ، على العكس من ذلك تم وضع عدد من البيض أقل عند التغذية علي الأطوار غير الكاملة للحلم الاكاريدى (37.7 بيضة). خلال فترة التطور للحياة الكاملة للمفترس كان هناك اختلاف معنوى فى إجمالى العدد الكلى للفرائس المستهلكة فكانت 138.7و 90.4 فريسة عندما تغذت اناث وذكور المفترس على *R. robin* على التوالى .