

BIOLOGY OF THE PREDAEUS MITE *Cheyletus eruditus* (SCHRANK) (ACARI: CHEYLETIDAE) WHEN FED ON THE ASTIGMATID MITE *Acarus siro* (OUDEMANS) AT DIFFERENT TEMPERATURES

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ABSTRACT

The mite species *Cheyletus eruditus* was reared on eggs and immatures of the acarid mite, *Acarus siro* (Oudemans) at 20 and 30 °C. All biological aspects of the predator were significantly affected by the temperature. The incubation period, life cycle and longevity of males and females were significantly increased when the cheyletid mite fed on *A. siro* eggs at 20 °C. in comparison with 30 °C. Incubation period of *C. eruditus* significantly differed between the male and female and further more between the different temperature degrees. The longest incubation period recorded when the males fed on the immature of *A. siro* 8.3 days at 20 °C and the shortest period 4.4 days when the male fed on eggs of *A. siro* at 30 °C. The female life cycle lasted 30.7 and 19.1 days on eggs of *A. siro* at 20 and 30°C, respectively, changed to 24.8 and 14.4 days when the males fed on the same prey, respectively. On the other hand, when the immatures of *A. siro* were used, *C. eruditus* life cycle lasted 32.6, 24.7; 19.9 and 15.1 days for the females and males, respectively. The adult female longevity of *C. eruditus* differed and reached to the highest level when fed on eggs of *A. siro* at 20 °C recorded 42.9 days and showed the shortest period when the males fed on immature stages of *A. siro* (14.0 days). The generation period of *C. eruditus* female lasted 36.1 and 21.2 days when fed on eggs of *A. siro* at 20 and 30 °C, changed to 36.6 and 22.5 days when the mites fed on immature stages of *A. siro*. Fecundity was significantly higher when the female fed on eggs of *A. siro* recorded 49.92 eggs at 30 °C and decreased to recorded the lowest number of deposited eggs at 20 °C when the females fed on immature stages of *A. siro* (33.0 eggs). During the longevity and life span of *C. eruditus* females, the mites consumed 282.7 and 344.8 eggs of *A. siro* at 20 C respectively, changed to record 130.7 and 147 eggs of *A. siro* in case of male individuals at the same temperature. While at the female consumed 236.0 and 268.0 immatures of *A. siro* and male consumed 150 and 158 immatures of *A. siro* at the same temperature. When eggs of *A. siro* introduced as prey for *C. eruditus* at 30 °C, the female of the predator consumed 340.5 and 436 and males consumed 220 and 247 eggs during longevity and life span, changed to record 315.0 and 387 immatures of *A. siro* in case of adult female of the predator and 150 and 163.6 immatures in case of male individuals in the same temperature.

INTRODUCTION

There is ample evidence that predators and parasitoids can play a significant role in the decline of moth populations in storages. Graham (1970), for example, described the buildup and decline of *Cadra cautella* (Walker)

(Lepidoptera: Pyralidae) (infesting bagged maize in Kenya, and concluded that predation by the mite *Blattisocius tarsalis* Berlese (Acarina: Ascidae) was the major cause of decline. Several mite predators have been documented to be associated with or even considered to be biological control agents against certain species of these pests. But much of the research has been restricted either to the laboratory studies, the biology of *C. malaccensis* was studied in the laboratory, using eggs of *Corcyra cephalonica* as prey, Nangia *et al.*, (1994). The authors noticed that the predator egg, larval, protonymph and deutonymph stages lasted 6.0, 3.0, 4.0 and 4.0 days, respectively. The average fecundity was 58.6 eggs/female. Cannibalism was common in the adult stage. Adult females exhibited partial parental care, guarding eggs for 2.0 days or until the larva emerged. Also a study was carried out on the life history of *C. malaccensis* when fed on *Lepidoglyphus destructor* by Zhang *et al.*, (1997). The whole life history required 48-50 days, including 5 stages (eggs, larvae, protonymphal and deutonymphal stage, and adults). Each mite consumed approximately 10-12 prey items / day and a total of 500 prey items during its life time. The predatory capacity decreased (with an unchanged number of prey) when the density of *C. malaccensis* increased. Yassin *et al.*, (2008) studied the feeding of the cheyletid mite, *Cheletomorpha lepidopterorum* (Schaw) on different astigmatid mites and mentioned that *T. putrescentiae* was the most favorable preys than *Lepidoglyphus destructor*, *Rhizoglyphus echinopus* and *Caloglyphus betae* and this might be due to *T. putrescentiae* contained the highest contents of total sugar and high relative concentration of glucose. Future studies should further contribute to improvement of rearing of this predator. Our data provide fundamental information for understanding the effect of different stages of stored product pest (*Acarus siro*) on development of the cheyletid mite, *C. eruditus* Future studies should further contributed to improvement of rearing of this predator at different conditions on different prey and this will increase its ability as a biological control agent. Mohamed *et al.*, (2012) reared *C. eruditus* on different sources of food (eggs and immatures of *Rhizoglyphus robini* and eggs of *Plodia interpunctella* (Hubner) and eggs of *Callosobruchus maculatus* (Fabricus) at different temperature and recorded that the type of prey and temperature affected significantly on *C. eruditus* males and females. The present work aim to study the effect of different prey and temperature on biological aspects, fecundity of the predatory mite , *Cheyletus eruditus* (shrank)

MATERIALS AND METHODS

Females and Males of the cheyletid mite, *Cheyletus eruditus* were isolated from standing cultures and transferred into small plastic diameter, 4 cm in depth).The bottom of the cell was covered with a mixture of plaster of Paris: charcoal (9: 1) and tightly covered by a glass slide as mentioned by Kandil (1982) and Salem *et al.*, (2005).The upper par of vials was surrounded by Vaseline to avoid escaping of mites. Newly hatched predatory larvae (protonymphs and deutonymphs) were confined singly in other cells and supplied with a known number of *A.siro* (eggs and immature stages) as prey

mites till reaching maturity. Drops of water were added daily to maintain suitable moisture. Emerging mite females were copulated with males and supplied with known number of eggs. All biological aspects of the predator were conducted at 20 and 30 ± 2 °C and 70 ± 5 % R.H. All presented data were subjected to one-way analysis of variance (ANOVA) and means were separated by Duncan's multiple range test (Duncan 1955).

Biological studies: In this study, the trials were conducted in the laboratory conditions (20 and 30 °C) and relative humidity 75 % to study the different biological aspects of the predaceous cheyletid mite, *Cheyletus eruditus* when fed on the astigmatid mite *Acarus siro* (eggs and immature stages).

Habitat and feeding: *Cheyletus* is mainly free-living predator that feed on various microarthropods, particularly herbivorous, fungivorous and saprophagous acaroid mites (Zdarkova, 1979). Cheyletids penetrate insects and mites with their chelicerae and immediately inject saliva that paralyzes the prey (Yoshikawa, 1985).

Mating: Virgin females of *Cheyletus* gave rise to male progeny (100 %), while fertilized females produced both sexes, Palyvos *et al.*, (2008).

Moulting: The presence of an exuvium was used criterion for successful moulting between each mite stage and the following one. In this stage the mite stops feeding and movement, and the quiescent individual practiced several movements to loosen itself from the old glassy whitish exuviae these continuous movements resulted in an n-shape rupture surrounding anterior and lateral sides of the prodosoma.

RESULTS AND DISCUSSION

Incubation period: Incubation period of the predatory mite *C. eruditus* significantly differed through the research and has been varied between the male and female and further more between the different temperature degrees. The tabulated data in Tables (1&2) showed that the incubation period of *C. eruditus* significantly differed when the individuals (males and females) fed on the two types of prey, as it recorded 8.1, 8.2 ; 4.5 and 4.4 days when female and male fed on eggs of *A.siro* at 20 and 30 °C, respectively, Table (1), while these periods recorded 8.2, 8.3 ; 4.8 and 4.9 days when the same mites fed on the immature stages of the astigmatid mite, *A. siro* at the same conditions, Table (2).

Life cycle: The prey and temperature suitability clearly affects the life cycle of *C. eruditus*. From the obtained data, Tables (1 and 2) it was showed that the female life cycle durated 30.7 and 19.1 days when fed on eggs of *A.siro* at 20 and 30 °C, respectively, changed to 24.8 and 14.4 days when the male individuals fed on the same prey at the conditions, respectively, Table (1). on the other hand, when the immature stages of *A. siro* were used as food type,

Table (1): Duration of the different stages of predatory mite *Cheyletus eruditus* when fed on eggs of *Acarus siro* at different temperatures

Developmental stage	20 °C		30 °C		L.S.D. at 0.05	
	Female	Male	Female	Male		
Incubation period	8.1+0.55	8.2+0.64	4.5+0.42	4.4+0.37	0.572	
Larva	A	6+0.47	6.8+0.27	3.8+0.21	3.9+0.19	0.355
	Q	1.5+0.11	1.4+0.11	1.3+0.12	1.4+0.13	0.122
Deutonymph	A	6.4+0.32	6.9+0.3	3.2+0.3	3.5+0.21	0.367
	Q	1.4+0.13	1.5+0.14	1.1+0.1	1.3+0.11	0.138
Deutonymph	A	5.7+0.32	-	3.8+0.24	-	0.320
	Q	1.6+0.12	-	1.4+0.09	-	0.111
Life cycle	30.7+1.6	24.8+1.0	19.1+0.84	14.4+0.75	1.68	
Generation period	36.1+1.5	-	21.2+1.5	-	2.15	
Longevity	42.9+2.2	28.0+1.6	25.2+1.4	15.2+0.97	3.14	
Life span	73.8+3.2	52.8+2.9	44.6+3.1	29.3+1.3	5.24	
Fecundity	40.5+2.5	-	49.92+3.4	-	3.36	

Table (2): Duration of the different stages of predatory mite *Cheyletus eruditus* when fed on immature stages of *Acarus siro* at different temperatures

Developmental stage	20 °C		30 °C		L.S.D. at 0.05	
	Female	Male	Female	Male		
Incubation period	8.2+0.65	8.3+0.47	4.8+0.27	4.9+0.33	0.584	
Larva	A	6.9+0.44	6.9+0.34	4.0+0.24	0.365	0.365
	Q	1.5+0.11	1.6+0.14	1.4+0.10	0.123	0.123
Deutonymph	A	6.9+0.33	6.4+0.41	3.3+0.24	0.387	0.387
	Q	1.3+0.11	1.5+0.12	1.2+0.16	0.142	0.142
Deutonymph	A	6.5+0.41	-	4.0+0.38	0.321	0.321
	Q	1.3+0.09	-	1.2+0.11	0.102	0.102
Life cycle	32.6+1.6	24.7+1.1	19.9+0.89	15.1+0.67	1.81	
Generation period	36.6+1.2	-	22.5+0.97	-	2.32	
Longevity	40.2+1.6	22.0+1.0	22.1+1.4	14.0+0.74	3.06	
Life span	72.2+3.5	46.7+2.7	42.0+2.4	29.1+1.4	5.20	
Fecundity	33.0+2.2	-	37.5+2.8	-	3.66	

The predatory mite *C. eruditus* life cycle lasted 32.6, 24.7; 19.9 and 15.1 days for the females and males, respectively, Table (2)

Longevity: Concerning the adult female longevity of *C. eruditus*, Tables (1 and 2), it was observed that this period differed on the different tested food, reached to the highest level when the female individuals fed on eggs of *A. siro* at 20 °C (42.9 days) and showed the lowest period when the males fed on immature stages of *A. siro* (14.0 days) at 30 C⁰.

Generation period: As shown in Tables (1 and 2), the generation period of *C. eruditus* female durated 36.1 and 21.2 days when the individuals fed on eggs of *A.siro* at 20 and 30 °C, Table (1), changed to recorded 36.6 and 22.5 days when the mites fed on immature stages of *A.siro*, Table (2).

Life span: Accordingly, the life span of *C. eruditus*, also highly affected by the types of food. The female life span of this mite was 73.8, 52.8; 44.6 and 29.3 days when the females and males of the predatory mite, *C. eruditus* fed on eggs of *A.siro* at 20 and 30 °C, respectively, Table (1). On the other hand, when the immature stages of the astigmatid mite, *A.siro* were used as rearing source, the life span of *C. eruditus* took 72.2, 46.7; 42.0 and 29.1 days, respectively at the same used conditions, Table (2).

Fecundity: Mating is essential for egg deposition of *C. eruditus* Eggs production in *C. eruditus* was influenced by the type of used food, Tables (1 and 2). Fecundity was significantly higher when the adult female fed on eggs of *A.siro* recorded 49.92 eggs at 30 °C and decreased to recorded the lowest number of deposited eggs at 20 °C when the females fed on immature stages of *A.siro* (33.0 eggs), Table (2)

Predation capacity of *C. eruditus* on eggs and immatures of *A. siro* at 20 °C. The predatory mite *C. eruditus* females preyed upon *A. siro* eggs with an average of 11.5, 20.2, 30.4, 35.5, 196.6, 50.2, 282.7 and 344.8 eggs of the astigmatid mite *A. siro* during larva, protonymph, deutonymph, Preoviposition period, oviposition period, postoviposition period, longevity and life span, respectively, but the same individuals consumed 130.7 and 147.0 eggs in case of male during longevity and life span period at 20 °C, Table (3). On the other hand, the female individuals of the predator preyed on 7.0, 10.2, 15.1, 18.2, 177.2, 40.3, 236.0 and 268.0 immature stages of *A.siro* at 20 C, for the same previously mentioned stages of *C. eruditus* female, but in case of longevity and life span of male individuals, the mites consumes an average of 150.0 and 158.0 immatures of *A.siro*, respectively, Table (3).

Predation capacity of *C. eruditus* on eggs and immatures of *A. siro* at 30 °C.

As shown in Table (4) the predatory mite, *C. eruditus* males and females (different stages) fed successfully on the astigmatid mite, *A. siro* at 30 °C with the same trend in case of 20 °C, but differed in the number of consumed preys of *A.siro* eggs and immature. The obtain data indicated that during the oviposition period of *C. eruditus* the mites consumed 250.2 eggs and 230.2 immatures of *A.siro* .On the other hand, the male individuals of *C. erudits* preyed on 150.3 and 163.0 immature stages and 220, 247 eggs of *A. siro* during its longevity and life span respectively Table (4).

Table (3): Efficiency of *C. eruditus* as consumed different preys at 20 °C and 70% R. H.

Type of prey	Developmental stages of <i>C.eruditus</i>	Mean numbers \pm S. E. of prey consumed by one cheyletid mite	
		Female	Male
Eggs of <i>A. siro</i>	Larva	11.5 \pm 0.45	3.2 \pm 0.24
	Protonymph	20.2 \pm 1.0	13.1 \pm 0.5
	Deutonymph	30.4 \pm 1.6	-
	Preoviposition	35.5 \pm 1.8	-
	Oviposition	196.6 \pm 6.4	-
	Postoviposition	50.2 \pm 2.5	-
	Longevity	282.7 \pm 6.8	130.7 \pm 5.5
	Life span	344.8 \pm 7.4	147.0 \pm 5.8
Immatures of <i>A.siro</i>	Larva	7.0 \pm 0.35	3.0 \pm 0.16
	Protonymph	10.2 \pm 0.65	5.0 \pm 0.34
	Deutonymph	15.1 \pm 0.87	-
	Preoviposition	18.2 \pm 1.2	-
	Oviposition	177.2 \pm 5.6	-
	Postoviposition	40.3 \pm 2.4	-
	Longevity	236.0 \pm 5.0	150.0 \pm 5.4
	Life span	268.0 \pm 5.9	158.0 \pm 5.2

Table (4): Efficiency of *C. eruditus* as consumed different preys at 30 °C and 70% R. H.

Type of prey	Developmental stages of <i>C.eruditus</i>	Mean numbers \pm S. E. of prey consumed by one cheyletid mite	
		Female	Male
Eggs of <i>A. siro</i>	Larva	20.2 \pm 1.2	12.0 \pm 0.34
	Protonymph	30.1 \pm 1.6	15.0 \pm 0.56
	Deutonymph	45.2 \pm 2.5	-
	Preoviposition	50.0 \pm 2.7	-
	Oviposition	250.2 \pm 5.8	-
	Postoviposition	40.3 \pm 2.7	-
	Longevity	340.5 \pm 6.8	220.0 \pm 4.2
	Life span	436.0 \pm 7.8	247.0 \pm 5.8
Immatures of <i>A.siro</i>	Larva	12.0 \pm 0.45	6.2 \pm 0.6
	Protonymph	16.0 \pm 0.87	7.1 \pm 0.74
	Deutonymph	25.2 \pm 2.6	-
	Preoviposition	50.3 \pm 3.5	-
	Oviposition	230.2 \pm 6.0	-
	Postoviposition	35.3 \pm 2.7	-
	Longevity	315.0 \pm 5.9	150.3 \pm 5.0
	Life span	387.0 \pm 6.1	163.6 \pm 4.5

Several researchers have studied the biological aspects of the genus *Cheyletus* and different results were obtained, e.g., regarding developmental stages duration, fecundity, reproduction mode, and prey consumption (Zaher and Soliman 1971; Yousef *et al.*, 1992; Saleh *et al.* 1986; Nangia *et al.*, 1994; Pekar and Hubert 2008). Those differences may be attributed to the occurrence of various biotypes in different regions of the world (Palyvos and Emmanouel 2004). Other sources of variation would be the ambient temperature (s) or the prey types. The effect of temperature on the development of immature stages of the predator *C. eruditus* Oudemans, produced by either fertilized or virgin females, was studied at 17.5, 20, 25, 30, 32.5, and 35 °C, 80 ± 5% relative humidity, in complete darkness, while fed on *Tyrophagus putrescentiae*, Nickolas *et al.*, (2009). Based on total produced developmental time, males developed more quickly than females, at all temperatures. Also, El-Shannat in Egypt_(2009) studied the biological aspects of the predatory mite, when reared on the grain mite, *Acarus siro* at 25 and 30 °C and 90 % R.H. and noticed that the duration of female longevity reached 48.0 and 38.0 days respectively. The number of recorded deposited eggs was 173.0 and 210.0 eggs, respectively at the same temperature. Similar results were obtained by Zaher and Soliman (1971) when reared *C. malaccensis* in the laboratory on *Caloglyphus* sp.. They noticed that the egg stage averaged 6.6 days at 19.5 °C and the larval, protonymphal and deutonymphal stages together averaged 19.4 days for females and 16.5 for males at 22 °C. Similar results were also obtained by Rakha *et al.*, (1991) noticed that eggs of *Lasioderma serricornis* L. seem to be a very adequate prey for this predaceous mite, *C. malaccensis*. During larval, protonymphal and adult stages, the male consumed 2.0, 4.2 and 2.6 eggs, while the female consumed 2.3, 3.6 and 106.4 eggs, respectively. The efficacy of the cheyletid mite *Acaropsis sollers* (Rohd.) as a biological control agent on eggs of the southern cowpea beetle, *Callosobruchus maculatus* (F.) and the cowpea beetle, *Callosobruchus chinensis* (L.) was studied under laboratory conditions.

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بيولوجية الأكاروس المفترس *Cheyletus eruditus* (Schrank) عند تغذيته على الأكاروس عديم الثغر *Acarus siro* (Oudemans) عند درجات حرارة مختلفة

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اجريت دراسات معملية على المفترس الأكاروسى *Cheyletus eruditus* والمنتمى لعائلة Cheyletidae من تحت رتبة الثغر الامامى Prostigmata وذلك عند تغذيته على البيض والاطوار غير الكاملة للأكاروس عديم الثغر *Acarus siro* وذلك عند درجتى الحرارة 20 و 30 م° ورطوبة نسبية مقدارها 70 % واتضح من النتائج المتحصل عليها ان جميع المظاهر البيولوجية من فترة حضانة البيض و دورة الحياة وفترة الجيل للأفراد الاناث وطول فترة حياة الافراد البالغة والفترة الكلية للأكاروس والخصوبة الجنسية لافراد الاناث تأثرت باختلاف درجات الحرارة ونوع الغذاء واتضح من النتائج ان الافراد المنتمية لهذا النوع لا بد لها من حدوث تزاوج بين الافراد الذكور والافراد الاناث لى تضع الانثى بيضا مخصبا وكانت اطول فترة لحضانة البيض عند تغذية الافراد الذكور والاناث على بيض الأكاروس *A.siro* (8.1 و 8.2 يوما على التوالي) , (4.5 و 4.4 يوما على الترتيب) وذلك عند درجتى الحرارة 20 و 30 م° وتغيرت هذه الفترات الى 8.2 و 8.3 يوما و 4.8 و 4.9 يوما على الترتيب عند تغذية نفس الافراد على الاطوار غير البالغة للأكاروس *A.siro*. و اتضح ان دورة حياة الأكاروس *C. eruditus* استغرقت زمنا مقداره 30.7 و 19.1 يوما عند تغذية اناث المفترس على بيض الأكاروس *A. siro* علي درجة 20 و 30 م° وتغيرت لتسجل 24.8 و 14.4 يوما للأفراد الذكور عند نفس التجربة. اما عند التغذية على الاطوار غير الكاملة للفريسة فقد استغرقت هذه الفترات زمنا مقداره 32.6 و 19.9 وللاناث و 24.7 و 15.1 يوما للذكور على الترتيب. وتأثرت ايضا طول فترة الافراد البالغة بنوع الغذاء ودرجة الحرارة المستخدمة والتي سجلت 42.9 يوما وهي اعلى فترة عند 20 م° على بيض الفريسة و اقل فترة سجلت كانت للأفراد الذكور للمفترس مسجلة 14 يوما فقط على الاطوار الغير كاملة للفريسة. اما فترة الجيل لاناث المفترس الأكاروسى فقد استغرقت فترة مقدارها 36.1 و 21.2 يوما عند تغذية الاناث على بيض الفريسة عند 20 و 30 م° تغيرت لتسجل 36.6 و 22.5 يوما على الاطوار غير البالغة للفريسة على الترتيب. و اوضحت الدراسة ايضا ان اكبر عدد بيض لوضع لاناث اكاروس المفترس كان مسجلا عند 30 م° عند التغذية على بيض الأكاروس *A.siro* (49.92 بيضة) و اقل الاعداد كانت (33 بيضة) عند تغذية الافراد على الاطوار غير الكاملة للفريسة عند 20 م°. اتضح كذلك من النتائج المتحصل عليها انه اثناء فترة الحياة للأفراد البالغة *Longevity* والمدة الكلية للأكاروس المفترس *Life span* قام الأكاروس المفترس بالتغذية على عدد مقداره 130,7 و 147 بيضة من بيض الفريسة عند درجة حرارة 20 على التوالي للأفراد الذكور اما بالنسبة للأفراد الاناث فكان العدد المستهلك من الفريسة 282.7 و 344.8 بيضة من الفريسة *A. siro* عند نفس درجة الحرارة التي تغيرت الي 150 و 158 بيضة فى حالة تغذية ذكور المفترس عند نفس الظروف ولكن على الاطوار غير الكامله للفريسة . بينما قامت الاناث باستهلاك ما مقداره 236 و 268 طور غير بالغ للفريسة عند نفس الظروف. اما عندما قدم بيض الفريسة كغذاء للمفترس عند 30 م° لوحظ ان اناث المفترس قامت بالتهام 340 و 436 بيضة بينما استهلكت الذكور 220 و 247 بيضة اثناء فترتى الافراد البالغة والمدة الكلية للمفترس علي التوالي. وتغيرت لتسجل عددا من الفرائس مقداره 315 و 387 من الاطوار غير البالغة فى حالة الاناث و 150,3 و 163,6 طور غير بالغ بالنسبة لذكور المفترس وذلك عند نفس الظروف .