

The Biology of *Trogoderma granarium* (Everts) (Coleoptera: Dermestidae), in the Central Province of Saudi Arabia

Yousif N. Aldryhim and Elshami E. Adam

*Plant Protection Department, College of Agriculture, King Saud University,
Riyadh, Saudi Arabia*

Abstract. Studies on the biology of *Trogoderma granarium* (Everts), were carried out under laboratory conditions, in the Riyadh region throughout 1986-1987. Four annual generations were recorded for this pest, the duration of generations ranged between 36.5 and 200 days. Females lived relatively longer than males, and the adult longevity tended to decrease as the temperature increased. The number of eggs laid per female throughout its life ranged from 41.8 to 51. The shortest and longest incubation periods for eggs were 4.1 days in June, and 13.5 days in October. Larvae of males developed faster than those of females. The shortest mean periods recorded were 26 and 30 days for both sexes respectively. Females had one more moult than the males. During different generations, the prepupal and pupal stages of both sexes showed little variation. Those of the preoviposition, oviposition, and postoviposition periods of females showed significant variations.

Introduction

The khapra beetle, *Trogoderma granarium* (Everts), is native to the Indian subcontinent [1]. It is an extremely important pest in granaries and warehouses, in many parts of the world [2]. This species seems to be confined to hot climatic regions [3], which provide optimum conditions for oviposition and subsequent development of the species.

In Saudi Arabia, specimens of the khapra beetle were collected by Mostafa, *et al.* [4], from all localities visited. The beetles were found feeding on grain residue, beans, and peas.

The biology and control of this species have been extensively studied by many authors [1, 3, 5, 6]. In most cases, controlled conditions of temperature and relative humidity were used. In nature, however, such constant conditions do not exist. The daily fluctuations of temperature and relative humidity have, in many cases, quite a

different effect on the development of these beetles. Therefore, the present study on the biology of *T. granarium* was carried out under laboratory conditions in the College of Agriculture, King Saud University, Riyadh, Central Region of Saudi Arabia.

Methods

The present studies were conducted in the Plant Protection Department, College of Agriculture, King Saud University, Riyadh, from October 1986 to October 1987. Ten pairs of newly emerged adult beetles, from the stock culture, were placed each in a Petri dish (5.2×1.5 cm) with a small amount of white wheat flour as an oviposition substrate medium. The preoviposition, oviposition, and postoviposition periods, the longevity of adults, total egg output of each female, the incubation period of eggs, and the hatchability percentage were recorded.

Eighty newly hatched larvae were isolated, each in a separate Petri dish (5.2×1.5 cm), and provided with whole wheat flour as food. The durations of the different larval instars, prepupal, pupal and preemergence periods were recorded. Several generations were reared, each from eggs laid by fertilized females of the previous generation.

Daily records of temperature and relative humidity were taken using a thermohygrograph. Data were analyzed using t-test and Duncan's multiple range test at $p=0.05$ level with a program from the Statistical Analysis System [7].

Results and Discussion

The climate at the experimental site is hot and dry in summer, with moderate temperature and humidity during winter (Fig. 1). The minimum and maximum temperatures recorded during this study were 10°C, and 37°C, during December 5, 1986 and July 26, 1987, respectively.

T. granarium passed through four annual generations; Those generations were designated (F_1 , F_2 , F_3 & F_4). The starting dates for these generations were October 25, 1986, May 16, June 26, and August 14, 1987, respectively.

The preoviposition, oviposition, and postoviposition periods of females tended to decrease with increased temperature (Table 1). These periods ranged from 1.07-2.50, 3.8-7.1, and 1.1-6.40 days, respectively.

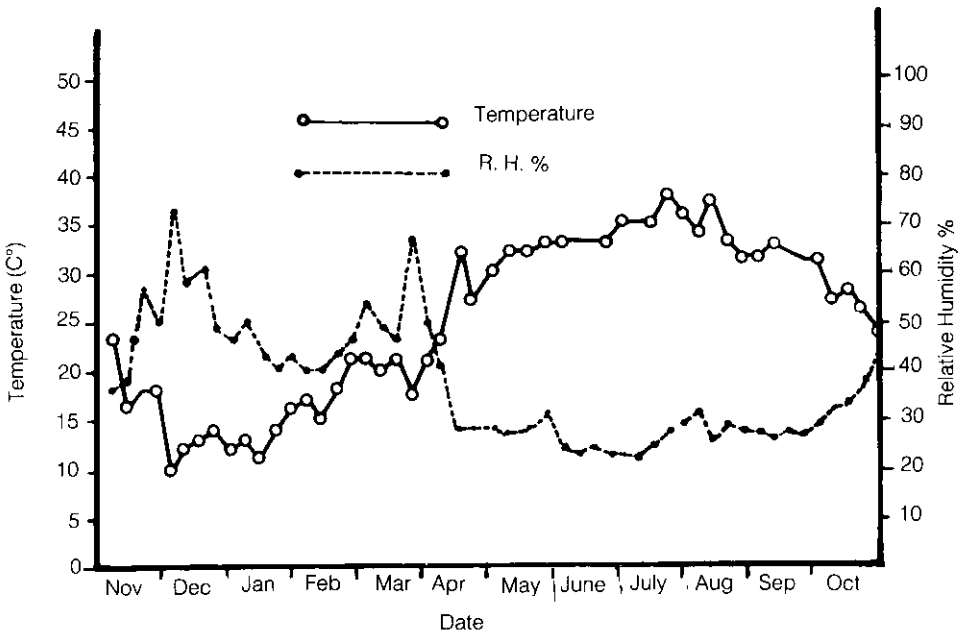


Fig. 1. Temperature and relative humidity (Nov. 1986-Oct. 1987) in the experimental room

Table 1. Mean duration in days, of the preoviposition, oviposition, and postoviposition periods of *T. granarium* females at different generations.

Generation	Starting date	Mean duration (in days) \pm SE		
		Preoviposition period	Oviposition period	Postoviposition period
F ₁	Oct. 25 1986	2.5 \pm 0.3 n=10	7.1 \pm 0.7	6.40 \pm 0.7
F ₂	May 16 1987	1.8 \pm 0.2 n=12	4.7 \pm 0.3	1.9 \pm 1.9
F ₃	June 26 1987	1.6 \pm 0.2 n=15	3.8 \pm 0.3	1.6 \pm 0.2
F ₄	Aug. 14 1987	1.07 \pm 0.3 n=15	3.8 \pm 0.2	1.1 \pm 0.1

n = number used

The adults of *T. granarium* were short-lived and the females lived significantly longer than males (Table 2). This was common in all generations. Contradicting results were, however, given by Hadaway [1] and Badawi [3]. The adult longevity decreased with increasing temperature. The longest and the shortest adult longevities were 16 and 6 days for females and 8.5 and 4.5 for males respectively.

Table 2. Mean \pm SE adult longevity, number of eggs laid per female and percent of hatch of *T. granarium*

Generation	Longevity (days)		Eggs/ female	Hatchability %
	Female	Male		
F ₁	16 \pm 0.6 A n=	8.5 \pm 0.1 B	44.1 \pm 3.0	73.3 n=300
F ₂	8.5 \pm 0.2 A n=15	5.3 \pm 0.2 B	41.8 \pm 4.2	88.3 n=400
F ₃	7.1 \pm 0.2 A n=15	5.4 \pm 0.3 B	50.3 \pm 1.8	83.5 n=400
F ₄	6.0 \pm 0.3 A n=15	4.5 \pm 0.2 B	51.1 \pm 2.5	61.5 n=400

Mean with same letter, at same generation, are not significantly different.

The mean number of eggs laid by females of different generations showed little variation (Table 2). The highest and lowest means recorded were 41.8, for an F₂ female and 51.1, for an F₄ female respectively. The maximum and minimum numbers laid by any single female were 76, and 16 eggs respectively.

Hatchability percentage above 80% were recorded for eggs of the F₂ and F₃ generations (Table 2) at mean temperatures of 29°C and 30°C respectively. Relatively lower percentages of hatchability were observed with eggs of the first and last generations. The mean temperatures recorded for these two generations were 21°C and 34°C respectively. Extremely high or low temperatures seem to have an adverse effect on hatching.

The incubation period was less than five days for F₂, F₃ and F₄ generations. It was, however, 13.50 days for F₁ generation (Table 3).

Larvae of the first generation overwintered for about six months. Similar results were obtained by Badawi [3]. The duration of the larval periods of the first genera-

Table 3. Mean (\pm SE) periods in days of the different developmental stages of *T. granarium*

Stage	Generations				
	Sex	F ₁	F ₂	F ₃	F ₄
Egg		13.5 \pm 1.4 n=220	4.4 \pm 0.6 n=353	4.1 \pm 0.54 n=334	4.7 \pm 0.23 n=264
	F	181 \pm 1.9 A n=26	30 \pm 0.5 C n=35	31 \pm 0.6 C n=32	40 \pm 0.8 E n=30
Larval	M	174 \pm 2.6 B n=22	26 \pm 0.7 D n=32	33 \pm 0.7 C n=26	36 \pm 0.5 F n=20
	F	2.8 \pm 0.3 B	2.2 \pm 0.1 B	2.4 \pm 0.1 B	2.7 \pm 0.2 B
Prepupal	M	2.6 \pm 0.2 B	2.6 \pm 0.2 B	2.4 \pm 0.1 B	3.0 \pm 0.1 B
	F	3.9 \pm 0.4 A	4.0 \pm 0.26 A	4.1 \pm 0.2 A	3.6 \pm 0.1 B
Pupal	M	4.3 \pm 0.2 A	3.6 \pm 0.4 B	3.9 \pm 0.1 A	3.6 \pm 0.1 B
	F	3.8 \pm 0.2 A	2.7 \pm 0.1 B	2.4 \pm 0.2 B	2.6 \pm 0.3 B
Pre-emergence	M	2.4 \pm 0.4 B	1.8 \pm 0.2 C	2.5 \pm 0.6 B	2.1 \pm 0.3 B
	F	200 \pm 4.5 A	40.8 \pm 0.3 C	46.9 \pm 0.5 E	51.1 \pm 0.5 F
Generation	M	193 \pm 5.3 B	36.5 \pm 0.5 D	44.1 \pm 0.6 E	47.8 \pm 0.6 E

Means with the same letters within the same stage are not significantly different.

F : females

M : Males

tion was 181 and 174 days, for females and males respectively. The duration of the female larval period was always longer than that of the male. The shortest durations recorded were 30 and 26, days for females and males respectively. This occurred during the second generation (Table 3).

Female larvae always tended to have one more moult than males. During the last three generations (F₂, F₃ & F₄), 84.61-100% of females moulted five times and 86.91-100 % of males moulted four times. An additional moult was noted with overwintering larvae; above 90% of these larvae moulted 6-7 times in the case of females and 5-6 times in the case of males.

The prepupal, pupal, and preemergence periods of both sexes showed little variation in any of the four generations (Table 3).

The female lifespan was longer than that of the male. Males usually emerge earlier than females so that they may - according to Burkholder [8] - have enough time to search for a suitable site for mating and attract other adults by the aggregation pheromone they secrete.

The duration of generation ranged from 40.80-200 days for females and 36.5-193.5 days for males (Table 3). The shortest generation was that of the spring (F_2). The increased lengths of the F_3 and F_4 generations were probably due to the high temperature and dryness that created unfavorable conditions for development of this pest.

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دراسة بيولوجية لخنفساء الكابرا في المنطقة الوسطى من المملكة العربية السعودية

يوسف ناصر الدريمم و الشامي الصديق آدم

قسم وقاية النبات، كلية الزراعة، جامعة الملك سعود، المملكة العربية السعودية

ملخص البحث. أجريت هذه الدراسة تحت ظروف المعمل في قسم وقاية النبات بكلية الزراعة بجامعة الملك سعود بالرياض في الفترة من أكتوبر ١٩٨٦ إلى أكتوبر ١٩٨٧ م.

اتضح من هذه الدراسة أن هذه الآفة أربعة أجيال في العام وقد تراوحت مدة الجيل بين ٣٦ و ٢٠٠ يوم وكانت الأنثى أطول عمراً من الذكر. وقد تناقص عمر الحشرة الكاملة مع ارتفاع درجة الحرارة. وقد اتضح أن معدل وضع البيض للأنثى الواحدة طول حياتها يتراوح بين ٨، ٤١ و ١، ٥١ بيضة. وكانت أقصر وأطول فترة لحضانة البيض هي ١، ٤ و ٤، ١٣ يوم في يونيو وأكتوبر على التوالي.

وقد لوحظ أن يرقات الذكور تنمو أسرع من الإناث وتنسلخ عددًا أقل منها. وكانت أقصر فترة للأعمار البرقية لكل من الذكر والأنثى ٨، ٢٦ و ٣٠ يوماً على التوالي. وكانت الاختلافات بسيطة بين كل من الذكور والإناث بالنسبة لأطوار ما قبل العذراء والعذراء ولكنها كانت أكثر وضوحاً في أطوار ما قبل الوضع والوضع وبعد الوضع.

