Journal of Entomology 2 (1): 17-20, 2005
ISSN 1812-5670

Studies on the Biology and Distribution of Cadelle, *Tenebroides mauritanicus* (L.) (Coleoptera: Trogossitidae) in Bursa, Turkey

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Abstract: In this study, investigations on the biology and distribution of Cadelle (*Tenebroides mauritanicus* Linneaus (Coleoptera: Trogossitidae)) were carried out in Bursa Province, from 1996 to 1998. The studies were conducted in the laboratory at constant temperature of 27±1°C, 65±5% r.h., dark conditions and under natural conditions where *T. mauritanicus* lives in. At the end of the studies, *T. mauritanicus* was found two flour factories in Kestel and Osmangazi districts in Bursa Province during 1996-1998. This is the first record about the presence of *T. mauritanicus* in Bursa, Turkey. In addition, it was determined that the first adults emerged at the beginning of June. In the laboratory studies, the eggs laid by female developed on grain hatched in 4.01±0.48 days. The number of eggs which laid by adult beetles developed on grain was 103±78.8 and the ratio of hatching was 95%. Emerging larvae usually pass through 5 instars. Average development duration of larvae feeding on grain was 171±106.8 days. Pupal stage lasted average 12 days. Preoviposition was found average 15.2 days. Thus, development period was found minimum 67, maximum 342 days and one generation completed in average 205.8 days. In addition, sexual ratio (female:male) of adults feeding on grain was 2:1.

Key words: Cadelle, *Tenebroides mauritanicus*, biology, distribution, Turkey

INTRODUCTION

The cadelle, *T. mauritanicus* is widespread over the world and is frequently found in mills, granaries and storehouses where it infests flour, meal and grain. Both larva and adult feed on grain and have the destructive habit of going from kernel to kernel and devouring the germ. Moreover, the cadelle is one of the longest living stored product pests that attack stored grain[1]. It is sometimes called the bolting-cloth beetle because of its habit of cutting the silk cloths of bolting reels and redressing machines in flour mills[2]. The French called it the "Cadelle" and this is the name by which it is commonly known at the present time[3]. According to Munro[4] the cadelle is mainly a pest of flour mills, where it feeds on flour and also on other insects.

In this study, the biology and distribution of Cadelle (*T. mauritanicus*) is investigated both in flour factories in Bursa, Turkey and under controlled constant conditions in the laboratory. Since there is not so much information available about this pest, more research needs to be done to understand the biology of Cadelle.

MATERIALS AND METHODS

To investigate the distribution of Cadelle, 18 flour factories were visited biweekly from April to November in Osmangazi, Kestel, Karacabey, Mudanya, Nilufer, Gemlik districts of Bursa during 1996-1998.

Samples and waste products taken from flour factories were sifted by sieve to collect adults and larvae. The adults were separated from larvae and they were kept in a box (16x21x20 cm) whereas the larvae were kept in 70% ethanol. Head capsul size of each larval instar was measured. Ten pairs of adults, mated in a box, were put into 500 cc glass jars with wheat grains. Wheat grains were sterilized in incubator at a setting of 52°C for a period of between 5-6 h[5]. In order to balance the humidity lost during the drying process, the sterilized food were placed in incubator which was set at 65% r.h. and 27±1°C for a period of between 3-7 days[6]. The duration of preoviposition and the number of eggs laid per female were recorded. To determine the embryonal development of cadelle' eggs and the percentage egg hatching, 10 newly-laid eggs were collected from each female and a

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total of 100 eggs were used to establish a culture. The eggs were checked on daily. When the larvae hatched from the eggs they were placed in plastic feeding boxes (3x5 cm) containing wheat. This study was carried out on 40 individuals. Experiments were carried out in an incubator adjusted to 27±1°C and 65±5% r.h. Mature larvae were placed into petri dishes with a diameter of 6.5 cm within paper in an M formation to determine the duration of prepupal and pupal developmental period. Feeding boxes and petri dishes were checked and recorded on a daily basis to document the death rate of the larva and the duration of larval, prepupal, pupal stages were determined accordingly. Mature larvae were brought to the laboratory from flour mills in order to determine its natural enemies. Sexual ratios (female: male) within the adult and pupal population obtained in the laboratory on various dates were used to find out the sexual proportion of the *T. mauritanicus* .

RESULTS AND DISCUSSION

Cadelle adult and larval feeding damage was observed in two flour factories located in the districts of Kestel and Osmangazi both in 1996 and 1998. This is the first record about the presence of *T. mauritanicus* in Bursa. However Özer[7] found *T. mauritanicus* in Marmara Region including the cities of Istanbul, Kocaeli, Balikesir and Çanakkale. Similarly, Erakay[8] determined adults of *T. mauritanicus* in Ege Region. In addition, Faber[9] found that *T. mauritanicus* was one of the secondary pest of stored grain in Austria. Lal and Srivastova[10] also reported *T. mauritanicus* as a stored wheat pest in Madhya Pradesh in India.

Observations on *T. mauritanicus* showed that adults emerged from late May to early June and the numbers of adults began to increase in July in the flour factories. In addition larvae were found to take samples in the winter season in flour factories. Thus, it was thought that *T. mauritanicus* caused to damage throughout the year. Both larvae and adults were active during the winter season. They were not active during extremely low temperatures due to their inability to withstand the extreme cold during the winter months[7]. However, El-Nahal and El-Halfawy[11] determined that the numbers of *Tenebroides* in the mound were highest in August and September; they fell rapidly from early October and remained low until they began to increase fairly rapidly in March. In addition, the numbers of *Tenebroides* on the sacks were highest in late July and lowest in February.

In the laboratory studies, females laid their eggs either singly or in batches in the food medium on the surface of the glass jars. *T. mauritanicus* on wheat deposited its eggs inside splits in the husk of damaged grains, thrusting the eggs in as far as the ovipositor could reach. Halstead[12] also found that this habit of inserting eggs in cracks, presumably for protection, as for the *Lophocateres pusillus* (Klug) from Trogossitidae family. The eggs were deposited in batches of 30-40 eggs. Present results are similar to those reported by Bond and Monro[13] who found that the females laid their eggs in batches on the food medium. The number of eggs laid per female was shown in Table 1. The number of eggs laid per female average 103±78. It was also observed that they did not lay eggs everyday. However, it was determined that the average preoviposition period was 15.2±3.4 days (Table 1). In addition, eggs were observed daily from initiation of oviposition until the eclosion of the first larva, to establish the incubation period. Consequently, the duration of incubation period was recorded as 4.01±0.48 days and hatch ratio was 95%.

Head capsule size for each larval instar was measured (Table 2). It was determined that *T. mauritanicus* larvae passed through 5 instars. However, mean duration of the larval instars were found 171±106.8 days on grain (Fig. 1). As a result of this study, 50% of the larvae developed between 53-78 and 216-316 days, respectively. Mallis[3] cited that the duration of larval period varies with the environment and may extend from 39 to 414 days. Larvae reared under the same conditions were seen to have significant variations that we were unable to explain. However, it was thought that 50% of the larvae entered diapause. This finding was similar to that of Cotton[14] who recorded that larvae entered into hibernation and completed their growth the following spring.

Under laboratory conditions the duration of prepupal and pupal periods were found to be as follows; 3.1±0.44 days and 12±1.65 days. In addition, sexual ratio (female:male) was determined to be 2:1. As seen in Table 3, the duration of larval, prepupal, pupal and preovipositional periods under the described laboratory conditions were as follows; 4, 171.4 , 3.1 , 12.1 , 15.2 days. According to these results, one generation completed 205.8 days as average and the duration of development period changed from 67 to 342 days. Özer[7] found that cadelle required 62-78 days to develop from egg to adult at 26°C. According to Mallis[3] there may be two generations with a partial third and it is believed that there are three generations in tropical countries.

It was observed that Cadelle larvae ate the wheat germ. The emerged larvae fed under the germ coat, unobserved. After eating the germ these insects continued feeding into the endosperm. Finally, they ate the brush end of the kernels. Present results support the findings of Wilbur and Halazon[15] who found that larvae and adults eat the germ and smaller larvae may feed

Table 1: The number of eggs deposited per female *Tenebroides mauritanicus* for each replicate under the laboratory conditions

	Number of pairs									
Dates	1	2	3	4	5	6	7	8	9	10
01.06.1997	†	†	†		†		†	†	†	
10.06.1997							7			
14.06.1997		33						11		
19.06.1997			15		23				15	
20.06.1997	29									
22.06.1997	19			†		†				
24.06.1997										†
01.07.1997				29						
02.07.1997										
03.07.1997									8	
07.07.1997						32	60		10	24
10.07.1997	28		26	34						
11.07.1997				77	36		45			
14.07.1997				40		31	38		24	68
18.07.1997							40			8
19.07.1997		9							7	
21.07.1997			29	9						
28.07.1997										
30.07.1997				21	8		33			
07.08.1997	3		18	32	2					
08.08.1997							23			
11.08.1997	5			7		4				9
13.08.1997										
16.08.1997	13									
18.08.1997				11						
Total egg	97	42	88	260	69	67	246	11	64	109

† Mating

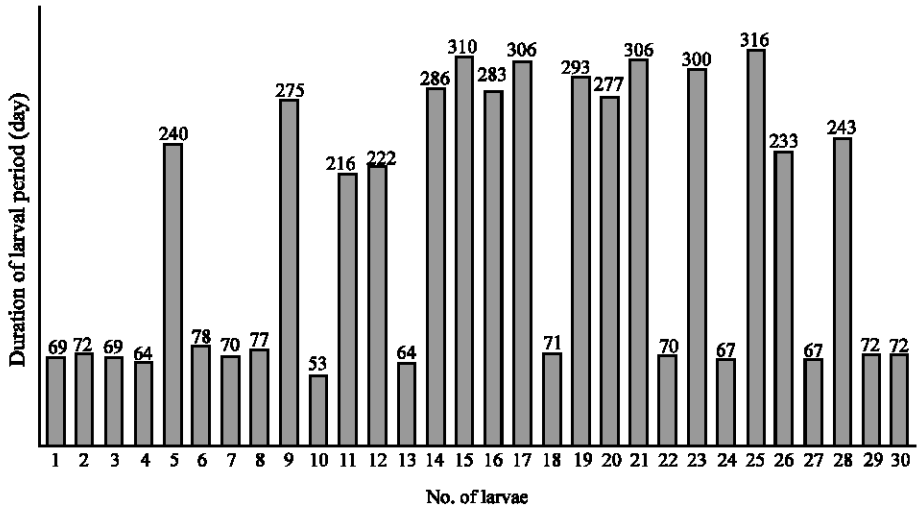

Fig. 1: The duration of larval development of the *Tenebroides mauritanicus* for each replicate on wheat

under the germ coat. Present observations showed that mature larvae left the food and bored readily into plastic feed boxes before pupating. Cline[16] showed the ability of larvae of 11 stored-pest species to penetrate flexible packaging materials in laboratory studies in the USA. Only *T. mauritanicus* and *Trogoderma variable* Ballion penetrated all 7 materials.

In order to determine natural enemies of cadelle mature larvae were brought to the laboratory from flour factories but natural enemies did not found.

In conclusion, *T. mauritanicus* have distinctive biological characteristics. They are a real threat to flour mills that are constructed in part using wood. The larvae would burrow into the wooden parts and hide in these

Table 2: Head capsule size of larval instars of *Tenebroides mauritanicus*

	Head capsul size (mm)		
Larval instar	Minimum	Maximum	Average
1	0.225	0.450	0.30±0.07
2	0.500	0.725	0.59±0.06
3	0.750	0.870	0.80±0.04
4	0.925	1.175	1.06±0.07
5	1.200	1.500	1.35±0.11

Table 3: Developmental period of *Tenebroides mauritanicus* feeding on wheat grains

Developmental stage	Minimum time (day)	Maximum time (day)	Average time (day)
Egg	2	6	4.00
Larva	53	316	171.40
Prepupa	3	5	3.10
Pupa	9	15	12.10
Preoviposition	10	20	15.20
Totals	77	362	205.80

recesses to gain access to the new produce and in effect prolong the duration of larval stage and maximum the rate of destruction caused. Infestations may be particularly difficult to eliminate because of the boring habits of the larvae.

ACKNOWLEDGMENTS

We thank the directors of flour mills for their assistance at various stages of the study. This study is a part of M.Sc. thesis approved by Applied Institute of Uludag University, Bursa, Turkey.

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