Some Aspects of the Biology of the Maize Stalk Borer *Busseola fusca* Fuller (Noctuidae:Lepidoptera) in Kenya[1]

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ABSTRACT

The egg incubation period of *Busseola fusca* was 7.5 ± 0.5 days. Of the 188 eggs incubated from a single female, 71.8% hatched into viable larvae, 30.4% of which experienced diapause while the rest (69.6%) had normal development. Larval duration period of diapause larvae was longer (238.5 ± 13.1 days) compared to that of non-diapause larvae (40.9 ± 0.5 days). Pupal period was 19.5 ± 2.1 days and female and male longevities 5.8 ± 3.1 and 5.3 ± 2.2 days, respectively. Overall, diapause generations performed better than non-diapause ones, as they had a longer oviposition period (3.4 ±1.1 as against 2.8 ± 2.2 days) and were more fecund (570.2 ± 173.9 as against 318.4 ± 278.0 eggs/female). The sex ratio was approximately 1:1 and observational evidence indicated that females entertained multiple matings.

Key words: ***Busseola fusca*, maize pest, biology, and ecology.**

RESUMEN

El período de incubación de los huevos de *Busseola fusca* fue de 7.5 ± 0.5 días. De los 188 huevos incubados por una sola hembra, el 71.8% ovipositó larvas vivas, de las cuales el 30.4% experimentó diapausa, mientras que el resto (69.6%) tuvo un desarrollo normal. La duración del período de las larvas con diapausa fue más larga (238.5 ± 13.1 días) en comparación a aquellas sin diapausa (40.9 ±0.5 días). El período pupal fue de 19.5 ± 2.1 días, y la longevidad de machos y hembras, de 5.8 ± 3.1 y 5.3 ± 2.2 días, respectivamente. En el transcurso, las generaciones por diapausa se formaron mejor que aquellas sin diapausa; su período de oviposición fue más largo (3.4 ± 1.1 contra 2.8 ± 2.2 días) y con mayor fecundidad (570.2 ± 173.9 contra 318.4 ± 278.0 huevos por hembra). La distribución por sexo fue de 1:1 y se observó que las hembras mostraban múltiples coitos.

INTRODUCTION

The maize stalk borer *B. fusca* Fuller is endemic in Africa (Mally 1920) and evidence abounds in the literature implicating the species as the most serious pest of maize (Bohlen 1973; de Pury 1968; Du Plessis and Lea 1943; Fuller 1990; Gebre-Amlak 1988; Harris 1962, 1964; Hill 1975; Ingram 1958; Jepson 1954; Kaufmann 1983; Schmutterer 1969; Smithers 1960; Swaine 1957; Usua 1968a; Van Rensburg 1980; Walker 1960a, Walker 1979). In Kenya, maize is the staple food crop and this pest is apparently responsible for considerable yield losses (Bullock 1958; Cocker 1956; Khaemba 1985; Le Pelley 1959; Seshu 1983; Unnithan 1987; Walker 1960b, 1967, n.d.; Wheatley and Crowe 1967)

Despite its destructiveness on maize in Kenya, detailed information on the biology and life cycle of *B. fusca* in Kenya's high altitude areas (1000 m - 2400 m), where the bulk of the crop is grown, is not available. The present studies were undertaken to gain a better understanding of the pest as a prelude to designing appropriate control strategies to minimize losses it causes.

MATERIALS AND METHODS

Development of *B. fusca*

This study was conducted at the Plant Breeding Centre, Njoro, Kenya (2165 m; 0° 20'S - 35° 56'E). Cultures of *B. fusca* were initiated by collecting pupae from the field, which were kept in glass vials (5 mm x 25 mm) in the laboratory. Genital characteristics were used to sex male and female pupae. In the case of the female, the genitalia scar was situated on the 8 th sternum, while in the male pupa it was on the 9th sternum. The male and female pupae were then retained separately until adult moth emergence. Moths were paired by sex and kept for oviposition.

In order to determine the duration of developmental stages, a batch of 188 eggs laid at the same time (0 h

1 Received for publication on July 10, 1992

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- 12 h) by the same female which were placed in plastic Petri dishes (15 mm x 5 mm) lined with moistened filter paper. The Petri dishes were then placed in a controlled environmental chamber (Conviron Model 123L) set at 23.5°C, 50% - 70% rh, with a photoperiod regime of 12 h light and 12 h darkness to simulate environmental conditions prevalent in Kenya's high-altitude areas. The eggs were observed daily until they hatched.

The newly hatched larvae were then introduced by the use of a camel hair brush into leaf whorls of terminal funnels of maize (variety H625) aged four weeks. The larvae were transferred to fresh stems within leaf whorls at three-day intervals. When the larvae started dispersing from leaf whorls to stems, they were each transferred to a portion of maize stem measuring 16 cm. The infested stems were then placed into perspex cages (40 cm x 25 cm x 25 cm) and held in the controlled environmental chamber.

As *B. fusca* larvae fed and increased in size, they were transferred to maturer portions of maize stems. Introduction of the larvae into the stems was accomplished by punching holes into them with a 10 cm nail before the larvae were placed into each hole. They were then allowed to tunnel through the stem until they attained maturity. Full maturity which was detected when the larvae started chewing small perforated "windows" (exit holes) in the outer stem tissue; this also marked the commencement of the pupation period prior to emergence as moths. Incubation period, durations of larval and pupal stages were determined.

Studies on the longevity, fecundity and sex ratio of *B. fusca* moths obtained from contrasting seasons

Comparative studies on longevity, fecundity and sex ratio of *B. fusca* were conducted after separately establishing laboratory colonies with larvae collected from the field during two seasons:

— The dry season (March) for recovery of diapausing larvae from the dry stalks of maize;

— the wet season (July) for recovery of non-diapausing larvae from fresh stalks of maize.

The pupae derived from larvae during these seasons were confined singly in plastic Petri dishes (15 mm x 85 mm) after sexing until adult emergence. After eclosion, moths that emerged on the same day were paired by sex and kept in perspex cages (40 cm x 25 cm x 25 cm) for oviposition after mating.

No food was provided to adult moths in view of the findings of Kaufmann (1983) and Unnithan (1987) that it neither affected their survival nor fecundity. The moths were, however, provided with tap water contained on soaked cotton wool pads.

Maize seedlings (variety H625) aged four weeks were introduced into the rearing perspex cages on daily basis for oviposition. The eggs laid were collected every morning and counted prior to being incubated in Petri dishes lined with moistened filter paper. Adult longevity, pre-oviposition, oviposition, and post-oviposition periods and fecundity were determined. Data obtained were subjected to statistical analysis in order to ascertain if there were any significant differences between moths obtained during the two different seasons.

In order to establish the sex ratio for diapause and non-diapause generation, 106 sixth instar larvae were retained in rearing cages. The diapause larvae were retained within dry stems, while the non-diapause larvae were retained within fresh stems, both with a single larva in its own portion of stem. Emerging moths from each of the two treatments were then counted and sexed. In order to establish whether there were differences in survival and sex ratio between the moths derived from diapause and nondiapause larva, data obtained was analyzed using the Chi-square test.

RESULTS

Development of *B. fusca*

The developmental periods of various stages of *B. fusca* are summarized in Table 1. Of the total of 188 eggs incubated, 135 eggs (71.8%) hatched into viable larvae. The incubation period of the eggs lasted 7-9 days (mean 7.5 ± 0.5 days). Of a total of 135 larvae reared, 41 (30.4%) underwent diapause, while the other 94 larvae (69.6%) had normal development without experiencing an intervening diapause period.

The larval period of non-diapause larvae lasted 31-60 days (mean 40.9 ± 0.5 days). On the other hand, the duration of the larval period of diapause larvae was much longer, ranging from 221–256 days (mean 238.5

Table 1. Mean durations (± S.E.) in days of the developmental stages of the maize stalk borer *B. fusca*, Njoro, Kenya, 1990.

Developmental stages	Mean duration ± S E	Range days	Number in sample (a)
Egg	7 5 ± 0 5	7-9	188
Non-diapause larvae	40 9 ± 0 5	31-60	94
Diapause larvae	238 5 ± 13 1	221-256	41
Pupae	19 5 ± 2 1	14-21	23
Adult			
Male	5 8 ± 3 1	2-9	10
Female	5 3 ± 2 2	3-8	10

± 13.1 days). The pupation period was 14-21 days (mean 19.5 ± 2.1 days). The average longevities of males and females were 5.8 ± 3.1 days and 5.3 ± 2.2 days, respectively (Table 1).

Studies on the longevity, fecundity and sex ratio of *B. fusca* moths obtained from contrasting seasons

Data on the life history of *B. fusca* moths arising from larvae obtained during dry and wet seasons, indicating durations of pre-oviposition, oviposition and post-oviposition periods, longevity and fecundity, are given in Table 2. Table 2 shows that female moths from both diapause and non-diapause generations had similar pre-oviposition periods lasting 1-2 days (mean 1.2 ± 0.4 days). Diapause female moths had a longer oviposition period (3.4 ± 0.4 days). Diapause female moths also had a longer oviposition period (3.4 ± 1.1 days) (range 3-5 days) as compared to that of non-diapause female moths, which was 2.8 ± 2.2 days (range 2-6 days). However, this difference was not significant (P > 0.05).

The post-oviposition period lasted on average 1.2 ± 1.3 days (range 0-3 days) in diapause moths and 1.2 ± 0.4 days (range 1-2 days) in non-diapause females (Table 2). The post-oviposition period also did not differ significantly (P > 0.05) between diapause and

Table 2. Pre-oviposition, oviposition, post-oviposition periods, longevity and fecundity of *B. fusca* collected in the wet and dry seasons, Njoro, Kenya, 1990.

	Diapause female moths		Non-diapause female moths		F
Parameter of oviposition	Mean (± S E)	Range	Mean (± S E)	Range	Value
Pre-oviposition period (days)	1 2 ± 0 4	1-2	1 2 ± 0 4	1-2	0 01 ns
Oviposition period (days)	3 4 ± 1 1	3-5	2 8 ± 2 2	2-6	0 3 ns
Post-oviposition period (days)	1 2 ± 1 3	0-3	1 2 ± 0 4	1-2	0 01 ns
Total longevity (days)	5 6 ± 2 5	3-8	5 2 ± 1 8	4-8	0 24 ns
Mean number of eggs/female	570 2 ± 173 9	372-818	318 4 ± 278 0	111-747	2 95 ns

ns = non significant (P > 0 05)

Table 3. Sex ratios of the maize stalk borer *B. fusca* collected in different seasons, Njoro, Kenya, 1990.

Sources of larvae	No of larvae infested	No of larvae that survived	Survival ratio	No. of emerged females	males	Sex ratio
Diapause larvae	106	88	4 9	46	42	0 52:0 48
Non-diapause larvae	106	103	34 3	53	50	0 51:0 49
Chi-square (sex ratio)	= 0 012 ns	(P > 0 05)				
Chi/square (survival ratio)	= 11 8922**	(P < 0 01)				

non-diapause moths. The average longevity for diapause and non-diapause moths was 5.6 ± 2.5 days (range 3-8 days) and 5.2 ± 1.8 days (range 4-8 days), respectively. This parameter was also son significant (P > 0.05) between the diapause and non-diapause generations.

The average fecundity (eggs/female) between diapause and non-diapause moths was not significantly different (P > 0.05) (Table 2). However, the fecundity of diapause moths was higher, ranging between 372 - 818 (mean 570.2 ± 173.9 eggs/female); non-diapause moths ranged between 111 - 747 (mean 318.4 ± 278 eggs/female).

Data on sex ratio of *B. fusca* samples from diapause and non-diapause generations is given in Table 3. The female to male sex ratio was almost identical (Chi-square = 0.013; P > 0.05), being 0.52:0.48 for non-diapause moths. Non-diapause larvae showed a higher survival ratio of 34.3 as compared to diapause larvae which had a ratio of 4.9 (Chi-square = 11.892, P > 0.01).

DISCUSSION

From the data obtained in the present study, the average developmental period of *B. fusca* from egg to adult for non-diapause larvae was shown to be shorter as compared to that of diapause larvae, for which the period was about four times as long. Additionally, 30.4% of the larvae from the same egg batch entered diapause. Similar findings have been reported (Unnithan 1987), except that a higher percentage (72.0%) of larvae entered diapause after they had fed on mature stalks. It is evident that this is a common trait in the ethology of *B. fusca* to ensure its survival.

Pre-oviposition period is of considerable importance in *B. fusca*, as its duration has implications for the distance the moth could disperse before egg oviposition starts. In this study, the pre-oviposition was identical and quite short in both generations, implying that its role in pest dispersal was minimal.

Fecundity studies showed that there were no significant differences in the mean number of eggs laid per female between diapause and non-diapause moths. This finding was contrary to earlier observations (Gebre-Amlak 1988; Smithers 1960; Unnithan 1987; Usua 1968b). In other studies, it was stated that female moths from non-diapause generations laid significantly more eggs. The disparity in the observations was probably caused by the different environmental conditions under which the studies were conducted.

It was also observed that diapause larvae suffered higher mortality as compared to non-diapause larvae. This was in conformity with Usua's observations (1968b), which attributed the higher survival rate of non diapause larvae to better nutrition, as they fed on more stalks of young plants.

It was also demonstrated here that the sex ratio between the females and males of the pest was almost identifical for diapause and non-diapause generations. This was also the case in studies reported by Unnithan (1987). It was thus concluded that, in nature, the sex ratio approximated 1:1. Observational evidence gathered during these studies showed that males mated more than once as compare to females. It would appear that many of them could be deprived of the opportunity to copulate. This might have the advantage of increasing sexual competition to ensure a higher rate of successful and viable matings.

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