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Morphometrics and Aspects of Bio-Ecology Of Ephestia Cautella (Lepidoptera: Pyralidae) on Stored Date Fruit (*Phoenix Dactylifera*) and Hermetic Control Technique

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Abstract Rate of fecundity, life cycle, morphometic characteristics of *Ephestia cautella* and control were investigated. These were done on sterilized dried date (*Phoenix dactylifera*) as substrate. Mean daily fecundity of 17 eggs was recorded, while a total of 1117 eggs were laid by 15 adults female *E.cautella* within 6 days of oviposition in perforated date. In another separate setup the life cycle from egg to adult took 37 ± 1.92 days, under a temperature and relative humidity of 32.5 ± 1 ^{0}C and 70 ± 5% respectively. First filial generation (F1) of 1, 217 adults emerged after 30 days of culture using two pairs of *E.cautella*, from this F1, 54.7% and 45.3%, were males and females respectively. The morphometric characteristics of *E.cautella* revealed that female and male adult mean total body length ranges between 8.2 - 10.00 mm and 7.9 – 8.9 mm respectively. The control set up on larval stage using varied polythen bag layers of three, two, and one layer with thickness of 0.056mm confirmed that three bags layers was the best treatment. Recorded percentage mortality values of 74.20%, 19.36% and 0.26% were obtained respectively from the set up.

Key words: *E.cautella, Phoenix dactylifera*, Fecundity, Life cycle, Hermitic control.

Introduction

Ephestia cautella (Walker) "the tropical warehouse moth" is a Lepidoptera with high destructive qualities caused by larval stage, this establish the economic significance of the species. There is dearth of information on this pest in Nigeria.

Report from Australia have it that *E. cautella* is prolific spinner of silk on dried fruits and cereal products, this web spinning account for high loss in market value of infested date.

Date palm (*Phoenix dactylifera*), is a monocotyledon plant of economic importance in many countries, it presents a source of income to oases inhabitants [1]. Date palms are produced in hot arid regions of the world, countries like Egypt, Iran, Saudi Arabia, Pakistan and Iraq [2] and marketed worldwide as a high value confectionery.

The fruit of *Phoenix dactylifera* is known as a date [3] which contain a high percentage of carbohydrate (44-88%), fat (0.2-0.5%), 15% salts and minerals, protein (2.3-5.6%), vitamins and a high percentage of dietary fiber (6.4-11.5%). The flesh of dates contains 0.2-0.5% oil, whereas the seed contains 7.7-9.7% oil, [4]. Dry or soft dates are eaten as whole fruit, seeded and stuffed, or chopped and used in a great variety of ways: as ingredients in cereals, puddings, breads, cakes, cookies, ice cream, and confectionaries [5].

Dates are stored by farmer in locally available materials such as goatskins, baskets made of palm leaflets and old kerosene tins and oil drums to provide protection against pest [5]. Dates in store are devastated by insect pest, the most economic insect pest, being *Ephestia cautella* (Walker) and *Oryzaephilus surinamensis* (Linnaeus) [6, 7]. Adults *E.cautella* do not damage stored product directly but the larval stage is the only damaging stage, the larva is found as the primary pests, fairly mobile within produce [8] and damage results from webbing and infested [9].

This paper thus investigates the tropical warehouse moths' fecundity and lifecycle, morphometric characteristics and possible control measure.

Materials and methods

Test Insects

Insect pest *Ephestia cautella* used for this research were cultured for a period of 4 months under temperature and relative humidity of 32.5 ± 1 ^{0}C and 60 ± 5% respectively, in the Entomology research Laboratory, Department of Zoology, University of Ibadan. The culture stock contained combined substrates of dried wheat and dried date palm fruit 10g and 4.7g respectively sterilized at 60^{0}C in a Gallenchemp oven for 3 hours. The date palm fruits were perforated at the calyx to mimic an infested date fruit to allow for easy oviposition and development by the insect pest *E. cautella* introduced. Freshly emerged male and female moths from stock culture raised were introduced into new set up sterilized specimen bottle.30 replicates were used to raise the culture stock. The set up were kept in two screened cages, with dimension (60 x 30 x 30) cm each. Subsequently, *E.cautella* used in the research work was collected from these raised culture stock.

Fecundity evaluation in *E.cautella*

Paired adult *E.cautella* was put in petri dishes which were well aerated for oviposition, after mating. Oviposition was done on black carbon paper laid inside the petri dish, this enhance clear view of the eggs laid. The set up was screened in a wooden cage to prevent contaminating of the set up. Laid eggs of *E.cautella* were counted daily using a soft brush under a binocular microscope.

Life cycle study of *E.cautella*

Developmental stages of *E. cautella* were monitored from egg to adult stages. Furthermore, emergence of first filial generation (F_1) adult male and female *E.cautella* were monitored and recorded daily. After the emergence aspirator was used for the removal of emerged adults within few hours of emergence from each set up.

Morphometric characteristics measurement of *E.cautella*

The emerged *E.cautella* adults were measured under a dissecting microscope with stage graticules, graduated 100mm x 0.1=10mm. 20 adult males and females were used for the study. Parameters measured include: Total length of body, Length of antennae, Length of head, Width of head, Length of abdomen, Width of Abdomen, Length of thorax, Width of thorax, Length of fore wings, Width of fore wings, Length of hind-wing and Width of hind-wing.

Application of hermetic control technique on *E.cautella*

Ephestia cautella infestations on date were controled using hermitic control technique. 30 transparent polythene bags, (12x12) cm in dimension and 0.056mm thick, capable of holding 100g of date were prepared using an impulse sealing machine to achieve hermitic/airtight situation. The treatments were set up at three layers of polythene bags. Treatment A was made of a single layer bags, treatment B had a double layer bags while treatment C was made up of a triple layer bags, each treatment was replicated 10 times. After filling the polythene bags with 100g of sterilized date perforated at the calyx, the bags were infested with two pairs of adult *Ephestia cautella*. Air was removed using rubber tubing attached to a hand pump to expel the air trap in the polythene bags before they were finally sealed up. The set up were stored in a well screened cage free from insects and rodents for a period of 5 weeks in the laboratory. Each bag treatment was opened up after 5 weeks of storage to check level of infestation of *E .cautella* by scoring the number of emerged larvae, pupae and adults.

Results

Fecundity and Life cycle studies: Egg laying activity by the adult *E.cautella* was allowed to run for six days. The highest number of eggs was recorded by the fourth day, (Table 1). The mean fecundity follows the same pattern as mentioned above with a total number of 1,117 eggs from 15 adult female *E. cautella* within

the period of 6 days .This translate to about 75 eggs per day.

Table 1 Mean fecundity rate of adult *E. cautella* in dried date (*Phoenix dactylifera*) under temperature and relative humidity conditions of 32.5 ± 1 ^{0}C and 60 ± 5% respectively, within a period of 15 days.

Duration (Days)	Total eggs oviposition per day	Range of eggs Oviposition	*Mean±SE oviposition
1	185	6-38	12.3±3.45
2	222	5-40	18.50±3.13
3	271	3-34	18.07±2.87
4	348	2-64	23.20±5.13
5	76	6-26	15.20±3.44
6	15	0-15	15.00±0.00
Total	1117		

Each mean is in 15 replicate

The life cycle from egg to adult took a total mean period of 37.50 ± 1.92 days. The eggs hatches to larval within a mean period of 9.53±0.61 days (ranges between 5-25 days).Larval metamorphosis to pupa was within a mean period of 15.40±0.63, with a range of 10 – 25 days. While the pupa developed to adult within mean period of 12.57±0.68 days (ranges between 7-22 days), (Table 2).

Table 2 Rate of Development in Life cycle of Ephestia cautella from egg to adult in dried Date (Phoenix dactylifera) under condition of 32.5 ± 1 ^{0}C and 60 ± 5%

Stages of Development	Rate of Deployment (Days) Range	Mean ± SE
Hatching from egg to larval	5 - 25	9.53±0.61
Metamorphosis from larval to pupa	10 - 25	15.40±0.63
Metamorphosis from pupa to adult	7 - 22	12.57±0.68
Total	22 - 72	37.50±1.92

Adult *E. cautella* rate of emergence: After a period of 30 days of adult emergence 1,217 adult's *E. cautella* first filial generation were recorded. From this emerged population of *E.cautella* 666 (54.7%) were male, while 551 (45.3%) were females. This gives a sex ratio of 1:1 approximately. (Table 3)

Table 3 Rate of emergence of adult *Ephestia cautella* (F_1 generation) in dried date (*Phoenix dactylifera*) under condition of 32.5 ± 1 ^{o}C and 60 ± 5%, within a period of 30 days

	Total number of emergence	Number of male (%) emergence	Number of female (%) emergence
Total	1217	666 (54.7%)	551 (45.3%)
Mean±SE	40.60±4.57	22.2±2.65	18.37±1.92
Range	4 – 91	2 – 56	1 – 39

Morphometric characteristics of *E.cautella*: Summary of the mean values of morphometric characteristics of adult *E. cautella* and the Duncan's multiple range test are shown in Table 4.The total body length between the male and female revealed significant difference, same can be said about every other parameters measured. Both antennae length and head width are not significantly different at P<0.05 by Duncan's multiple range tests.

Table 4 Mean (± SE) values of morphometric characteristics of adult male and female *E. cautella* cultured in dried date (*Phoenix dactylifera*) under temperature and relative humidity conditions of 32.5 ± 1 °C and 60 ± 5% respectively.

Parameters measured (mm)	Range Male (mm)	Range Female (mm)	Male Mean ±SE	Female Mean±SE
Total body length	7.9-8.9	8.2-10.0	8.28±0.06	9.63±0.09**
Length of Antennae	3.1-3.9	3.4-4.7	3.53±0.04	3.57±0.19**
Length of head	1.2-1.2	0.0-1.2	1.20±0.00	1.20±0.00 ns
Width of head	0.6- 0.6	0.0-0.6	0.60±0.00	0.60±0.00 ns
Length of abdomen	3.9-4.8	3.5-5.0	4.35±0.05	4.77±0.07**
Width of abdomen	1.0-1.6	1.2-1.9	1.37±0.04	1.53±0.04**
Length of thorax	1.6-2.3	1.8-2.9	1.89±0.05	2.34±0.08**
Width of thorax	1.5-2.1	1.3-2.1	1.71±0.04	1.78±0.04**
Length of forewing	6.0-8.0	6.9-8.9	7.11±0.11	8.26±0.13**
Width of forewing	1.6-2.4	1.5-3.0	1.97±0.44	2.23±0.11**
Length of hind-wing	4.3-6.3	5.4-7.3	5.42±0.12	6.38±0.12**
Width of hind-wing	1.4-2.9	1.8-2.3	1.97±0.96	2.12±0.04**

**Significant difference, ns – no significant difference at P<0.05 by Duncan's multiple range test
Each mean value is from 20 replicate.

Treatment	Total	Mean±SE* Larval Emergence	Percentage (%)
Single bag (A)	46	4.6 ±1.01	74.20
Double bags (B)	12	1.20±0.44	19.36
Triple bags (C)	4	0.40±0.40	0.26

Table 5 E. Cautella Larva Emergence in Each Bag Treatments after 5 weeks of control in dried date (p. Dactylifera) under conditions of 32.5 ± 1 °C and 60 ± 5% rh.
*Each mean is from 10 replicates

Hermetic control technique on infested *E.cautella* in *P. dactylifera*: The hermetic control technique showed that emergence was drastically reduced and life cycle prolonged. Triple bags treatment had the least larvae population, while in double bags treatment, emergence was increased. Also, single bag treatment allows for more emergence, thereby recording the largest pest infestation, (Table 5).

Discussion

Ephestia cautella is a major pest of stored date with an average infestation level of 16.8% as reported by [9,10] in his work. [8], reported that about 200-500 eggs were laid after copulation, however this studies showed that the fecundity rate of *E. cautella* ranged

between 6 and 160, this fecundity value is less, this may be due to the difference in the condition under which this research were conducted and the type of substrate used. Substrate nutrient, quantity and state are important factors that determine fecundity rate of stored pests.

Life cycle of *E. cautella* takes about 38 days at laboratory temperature and relative humidity of 32.5 ± 1 ^{0}C and 60 ± 5% respectively. This slightly varied from [11] submission. He reported that at optimum temperature of 30^{0}C and 40-75% relative humidity, development takes about 30 days. The variation may be as a result of the laboratory environmental conditions where the experiment was conducted. During oviposition, eggs of *E.cautella* were laid singly. The eggs were oval in shape and sticks on the substrate. The eggs hatched to larvae which were yellowish-white in colour. Infestation starts through silk webbing by larvae, this was followed by frass that were produced due to feeding and boring activities of the larvae. Male *E.cautella,* lives for about two weeks (14 days) during which they mate with the female and died afterwards. On the other hand, female died immediately after oviposition. *E.cautella* male emergence ratio was higher than female, 54.7% male emerged compare to 45.3% female emergence; however it was approximately 1:1. This situation ensures the availability of male to mate with available female, as prolific oviposition encourages high pest population in the store.

The morphometric characteristics of adult tropical warehouse moth *E.cautella* WALKER recorded conformed with the results obtained by [8].The larvae were 15 mm long, yellow-white, sometimes pinkish, have a brown head and there were setae (hairs) arising from dark brown-pigmented spots, this was also reported by [12] and [13].Furthermore, both sexes have head length and width, so they can not be accurately differentiated base on these parameters. On the other hand from these studies the total body length of female is longer than male; also same can be said about the antennae. These parameters are statistically significant as well, so they good structures to consider when doing taxonomy work on the *E. cautella*

The hermetic storage investigation conducted revealed this technique as possible control measures with promising results. The technique mode of action was based on low level of oxygen and high level of carbon dioxide due to metabolic activity of the pest. This imposes high metabolic stress on the insect pest thereby enhancing mortality. This work revealed that the hermitic control technique was effective for the control of *E. cautella,* since only larval stage emerged after 5 weeks of infestation, in all the treated bags. The life cycle was prolonged since after 5weeks of infestation a single adult was not recorded to have emerged. Reduction of oxygen concentration and increase of carbon dioxide has slow down *E. cautella* metabolic activities which in turn eventually led to the death of the pest. Management and handling of the single layer bag might have cause damage to the bag and this may allow for entrance of some degree of air into the bag. The degree of damage to double and triple layer bags was less and consequently, little or no air was allowed into the bags, this helps to reduce oxygen and increase carbon dioxide concentrations. The triple bag set up was more effective than the double and single layer bags. This result agreed with the report of [14] that metabolic activities on commodity reduces to a greater extent if mites, insects and especially fungi causes local reduction in the concentration of Oxygen and increases in carbon dioxide. The result also correspond with the work reported by [15],where Ghanaian Cocoa Board completed a 6-week trial on three 1-tonne cocoons loaded with cocoa at initial moisture content of 6.7% humidity. By the end of the trial, oxygen levels in all the 3 cocoons loaded cocoa had reduced to zero percent. "When the cocoon was opened, it was seen that *Tribolium castaneum, Ephestia cautella, Cryptolestes* spp., *Oryzaephilus surinemensis, Araecerus* spp. introduced for infestation were dead at the bottom of the cocoon when the beans were being packed out. All insects introduced [for test purposes] in the prototype bags were also dead.

This outcome of research provides useful information's on some aspect of *E.cautella* bioecology which may help in the management of *E.cautella*

during infestation in storage. This will eventually bring about reduction of the pest population below economic threshold and allow for high quality date fruit with high market values.

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