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ASSESSMENT OF THE EFFECTS OF TEMPERATURE ON THE DEVELOPMENT OF HIDE BEETLE (*Dermestes maculatus* De Geer 1774)

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ABSTRACT
The present work was carried out to determine the effect of two temperatures (27^{0}C and 35^{0}C) on the development of hide beetle (Dermestes maculatus DeGeer 1774). This research was carried out at the Department of Biological Sciences, Usmanu Danfodio University, Sokoto, 2015. The samples of hide beetle were collected along with the infested dried fish from a local market in Sokoto metropolis, Sokoto State, Nigeria. The adult hide beetles were identified based on morphological features using standard taxonomic key and mother culture was maintained at ambient temperature and humidity. Eggs viability of 92.6% with 6 larval instars and 82.1 mean pupal survival at 27^{0}C was recorded. This was in comparison with 91.7% eggs viability, 8 larval instars and mean pupal survival of 86.7% at 35C. The results showed significant difference for eggs (t_{cal} of 4.4, t_{tab} 2.78 at 5% degree confidence level) larvae (t_{cal} of 6.8, t_{tab} at 2.45 at 5% degree confidence level) and pupae (t_{cal} of 7.44 as against t_{tab} of 2.36).
Keywords: Assessment, Development, Effect, Hide Beetle, Sokoto, Temperature.

INTRODUCTION

Dermestes maculatus (DeGeer 1774) belongs to the Phylum Arthropoda, Class Insecta, Order Coleoptera, Family Dermestidae, Genus *Dermestes* and Species *maculatus* (McNamara *et al*., 2008). It is commonly referred to as the hide beetle. The hide beetle feeds on carrion and dry animal products (McNamara *et al*., 2008). The adult beetles have forensic significance in helping to estimate the post-mortem interval in suicide or homicide cases (Richardson and Goff, 2001). These insects are also pests of the silk industry in Italy and India, and infest stored animal products such as dried fish, cheese, bacon, dog treats and poultry (Veer *et al*., 1996; Cloud and Collinson, 1986). Hide beetles play an important role in nutrients recycling and are commonly used as "museum volunteers" to clean carcasses as part of skeletonization processing for zoological specimens. The loss caused by hide beetles in dried fish has been attributed to consumer (nutrient quality) resulting to declining consumer acceptability and market price (economic losses) or both (Usman *et al*., 2012; Odeyemi *et al*., 2000).

Khan and Khan (2001) reported that at present, total fish production is about 1.2 million tones of which 15% of fishes are cured for mass people consumption for retailing the dry fish in rainy seasons. It was found that 10-20% of the stored products lost are due to insect infestation. Coombs (1979) observed the ability of some *Dermestes* species to develop on vegetable products alone without the presence of an animal protein.In Nigeria, *D. maculates* is reported to cause 50% weight loss in dry fish (Kemabonta *et al*., 2013). Dermestid beetles larvae are very destructive pests of stored products especially hide and skin (Olagunju, 2014). Lale and Sastawa (1996) as well as Odeyemi *et al.* (2000) recorded about 50% losses during storage of smoked fish products due to deterioration. This is dependent on length of storage, salt content, climatic conditions and general hygiene practices during processing and storage (Owoade, 2008; Moses, 1983). Lale and Sastawa (1996) also estimated 13-17% of losses in dried fish during three months of storage mainly by *D. maculatus.* Nigeria produces 150, 000 tons of fish products annually of which 40% is lost due to poor handling and storage with 30-50% loss in weight (Osuji, 1977; De Young *et al*., 2011).The main aim of the present research was to study the effects of temperature on hide beetle (*D. maculates*) with the view of understanding the biology of the pest for its effective and efficient management as it relates to temperature.

MATERIALS AND METHODS

Collection of Hide Beetle and Food Type Samples

This research was conducted in the months of July to October, 2015 in the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria. The samples of fish species were collected from infested fish stalks in Sokoto Meat, Fish and Vegetable Market. The hide beetle together with the fish debris were picked using soft brush and put into a glass jar covered with muslin cloth and taken to the laboratory for identification using standard taxonomic key and rearing to get mother culture.

Identification of the Hide Beetles

The adult hide beetles were identified based on morphological features as reported by Akinwumi *et al*. (2000), Haines and Rees (1989) as well as Hinton (1945). Hide beetles are small and dark. Adults are 5-10 mm and range from dark brown to black in colour. They are strong flyers and are attracted to decaying flesh and rotten meat. Larval forms are very ferocious eaters and pupal forms usually smaller. The identity was further authenticated by comparison with the identified hide beetle specimens preserved in the Museum of the Zoology Unit of the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria.

Rearing of Mother Culture

Ten pairs of adult beetles were picked from the stalks brought from the market and transferred to a glass jar (500 ml). Fish food (*Clarias gariepinus*) was provided to the beetles to feed upon along with the cotton soaked in water to provide drinking water. The jar was covered with muslin cloth tied with rubber band and kept under laboratory conditions for multiplying to produce mother culture.

Preparation of Fish Food

The fish was sterilized by heating at 60˚C for one hour in hot air oven in the laboratory in order to kill any insect pest that may be present(Atijegba,2004).

Experimental Design

The experiment was arranged as completely randomized design (CRD), replicated three times and kept in incubators. The life circle of the pest was determined on To assess the effects of different temperatures (27˚C and 35C˚) on the development of the hide beetles, thirty (30) pairs of newly emerged adults were obtained from the mother stalk and were kept in three (3) glass jars. Adults were fed on dried sterilized fish food alongside drinking water. The jar was covered with muslin cloth tied with rubber band. The jar was then kept in an incubator at 27± 2˚C and relative humidity of 65±5%. Similar procedure was repeated and the jars were kept at 35± 2˚C and 65±5% relative humidity in another incubator. All experiments were replicated thrice. The observations were made on maturation of adults, egg laying (fecundity), egg incubation, hatchability of eggs (viability), larval development, larval survival, pupal development, pupal survival and adult emergence (Atijegba, 2004).

RESULTS AND DISCUSSION

(a) Production of Eggs: Table 1 shows that the production and development of eggs was significantly affected by the temperature as the calculated t-value was at 4.4 as against 2.78 for t-tabulated. The highest mean number of eggs laid was at temperature of 27˚C (148) as against temperature of 35C˚. Incubation period was also affected as it took longer time (4 days) at temperature of 35℃ than temperature of 27˚C (3 days). Eggs viability was also affected as 92.6% were viable as observed at temperature of 27^0C against 91.6% at temperature of 35˚C. This finding agrees with the work of Richardson and Goff (2001) who worked on survivorship for *Dermestes maculatus* to be higher between 25˚C-30˚C. Similarly, Analdos *et al*. (2004) reported that full development of *Dermestes maculatus* is reached only when temperatures are consistently above 18˚C. This is in line with the work of Azeb *et al.* (1973) that eggs took 1 – 2 days at 30˚C and 10 – 11 at 16˚C to hatch. Eggs and the larval period lasted between 24 days and 96 days at 32˚C and 19˚C respectively. Jacob and Fleming (1982) also observed that eggs of *D. lardarius* took 3 days to incubate at 26˚C – 27˚C while at 23˚C – 24˚C it took 5 days.

(b) Development of Larvae: Table 2 shows that temperature has a significant effect against larval development. This was observed as temperature of 35℃ recorded the longest mean larval instars of VIII and duration of 28 days as against VI mean larval instars and 23 days at 27˚C. Larval survival was observed in reverse order as low temperature of 27˚C resulted in shorter survival rate (32.8%) as against temperature at 35˚C (60.8%).Temperature is one of the most important factors affecting hide beetles. At higher temperatures above 30˚C, they tend to die out. Their optimum growth temperature is between 25˚C – 30˚C. The work of Richardson and Goff (2001) who worked on survivorship for *Dermestes maculatus* individuals reported the highest survival between 25˚C – 30˚C. Similarly, full development of *Dermestus maculates* is only reached when temperatures are consistently above 18˚C as reported by Analdos *et al*. (2004). Fasunwin *et al.* (2011) also reported that development of *Dermestes maculatus* is not possible at 40℃ or above. Azeb *et al*. (1963) studied the life history of the beetle at constant temperature and relative humidity and found that incubation, larval and pupal period at 38℃ and 70% relative humidity was 2, 28 and 7 days respectively. Azeb *et al*. (1972) observed that the larval development was affected by both temperature and relative humidity. At 21˚C, 27˚C and 35˚C (at 75% relative humidity), development lasted an average of 53, 28 and 20 days respectively while at 27˚C with lower relative humidity of 55%, the period was increased to 35 days. Larval development of *D. maculatus* was shown by Osuji (1975) to be much more rapid in dried fish than in synthetic media. He further showed that moderate salting (3.2% - 10.2% sodium chloride content) when accompanied by effective dehydration of fish (6.2% - 9.2% moisture content) significantly prolonged the larval development period of *D. maculatus* and *N. rufipes*.

(c) **Development of Pupae**: Table 3 shows the significant effects of temperature on pupal development. Longer pupal duration was observed at temperature of 35˚C (6 days) as against temperature of 27˚C (4 days). Pupal survival rate was observed in reverse order as temperature of 35˚C has a mean pupal survival rate of 86.7% against temperature of 27˚C (82.7%). Azeb *et al*. (1973) reported the pupal duration at 5.1 days (ranging from 2 – 11 days) at 29˚C, the pre-oviposition period was 3 days at 35˚C and 19 days at 21˚C. James (1980) observed the rate of development of *D. maculatus* at different temperatures.

It was further noted that the eggs at 26˚C – 27℃ took 3 days for incubation, while at 23℃ – 24℃ they took 5 days. Larval duration at 23˚C was recorded as 44 days. Pupal development occurred within 35 days during winter when the temperature was very low, but at 20˚C – 25˚C, they took 14 days. The total development duration according to Him, at 28˚C – 30˚C was 42 – 46 days, while at 23˚C it was 55 days. He further observed that the duration may increase up to several years under adverse or unfavourable weather conditions.

Table 1: Eggs Production by Adults of Hide Beetle (*D. maculatus*) at Different Temperatures Fed on Fish Food

Adult Pairs	Temp (℃)	Mean Number of eggs laid	Mean Incubation period (days)	Mean number of eggs hatched (viable eggs)	Viability of eggs (%)	Non viability of eggs (%)
10	35℃	131	4	120±2.62	91.6	8.4
10	27℃	148	3	137±1.7	92.6	7.4

*Values are means of three replicates ± SE, within each row; means having the same letters in their superscripts are not significantly different from each other at 5% significance level.

Table 2: Larval Development at Different Temperatures Fed on Fish Food

Date and number of larvae	Temp (℃)	Mean number of larval instars (Mean larval duration in days)								Mean number of larvae pupated	Mean larval duration (days)	Mean larval survival (%)
		I	II	III	IV	V	VI	VII	VIII			
10/09/2015 120	35℃	120 (5)	104 (3)	103 (3)	93 (4)	89 (5)	83 (6)	82 (7)	73 (8)	67±2.85	28	60.8
13/09/2015 137	27℃	128 (2)	122 (3)	117 (4)	110 (4)	106 (6)	45 (7)			39±1.69	23	32.8

*Values are means of three replicates ± SE, within each row; means having the same letters in their superscripts are not significantly different from each other at 5% significance level.

Table 3: Development of Pupae of Hide Beetle (*D. maculatus*) at Different Temperatures Fed on Fish Food

Number of Pupae observed	Temp. (℃)	Mean number of adults emerged	Mean pupal survival (%)	Mean pupal duration (days)
67	35℃	58±5.5	86.7	6
39	27℃	32±2.1	82.1	4

*Values are means of three replicates ± SE, within each row; means having the same letters in their superscripts are not significantly different from each other at 5% significance level.

CONCLUSION

Based on the current findings, lower temperature of 27˚C is more favourable for the development with 92.6% viability of eggs produced compared to 91.6% at 35˚C, hence a significant difference when t-calculated of 4.4 against t-tabulated of 2.78. Six (6) larval instars with 39 mean larvae pupated at 27˚C to 8 larval instars with 67 mean larvae pupated at 35˚C given a significant difference of 6.8 as against t-tabulated of 2.45. Similarly, a significant difference at the pupal level with temperature of 27˚C and 35˚C recording a t-calculated value at 7.44 while t-tabulated was 2.36. Hence, it could be concluded that temperature has no significant difference, all at 5% confidence level.

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