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Morphometric Studies of Different Developmental Stages of *Dermestes maculatus* (Degeer, 1776) (Coleoptera: Dermestidae)

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Abstract: A pair of adult *Dermestes maculatus* was introduced into separate tubes containing each fish species to serve both as food and oviposition medium. Some eggs laid were collected and placed on each fish substrate in glass tubes for incubation and measurement. On hatching the larvae were separated into individual tubes (2.2 cm × 15 cm) containing 10 g of each fish species and kept under observation. The developmental stages were obtained from each substrate for measurement using Nikon Optiphot phase contrast microscope equipped with a drawing tube. The result indicates that larval instar 1 bred on mixed substrates was significantly shorter ($p<0.05$) than those bred on the other fish substrates. No statistical difference was observed among other larval instars on each of the different fish substrate. However, the fourth larval instar bred on *Synodontis* and *Clarias* were significantly longer ($p>0.05$) than those bred on the other substrates. There were significant differences in length among the various developmental stages with prepupae and pupae being significantly longer ($p<0.05$) than larvae.

Key words: Morphometrics, *Synodontis, Clarias, Dermestes maculatus* and *Necrobia rufipes*

INTRODUCTION

Insects are the most serious pests of cured fish; about 15 species were recorded as major pests on cured fish (FAO, 1990). *Dermestes sp.* and *Necrobia rufipes* DeGeer are considered to be the major pests on cured fish and hides and skins. They eat away the muscles leaving the skeletons when cured fish are stored for long periods. Lale and Sastawa (1996) and Odeyemi *et al.* (2000) put the losses due to susceptibility to pest infestation and deterioration of smoked fish products at 50% during storage, leading to reduction of nutritive quality and market price of smoked fish (Owoade, 1993; Odeyemi, *et al*., 2000). Lale and Sastawa (1996) estimated 13-17% losses in dried fish during three months of storage, mainly by *D. maculatus*. The study was carried out to determine the morphometrics of various stages of *D. maculatus* bred on different media so as to provide the basis for a knowledge based on assessment of potential losses that could be associated with different feeding stages of *D. maculatus*.

MATERIALS AND METHODS

Smoked samples of the fish species *Tilapia*, *Clarias*, *Balistes*, and *Synodontis* were obtained from Madina and Makola markets of Accra Ghana. Several unsexed adults of *D. maculatus* were obtained from naturally infested smoked fish materials. The cured fish species were sterilized thermally by heating at 60^0C for one hour in a hot air oven (Gallenkamp Oven) in the laboratory in order to kill any insect pests that may be present (Atijegbe, 2004). Adult *D. maculatus* were then transferred into jars containing the substrates and fed *ad libitum*. The adults were sieved out after fourteen days of oviposition to ensure that offspring of relatively same age were obtained and thus pure F1generation were used for the experiment. Pupae were isolated from the substrate after every 7 days and introduced into separate test tubes prior to adult emergence. This ensured that adult males and females were readily distinguished, their age determined (47 days) and kept unmated (virgin) until required. On emergence, the adults were placed in tubes containing each of the fish substrates and maintained at controlled [temperature (30ºC), relative humidity (65±5 %) and 12:12H (L: D)] conditions at the Food Security/Entomology Laboratory of the Department of Zoology, University of Ghana, Legon.

A pair of adult *D. maculatus* was introduced into separate tubes containing each fish species to serve both as food and oviposition medium; eggs laid were removed using soft brush and measured. Some eggs laid were collected and placed on each fish substrate in glass tubes for incubation. On hatching, the larvae were separated into individual tubes (2.2 cm × 15 cm) containing 10 g of each fish species and kept under observation. Each larval instar was determined by the presence of exuviae after each moult and measured, while pre-pupae and pupae obtained from the last larval instars were taken from each substrate for measurement.

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Table 1: Calibration of the microscope used in measurements

Objective lens	Graticule units	Stage-micrometer units	Unit length
X04	50	100	20
X10	74	59	8
X20	82	32	4
X40	70.5	1	42

Table 2: Mean measurements of length (mm) of each larval instar of *D. maculatus* on each Fish substrate

Fish species	larval instars ± S.E*					
	L1	L2	L3	L4	L5	L6
Synodentis	3.77^{a}±0.14	5.45^{a} ±0.26	7.72^{a} ±0.49	11.65^{a} ±0.49	11.95^{a} ±0.32	12.50^{a} ±0.10
Clarias sp	3.06^{a} ±0.07	6.05^{a} ±0.56	7.73^{a} ±0.17	12.58^{a} ±0.16	12.95^{a} ±0.22	-
Tilapia sp.	2.03^{a} ±0.28	3.83^{a} ±0.09	5.20^{a} ±0.44	8.90^{b}±0.32	10.46^{a} ±0.22	10.99^{a} ±0.35
Balistes sp.	2.48^{a} ±0.15	4.56^{a} ±0.28	6.31^{a} ±0.38	8.15^{b}±0.19	10.28^{a} ±0.16	11.38^{a} ±0.20
Mixed sub.	1.62^{a}±0.21	4.92^{a} ±0.44	7.93^{a} ±0.69	10.52^{ab}±0.44	11.89^{a} ±0.44	11.97^{a} ±0.59

LSD 3.18, *Values are means of four replicates ± S.E, Within each row, means having the same letters in their superscripts are not significantly different from each other at 5% significance level.

Specimens were measured using Nikon Optiphot phase contrast microscope equipped with a drawing tube. The microscope's eyepiece graticule was calibrated using a 10-mm stage micrometer divided into 100 units (Table 1).The length corresponding to a single eyepiece graticule unit was calculated by simple proportions.

RESULTS

Table 2 shows that larval instar 1 bred on mixed substrates was significantly shorter ($p<0.05$) than those bred on the other fish substrates. No significant differences were observed among second, third, fifth and sixth larval instars on each of the different fish substrate. The fourth larval instar bred on *Synodontis* and *Clarias* were, however, significantly longer ($p>0.05$) than those from the other substrates.

Table 3 shows the results of combined measurements (in mm) of each larval instar of *D. maculatus* on different fish substrates. There were significant differences between larval instars four, five and six on the one hand and those of other larval instars but not between larval instar 6 and larval instar 3. The least measurements were recorded in the first larval instar.

Table 4 shows the measurements of length of various stages of *D. maculatus* on different fish substrates from prepupa to adults and the sexes. Analysis of variance revealed no significant difference ($p>0.05$) between the various stages including sexes recorded on all the fish substrates. Table 5, however, shows a high significant difference in length among the various developmental stages with prepupa and pupa being significantly longer ($p<0.05$).

DISCUSSION

Egg length measurements: The egg length measurements did not show any variation among the eggs laid on the fish substrates. The white creamy eggs on average, measured 1.3 by 0.4, 1.5 by 0.4, 1.3 by 0.4 and 1.3 by 0.3 mm on *Synodentis* sp., *Clarias* sp., *Tilapia* sp. and *Balistes* sp., respectively. This confirms the findings of previous workers (Ede and Rogers, 1964; Osuji, 1973; Osuji, 1975; Jones and Elgar, 2004) and can therefore be inferred that the nutrients derived from the fish substrates may be an important factor in determining the egg size which in turn determines the weight of larval and adult progeny.

Table 3: Mean length of various larval instars of *D. maculatus* bred on four fish substrates.

Larval instar	Length (mm) ± S.E*
1	2.79^{d} ±0.13
2	4.96^{cd} ±0.22
3	6.98^{bc} ±0.31
4	10.36^{a} ±0.40
5	11.51^{a} ±0.26
6	9.37^{ab} ±0.20

LSD 3.18, *Values are means of four replicates ± S.E, Within each column, means having the same letters in their superscripts are not significantly (P>0.05) different from each other at 5% significance level.

Table 4: Measurements of length of various stages of *D. maculatus* on different fish substrates.

Fish substrates	Length (mm) ± S.E*			
	Pre-Pupa	Pupa	Adults	
			Females	Males
Synodentis sp.	9.38±0.43	8.87±0.15	7.44±0.10	6.46±0.12
Clarias sp.	8.42±0.14	8.84±0.19	7.89±0.10	6.71±0.11
Tilapia sp.	6.54±0.40	7.78±0.11	6.66±0.48	5.60±0.02
Balistes sp.	8.34±0.24	6.34±0.4	7.13±0.04	5.90±0.10
Mixed substrates	9.22±0.43	8.34±0.33	7.11±0.23	6.20±0.07

*Values are means of four replicates ± S.E

Table 5: Measurements of length of various developmental stages of *D. maculatus.*

Stages of development	Length (mm) ± S.E*
Prepupa	8.38^{a}±0.27
Pupa	8.03^{ab}±0.24
Male	6.17^{c}±0.10
Female	7.25^{bc}±0.14

LSD 1.12, *Values are means of four replicates ± S.E, Within each column, means having the same letters in their superscripts are not significantly (P>0.05) different from each other at 5% significance level.

Larval length measurements: Among the 1st larval instars, the least measurement (1.62) mm was recorded on larvae from the mixed substrates and the longest (3.77 mm) on *Synodentis* sp., while second instar ranged from 3.83mm on *Tilapia* sp. to 6.05 mm on *Clarias* sp. Growth change from L1 to L2 in the second larva instars doubled on all the substrates. The shortest length was still found on *Tilapia* sp. in the third instar larva with 5.20 mm and longest on mixed substrates 7.93 mm, while on fourth larval instars *Clarias* sp. had the longest measurements of 12.58mm and the shortest of 8.15 mm on *Balistes* sp. It followed the same trend in the fifth larval instar where *Clarias* sp had the longest measurements of 12.58 mm and shortest on *Balistes* sp. with 10.28 mm. In the sixth larval instar, *Synodentis* sp. had the longest measurements

with 12.50 mm and shortest on *Tilapia* sp. These findings did not conform to the observation of Samish *et al*. (1992) who recorded 16 mm as the highest measurement. These differences may be attributed to different cholesterol levels in the fish species since it plays a major role in larval development.

Prepupal and Pupal length measurements: Pre pupae measured between 6.54-9.38 mm on *Tilapia* sp. and *Synodentis* sp., respectively while the pupae measured between 6.34-8.87 mm on *Balistes* sp. and *Synodentis* sp. respectively as noted by (Osuji, 1973; Osuji, 1975). The differences found during the larval growth did not show in the latter stages except in *Tilapia* sp, where the prepupa measured far less than the others. Female *D. maculatus* measured slightly longer than their male counterparts on all the fish substrates. It was observed that larval growth rate was high during the early instars and this gradually declined as they reached the last instar. In managing this pest, early intervention in store during the peak of growth would guarantee a much better protection of smoked or sun-dried fish.

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