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Comparative Analysis Of The Population Growth Of *Dermestes Maculatus* And The Damage Caused On Three Smoked Fish Species

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Abstract: Fish is one of the major sources of protein in Nigeria and world-wide. Great losses to fish in storage have been attributed to insect pests and some other pathogenic organisms. In this study, laboratory experiments were conducted to analyse the population growth of *Dermestes maculatus* (Coleoptera: Dermestidae) and its damage on smoked *Clarias gariepinus* Burchell, *Tilapia niloticus* Linnaeus and *Synodontis nigrita* Cuvier in storage under ambient conditions. The experiment was conducted using Completely Randomized Design with each fish species replicated three times. The population of *D. maculatus* at different days after infestation and the respective damage on each fish species was analysed using ANOVA and differences in means were separated using LSD at p≤0.05. The results revealed that the population of *D. maculatus* was significantly higher in *S. nigrita* than in *T. niloticus* and *C. gariepinus*. The population of *D. maculatus* and damage caused on each fish species increased with increase in the days after infestation. A significantly higher damage was recorded on *S. nigrita* while *T. niloticus* suffered the least damage. The population of *D. maculatus* significantly correlated positively with the damage recorded on the three fish species.
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Key words: Population, weight loss, susceptibility, smoked fish, *Dermestes maculatus*

Introduction

Fish is a valuable source of high quality protein (Barrie *et al.,* 2003; Widjaja *et al*., 2009) comparing favourably with eggs, milk and meat in the nutritional value of its protein (FAO, 1998). It contains fats, minerals and it is a major source of protein in West Africa constituting about 40% of animal protein intake (Eyo, 2001). In Nigeria, it serves as an important source of animal protein (Akande, 1997) as well as a source of income (Amusan and Okorie, 2002).

In view of its importance as a source of food therefore, the demand for fish has been on the increase. Fish farming in commercial quantities has been gradually appreciating in the recent past in Nigeria, in the quest for meeting the needs of fish consumers across the West African sub region. Fish production, handling, processing and distribution provide means of livelihood for millions of people as well as foreign exchange earnings (Al-Jufaili and Opara, 2006).

The processing and preservation of fresh fish prevents economic losses and deterioration of fish (Okonta and Ekelemu, 2005). It has been reported that, 10% weight loss by fish is as a result of poor handling, processing, storage and distribution (Akande *et al.,* 1998, Madison *et al*., 1998). The longer the processor leaves the fish in condition favourable to spoilage, the greater the destruction.

Most processed fishes are susceptible to damage by insects such as bow fly larvae as they are voracious feeders (Madison *et al*., 1998, Procter, 1972). A number of insects infest processed fish but most important are the blow flies and beetles. The flies and beetles destroy large quantities of fish in developing countries like Nigeria. Fish are susceptible to attack by insect pests during processing and storage.

The commonest method of post-harvest fish preservation is smoking (Reed, 1997). Smoking provides very little control against insect's attack (Okorie, 2003). Under prevailing conditions, it is estimated that, between 25 -75% of the nutritional value of fish is lost due to insect attack (Johnson and Esser, 2000). Losses caused by insect infestation include, physical, economic and nutritional and these losses often lead to increase in the retail cost of fish beyond the purchasing power of the poor (Moses, 1992). Fish farmers and or sellers began to develop various means of storing fish in order to preserve it for a longer period. Smoking is one of the commonest methods of preserving fish in Nigeria. However, the response of different smoked fish to pest infestation is yet to be ascertained. The objectives of this study were to compare the population growth and the level of damage caused by *D. maculatus* to *T. niloticus*, *S. nigrita* and *C. gariepinus* in storage.

Materials and methods

Study area

Lagos State is located in South Western part of Nigeria between longitude $6^{O}35'$(N) and latitude $3^{O}45'$(S). It shares it boundary with Ogun State in the north and east, and with the Republic of Benin in the west. Behind its southern borders lie the Atlantic Ocean which is 22% of its 3,577km land mass. The estimated population of the state is, 17.552 Million (Lagos State Bureau of Statistics 2005). The major traditional occupation of the inhabitants of the state is fishing (Plate 1).

Source and identification of fish species

The smoked fish species, *T. niloticus*, *S. nigrita* and *C. gariepinus* were obtained from Oyingbo market in Lagos. They were wrapped tightly in polythene bags and transferred to the Entomology Laboratory, Nigeria Stored Products Research Institute (NSPRI) Yaba-Lagos where they were identified.

Establishment of *D. maculatus* culture

Adults of *D. maculatus* were sieved out of infested cured fish obtained from Oyingbo market. About 120g of oven-sterilized cured fish were put in a series of 1-litre glass jar and infested with 80 unsexed adults of *D. maculatus*.

Plate 1: Map of Lagos State

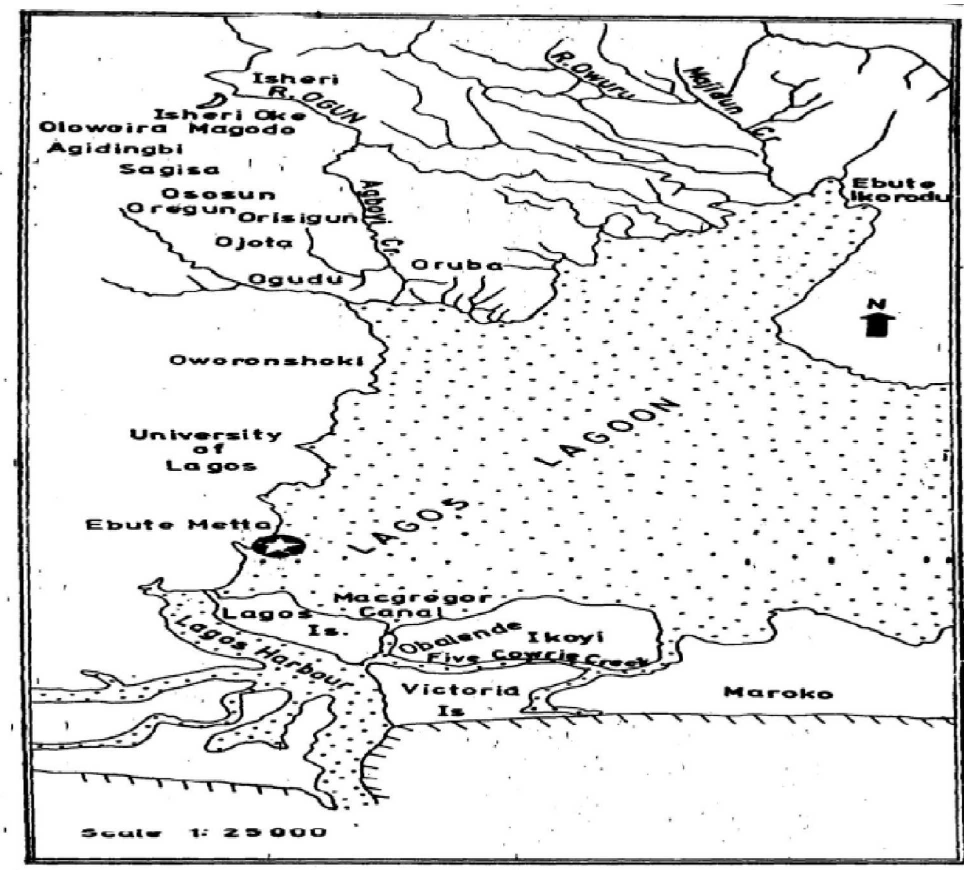

Plate 2: Map of Lagos State Showing Fishing Area

All the glass jars were covered with brown muslin cloth and secured on top with rubber band to keep the insects and to allow aeration. Three such cultures of each fish species were prepared at a time and placed on inverted Petri dishes in paraffin oil on shallow trays to keep out mites and other parasites. The parent adult insects were sieved off after two weeks of oviposition. The jars were left undisturbed until adults emerged. The F1 progeny of the insect (0-7 days old) were used for the experiments.

The three fish species were kept free of infestation at the commencement of the experiment by sterilizing the smoked fish thermally at 60^0C for one hour in an air circulated oven to kill any pest present and to keep the moisture content constant. The glass jars used were also sterilized by scrubbing the inner with cotton wool dipped in Methylated spirit. A medium sized sterilized fish weighing 65g of each species were weighed and placed in separate glass jars.

The fish species were individually infested with three adult females and two males of *D. maculatus*. Each fish species was replicated eight times and arranged in a Completely Randomized Design (CRD) in the laboratory under ambient conditions. The experiment was left undisturbed and observed for adult emergence. The population growth of the pest (larvae and adult) was counted at every two weeks interval and recorded.

Population growth of *D. maculatus* on different smoked fish species

Damage assessment of fish species

Damage assessment of the different fish species was carried out after three months of storage. The different fish species was oven dried at 60^OC for one hour after which the final weight was taken and recorded. The loss in weight of the fish was determined as the difference in weight of fish sample before the experiment and after the experiment and expressed as percentage using the formula:

$$\frac{F1 - F2 \times 100}{F1}$$

Where W1 = Initial weight of fish before the experiment, W2 = Final weight of residual fish after the experiment

Data analysis

The data obtained were analyzed using two way analysis of variance (ANOVA) and significantly means were separated using Least Significant Difference at $p \leq 0.05$. A regression analysis was carried out to determine the relationship between the population of *D. maculatus* and the damage caused on each of the fish species.

Results

The population of *D. maculatus* observed on *S. nigrita* at different periods after infestation was significantly higher than the numbers recorded on *T. niloticus* and *C. gariepinus* which were not significantly different from each other. The differences in the populations of *D. maculatus* recorded on *S. nigrita* increased from 119 at 40 days after infestation to 155.45 at 100 days after infestation, but the differences in the populations between these periods were not significantly different from one another. Contrarily, the populations of *D. maculatus* on *T. niloticus* and *C. gariepinus* increased significantly with increase in the days of infestation (Table 1).

Table 2 showed that the damage due to *D. maculatus* infestation recorded on the three fish species increased with increase in the days of infestation. The damage suffered by *S. nigrita* was significantly higher than the damage observed in *T. niloticus* and *C. gariepinus* with *T. niloticus* having the lowest percentage damage. The differences in the percentage damage inflicted by *D. maculatus* on *S. nigrita* were significantly different from one another between 40 and 100 days after infestation.

Table 1: Population of *D. maculatus* (±S.E) on three fish species at different days after infestation

	Days after infestation						
Fish species	40	54	68	72	86	100	LSD (0.05)
T. niloticus	24.00±3.63	30.88±3.39	35.13±5.13	39.63±3.67	41.75±5.31	44.75±3.51	11.94
S. nigrita	119.50±15.75	122.50±19.73	135.25±21.01	129.25±24.45	146.13±26.91	155.25±18.96	61.76
C. gariepinus	22.88±1.53	28.25±1.92	33.00±2.50	38.13±1.85	43.00±3.04	46.88±2.22	6.36
$LSD_{(0.05)}$	27.26	34.15	36.98	43.77	46.86	32.96	

Means followed by the same letter in the column are not significantly different at p≤0.05 LSD

Table 2: Mean damage (±SE) (%) of three fish species infested with *D. maculatus* at different days after infestation

Fish species	Days after infestation						
	40	54	68	72	86	100	LSD (0.05)
T. niloticus	6.54±1.04	9.68±1.22	11.79±1.16	13.73±1.06	15.66±1.11	18.91±1.17	3.22
S. nigrita	18.72±1.34	26.83±0.95	33.12±0.88	38.85±1.10	44.15±1.00	50.79±0.85	2.95
C. gariepinus	15.40±0.98	18.19±1.14	20.62±1.15	22.89±1.18	25.17±1.30	28.46±1.23	3.34
$LSD_{(0.05)}$	3.32	3.27	3.16	3.28	3.37	3.22	

Means followed by the same letter in the column are not significantly different at p≤0.05 LSD

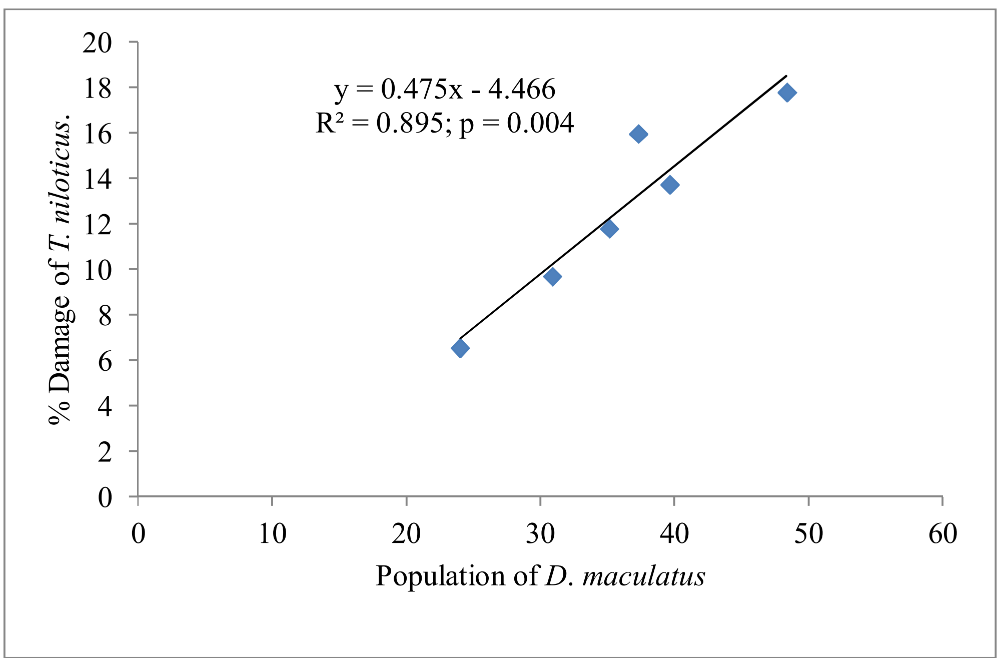

Figure 1: The relationship between the population of *D. maculatus* and percentage damage of *T. niloticus*

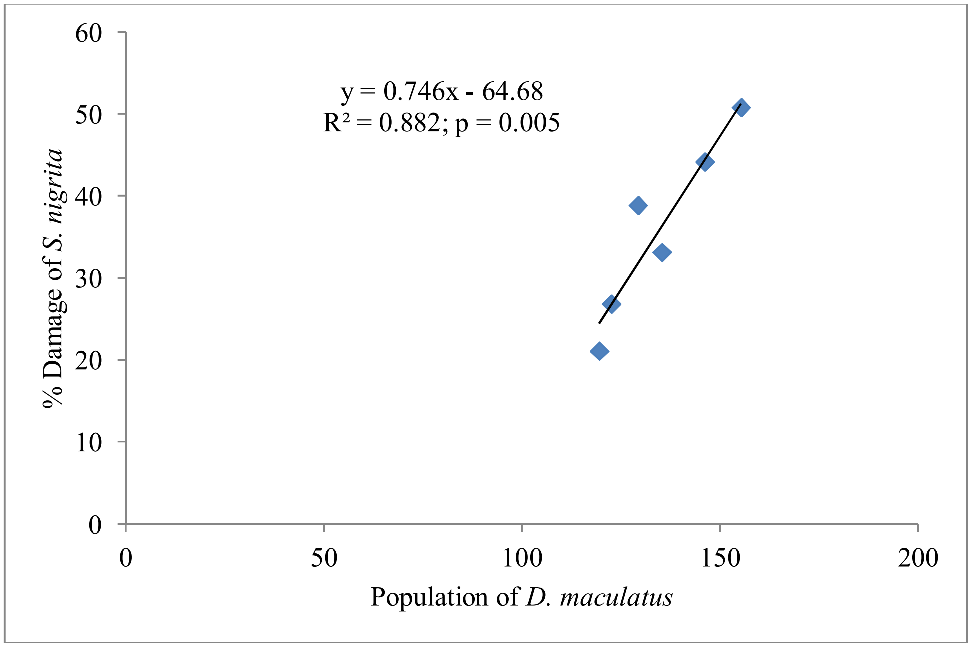

Figure 2: The relationship between the population of *D. maculatus* and percentage damage of *S. nigrita*

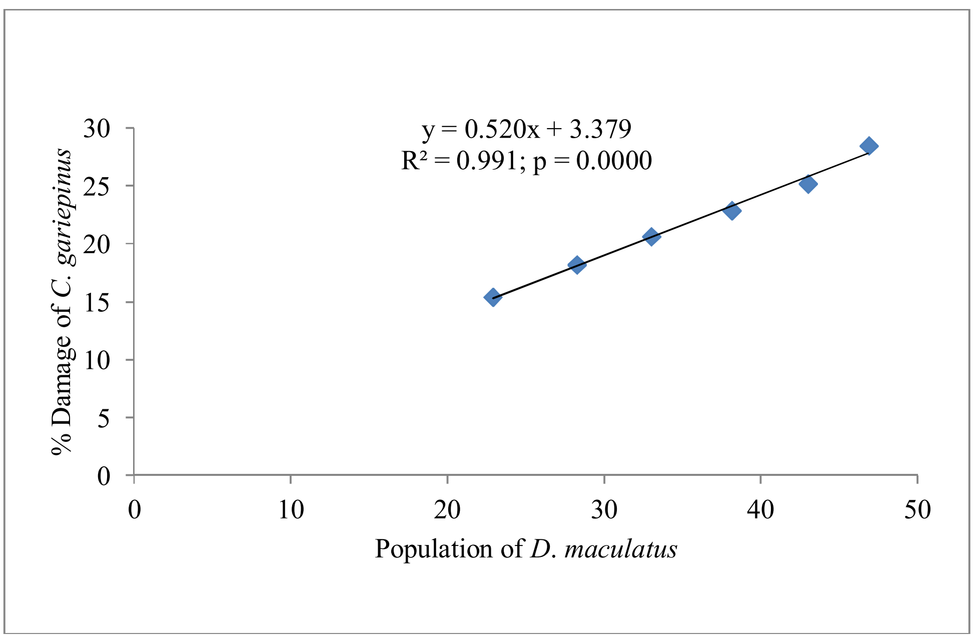

Figure 3: The relationship between the population of *D. maculatus* and percentage damage of *C. gariepinus*

Similarly, *T. niloticus* and *C. gariepinus* were observed to suffer significantly higher damage with increase in days of infestation. The population of *D. maculatus* significantly correlated positively with the percentage damage on *T. niloticus* (R2 = 0.895, p = 0.004), *S. nigrita* (R2 = 0.882, p = 0.005) and *C. gariepinus* (R2 = 0.991, p < 0.00001) as shown in Figures 1, 2 and 3, respectively.

Discussion

The results of this study indicated that a substantial loss in smoked fish occur due to infestation by *D. maculatus* although, fish species differ in their susceptibility to *D. maculatus*. Loss in weight is the result of damage caused by the scarification of the fish tissues and the partial or complete consumption of the fish tissues. Damage and weight loss are mostly caused by the tunneling and feeding activities of the larvae and adults (FAO, 1998). Lowest and highest weight loss was recorded in *T. niloticus* and *S. nigrita* respectively.

The weight loss in *S. nigrita* after infestation is at variance with the findings of Medugu and Kabir, 2013 who recorded highest weight loss in smoked *C. gariepinus*. The weight loss incurred could partly be due to the differences in length of the experiment and fish type. Furthermore, it could be explained that higher weight loss suffered by all the smoked fish species particularly *S. nigrita* was due to the multiplication of *D. maculatus* over a prolonged days (100 days) of exposure to infestation. Awoyemi (1991) has also reported fishes were reduced to frass and bones at 60 days of exposure to insect infestation.

The study also showed that there was a significant positive correlation between the population of *D. maculatus* and the damage caused on the three fish species. This further affirms that the loss of weight recorded in the three fish species is directly proportional to the level of infestation. The comparatively high population of *D. maculatus* and significantly high weight loss recorded on *S. nigrita* suggests that the fish was highly susceptible than *T. niloticus* and *C. gariepinus* and thus provides a more suitable substrate for the culture, growth and development of *D. maculatus*. The high infestation rate of *D. maculatus* in the three fish species is also an indication that the insect constitutes a serious threat to stored fish product.

The present study shows a considerable loss of the three fish species substrates leading to fragmentation and loss of quality. This is also attributable to extensive feeding habit of *D. maculatus* on fish substrates. Atijegbe (2004) evaluated quality loss during storage noting that, damage severity may be partly be a function of moisture content and lipid contents of the fish at the time of storage. Similar findings were also reported in previous investigations by Osuji (1974) that different fish genera may vary in their susceptibility to attack by beetles. Furthermore, Osuji (1974) found some indications that at least in some cases high lipid content may increase susceptibility to insect infestation. In addition to weight loss, infestation by insect can cause mould development, loss in nutritional and aesthetic values of fish (Osuji, 1974; Adedire and Lajide 2000).

This study has clearly shown that population and length of infestation are two important factors predisposing *T. niloticus*, *S. nigrita* and *C. gariepinus* to damage by *D. maculatus*. Efforts gearing towards the reduction of *D. maculatus* on these fish species is a positive step in reducing damage.

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