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Department of Fisheries, Faculty of Agriculture, University of Maiduguri, Nigeria
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Influence of Fish Species on Some Life History Characters of *Dermestes maculatus* DeGeer (Coleoptera: Dermestidae) and *Necrobia rufipes* DeGeer (Coleoptera: Cleridae)

[1]Medugu, M. A. *[2]Kabir, B. G. J., [2]Dauda, Z. and [2]Gambo F. M.
[1]Department of Crop Protection, School of Agricultural Technology,
Modibbo Adama University of Technology, P.M.B 2076 Yola, Nigeria
[2]Department of Crop Protection, Faculty of Agriculture, University of Maiduguri,
P.M.B 1069 Maiduguri, Nigeria

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ABSTRACT
Laboratory studies was carried out under uncontrolled conditions (25 – 34°C and 28 – 56% r.h.) to assess the influence of three host smoked fish species (*Clarias gariepinus*, *Synodontis nigritis* and *Tilapia niloticus*) on some life history characters of *Dermestes maculatus* DeGeer and *Necrobia rufipes* DeGeer. Studies were conducted on 100 g of smoked fish substrate infested with 20 mixed-sex adults of *D. maculatus* or *N. rufipes* for 7 days. Results showed significant influence of host fish species on progeny production and length of developmental period of *D. maculatus*; and progeny production of *N. rufipes*. Significant differences ($p \leq 0.05$) among fish species were noted in the number of developed progeny (ranging from 33.0±1.2 to 43.3±1.2) and length of developmental period (ranging from 50.3±0.3 to 57.8±0.8) of *D. maculatus*. In the case of *N. rufipes*, relatively fewer adults developed (9.0±0.7 to 13.0±0.4) and shorter length of developmental period (27.3±0.8 to 29.3±0.9) were recorded. Host fish species had no influence on live weight of adult of both insect species. Irrespective of host fish species, the male: female ratio for both insect species was 1:1.5. It was concluded that that host fish species influences some life history characters of *D. maculatus* and *N. rufipes* and may determine the development of these pest species and the degree of damage sustained during storage.

Keywords: *Dermestes maculatus*, *Necrobia rufipes*, development, smoked fish species, damage

INTRODUCTION

Fish supplies a good balance of protein (Fasakin and Aberejo, 2002; Azam *et al*., 2004; FDF, 2005; Aderolu and Akpabio, 2009), vitamins and minerals with very low carbohydrate content; hence its role in human nutrition is recognized (Ayeloja *et al*., 2011). In the tropics research confirms that fish is a rich source of essential nutrients required to supplement both infant and adult human diet (Abdullahi *et al*., 2001 and Adeparusi *et al*., 2003). Because of its high protein content it is mostly favoured than other animal proteins like egg, meat and milk (Eke *et al*., 2008; Idris and Omojowo, 2013).

Nigeria produces 150,000 tonnes of fish products from aquaculture which is important for food and income generation. Lake Chad supports the largest freshwater fishery in Nigeria with catches of around 50,000 tonnes annually, much of which is absorbed for local consumption (De Young *et al*., 2011). In the Lake Chad region the fish genera *Clarias, Synodontis* and *Tilapia* assume great commercial importance

*Corresponding Author: E-mail: bgkabir@yahoo.com, Tel: +234 (0) 8026798714

(Medugu and Kabir, 2013). The fishery sector also provides employment for over 2 million people, most of whom are engaged in fishing on a seasonal or part-time basis. The sector provides work for all generations within the population and an alternative opportunity for vulnerable members of fishing communities, requiring lower investment (De Young *et al*., 2011).

In Nigeria, smoking, drying and salting are the commonest methods of preservation (Akinola *et al*., 2006; Idris and Omojowo, 2013). The processing and preservation of fresh fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses (Okonta and Ekelemu, 2005). According to FAO (2002), 45% of total fish catch in Nigeria are utilized as smoked; and a major source of damage in stored smoked fish is insect infestation (Ayuba and Omeji, 2006) especially leather beetle, *D. maculatus* and copra, *Necrobia rufipes* (Adedire and Lajide, 2000). Attack on cured fish, mostly done by larvae of these beetles significantly reduces quantity and quality of fish flesh meant for human consumption and economic purposes and their infestation can also predispose the infested fish to microbial attacks (Osuji, 1974; Adedire and Lajide, 2000; Anon. 2010).

It has been reported that 40% of the total fish caught in Nigeria are lost annually due to inadequate or poor preservation, processing and handling (Oladosun *et al*., 1996) while, 30-50% loss in weight has been estimated for cured fish from the Lake Chad region of Borno State (Osuji, 1977). Variations in the susceptibility of different fish genera to infestation by *D. maculatus* and *N. rufipes* have been reported by previous workers (Osuji, 1974; Atijegbe, 2004; Medugu and Kabir, 2013). The environmental conditions during drying, particularly the relative humidity and the length of storage are the major factors which influence susceptibility of fish products to insect attack and spoilage (Lale and Sastawa, 1996). There are few literature on the life history characters of these insects and their fish substrate species preference are particularly lacking. Life history characters are essential for devising any control measure against a pest species. Therefore, this study was carried out to determine influence of three species of smoked fish (*C. gariepinus*, *S. nigritis* and *T. niloticus*) on some life history characters of *D. maculatus* and *N. rufipes.*

MATERIALS AND METHODS

The three most commonly smoked fish species (*Clarias gariepinus*, *Synodontis nigritis* and *Tilapia niloticus* hereafter referred to as *Clarias* spp., *Synodontis* spp. and *Tilapia* spp., respectively, for convenience) were purchased in Baga Motor Park Fish Market, Maiduguri. The test insects, *D. maculatus* and *N. rufipes* were also obtained from the same market. Adult insects were extracted from infested smoked fish and then cultured in the laboratory. About 500 g of each fish species were placed in 1 litter capaciy jars and 100 un-sexed adult were then counted from the parent stock and introduced into the culture medium. The jars were covered with muslin cloth and were secured with rubber bands to prevent escape of insects then placed on inverted Petri dish in vegetable oil on shallow tray to keep out mites and other unwanted insects. The insects were then sieved off after 7 days of oviposition. The breeding cultures were then left undisturbed until adult emergence. Offspring of a relatively synchronized age that emerged within 7 days (0-7 days old) were then used for the experiments.

Studies on the life history character of the two insect species focused on reproductive potential (progeny production), length of developmental period, live weight of adult insects and male: female ratio. Treatments consisted of three smoked fish species laid in completely randomized design (CRD) replicated 4 times. For each replicate, 100 grams of cured fish of each species was placed in 250 ml glass jar and 20 mixed-sex insects introduced into each jar and allowed to oviposit for 7 days after which insects were removed and the fish substrate kept under same conditions stated above. Daily observation for adult emergence were begun 20 and 30 days after infestation (DAI) for *N. rufipes* and *D. maculatus*, respectively. Counting and removal of adults was continue with there was no emergence for five consecutive days.

Progeny production was considered as the mean number of adults per treatment. Length of developmental period was estimated as the period from the middle day of the oviposition period (4th day) until 50% of adult have emerged. Adult live weight was calculated as the average weight of 10 randomly selected adult insects from each replicate of each treatment anesthetized with chloroform and weighed on an electronic balance (Mettler Toledo AB 50). Male: female ratio was determined as the proportion of male to female in 10 randomly selected adult insects from each replicate, examined under binocular microscope (Olympus).

All data obtained were subjected to one-way ANOVA and differences between treatment means were compared using Tukey-Krammer's Honestly Significance Difference (HSD) test at 5% level of probability.

RESULTS

The life history characters of *D. maculatus* on three host fish substrates are presented in Table 1. There were significant difference ($F_{2,9}$ =15.3, $P \leq 0.0013$) between the mean number of F_1 progeny produced by *D. maculatus* on the three host fish species. Higher number of progeny were recorded on *Clarias* spp. and *Tilapia* spp. than on *Synodontis* spp. The dynamics of emergence of these progenies are presented in Fig. 1. Analysis of the figure indicates that adults F_1 progeny started emerging earlier, 40 DAI on *Clarias* spp. and *Tilapia* spp., but emergence on *Synodontis* spp. was recorded three days later (43 DAI). Cessation of adult progeny emergence on *Clarias* spp. and *Tilapia* spp. were noted after 77 and 80 DAI, respectively. Fig. 1 also showed that the period of emergence on *Synodontis* spp. was shorter (31 days) than on for *Clarias* spp. and *Tilapia* spp. which lasted compared to 37 and 40 days, respectively. The cumulative daily emergence curve (Fig. 2) showed that throughout the period of adult emergence, higher number of adults emerged on *Clarias* spp. than *Tilapia* spp. lowest on *Synodontis* spp.

The length of developmental period of *D. maculatus* was significantly ($F_{2,9}$ =67.0, $P \leq 0.001$) affected by host fish species. The longest developmental period was recorded in *Claria* spp. followed by Tilapia spp. and the shortest *Synodontis* spp. However, host fish species had no influence on the adult live weight difference ($F_{2,9}$ =2.77, P=0.1154) and on male:female sex ratio of *D. maculatus*. (Table 1).

Although, fewer *N. rufipes* progeny developed, the type of host fish species. Significantly ($F_{2,9}$ = 52.2; P<0.001) influenced the number of emerged progeny. Thus higher number developed on *Clarias* spp. followed by *Tilapia* and then *Synodontis* species (Table 2).

The dynamics of emergence of adult F_1 progeny of *N. rufipes,* on three fish substrates were presented in Fig. 3. Adults emerged earlier, 22 DAI on *Clarias* spp. First adult emergence on *Synodontis* spp. and *Tilapia* spp. was recorded three days later (25 DAI). Completion adult emergence on *Clarias* spp. and *Tilapia* spp. were noted after 52 and 56 DAI respectively. The overall period of emergence on *Synodontis* spp. was shorter (24 days) than the other two species (*Clarias and Tilapia* species) which had 30 and 34 days, respectively. The number of daily emergence was also lower in *Synodontis* spp. than both *Clarias* and *Tilapia* species.

Table 1. Effects of smoked host fish species on some life history characters of *D. maculatus*

Fish spp.	Life history parameters			
	No. of progeny	Length of developmental period (days)	Live weight (mg)	Male: Female ratio
Clarias	43.3±0.9[a]	57.8±0.8[a]	30.6±0.2[a]	1:1.5
Synodontis	33.0±1.2[b]	50.3±0.3[c]	30.1±0.2[a]	1:1.5
Tilapia	40.5±1.8[a]	52.8±0.3[b]	30.4±0.2[a]	1:1.5
SED	0.16	0.04	0.02NS	

Means within a column followed by the same letter(s) are not significantly different according to Tukey-Kramer HSD test at 5% level of probability.

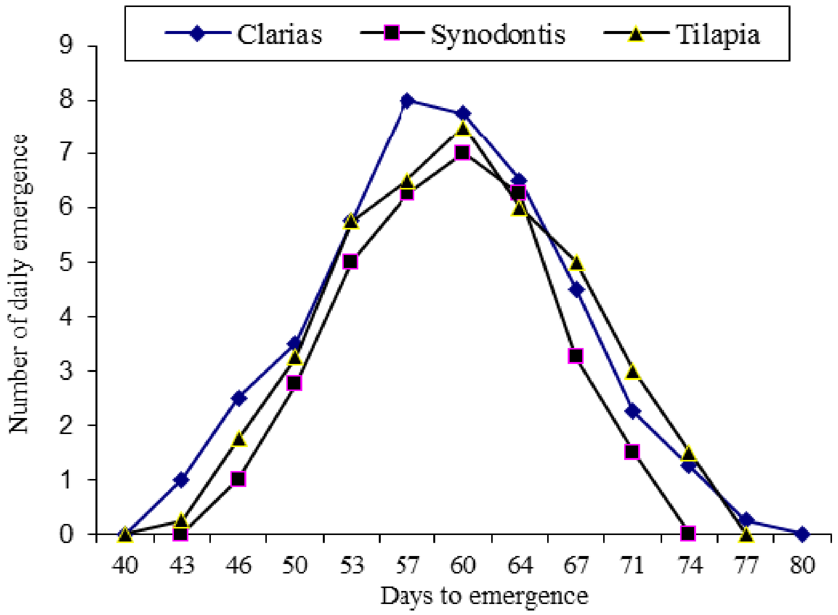

Figure 1. The dynamics of progeny emergence of *D. maculatus* from three smoked host fish species

The cumulative daily emergence curve for *N. rufipes* progeny (Fig. 4) showed that higher number of adults emerged on *Tilapia* spp. than *Clarias* spp. and *Synodontis* spp., with *Synodontis* spp. having the lowest. There was a significant difference ($F_{2, 9}$ =1.98, *P*=0.0315) in the length of developmental period of *N. rufipes* among the three fish substrates (Table 2). The length of developmental period of *N. rufipes* was relatively shorter and did not exceed 30 days on any fish substrate, compared to more than 50 days in the case of *D. maculatus*. In contrast, to *D. maculatus,* host fish substrate had significant ($F_{2, 9}$ =4.79, *P*=0.0383) effect on adult live weight of *N. rufipes.* The heaviest adults live weight (7.2 mg) was recorded when this insect species was bred on *Clarias* spp., though not different from *Tilapia* spp. Similarly, there was no difference in weight between insects bred on *Tilapia* spp. and *Synodontis* spp. (Table 1).

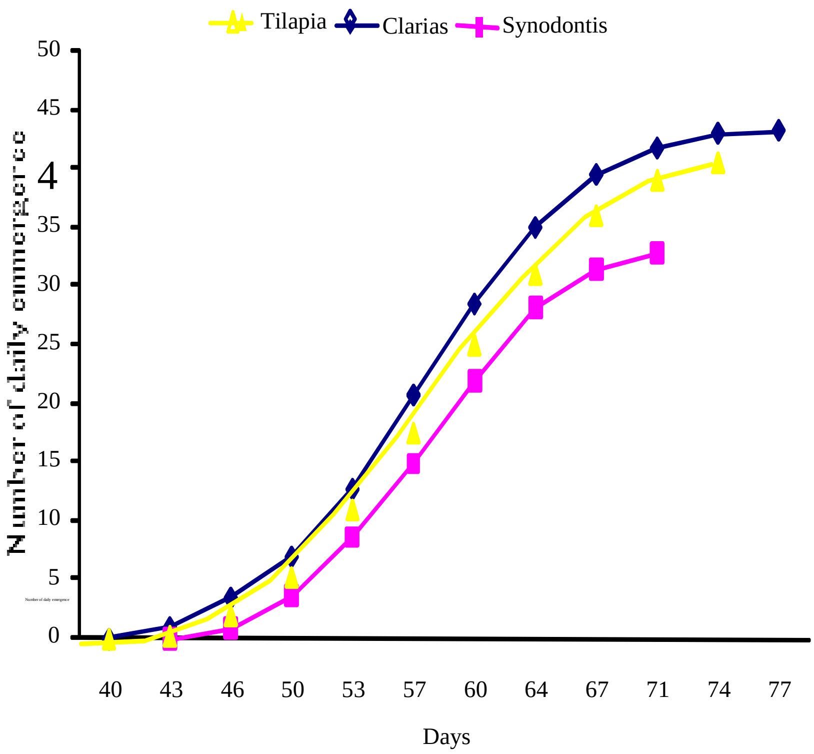

Figure 2. Cumulative emergence curve of *D. maculatus* progeny from three smoked host fish species

These results indicated that *N. rufipes* produced higher number of female than male in all the three host fish species. In all cases there was a tilt toward female, where the number of females that developed was about 1.5 times greater than the number of males (Table 2).

Table 2. Effects of fish species on some life history characters of *N. rufipes*

Fish spp.	**Life history parameters**			
	No. of progeny	**Length of developmental period (days)**	**Live weight (mg)**	**M:F ratio**
Clarias	13.0±0.4^{a}	28.3±0.3^{a}	7.2±0.02^{a}	1:1.5
Synodontis	8.5±0.9^{b}	27.3±0.8^{a}	7.0±0.06^{b}	1:1.5
Tilapia	9.0±0.7^{b}	29.3±0.9^{a}	7.1±0.04^{ab}	1:1.5
SED	0.14	0.09NS	0.01	

Means followed by the same letter(s) within a column are not significantly different according to Tukey-Kramer HSD test at 5% level of probability. **Key:** M = Male, F=Female

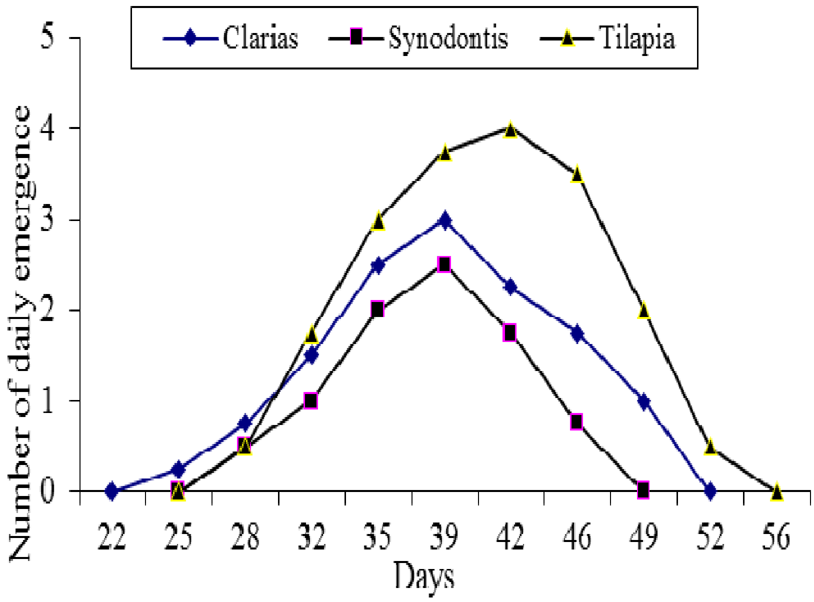

Figure 3. The dynamics of progeny emergence of *N. rufipes* from three fish species

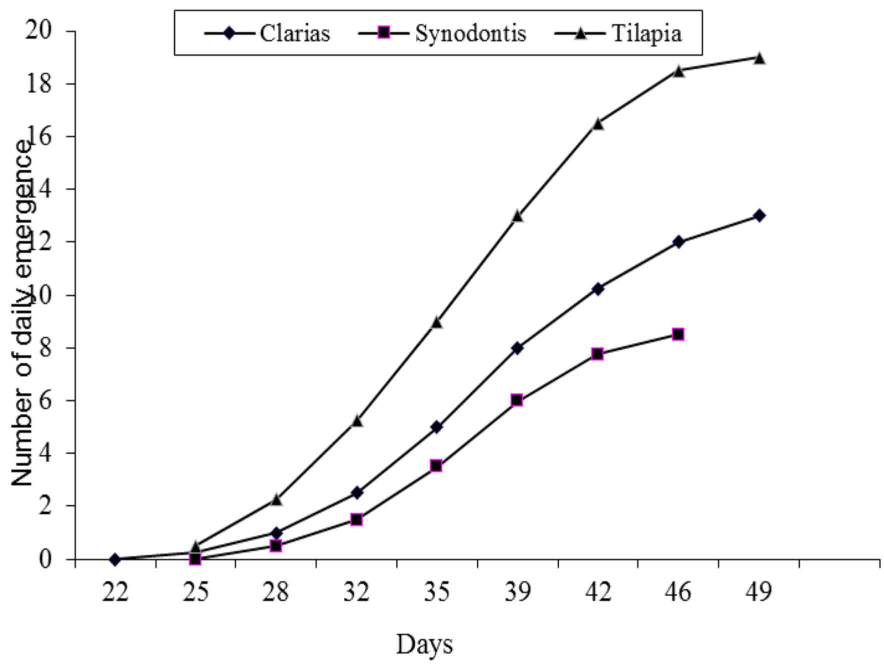

Figure 4. The Cumulative emergence curve of *N. rufipes* from three fish species

DISCUSSION

The present study has shown that host smoked fish species has substantial effect on biological parameters such as progeny production, length of developmental period and adult live weight of *D. maculatus* and *N. rufipes*. This is in accordance with the findings of previous workers (Ede and Rogers, 1964; Osuji, 1975) who reported that the nutrients derived from host fish may be an important factor in determining adult progeny development. Further, Osuji (1974), Atijegbe (2004) and Zakka *et al.* (2009) noted that difference in nutritional composition and texture of different fish substrate played an important role in the development of *D. maculatus*.

Comparing developmental period of *D. maculatus* and *N. rufipes* from eggs to adult and the fact that higher number of adults of both insect species developed on *Clarias* spp. followed by *Tilapia* spp. suggests rapid build-up of insect population on these two fish species. The shortest length of developmental period was recorded on *Synodontis* spp. Short development time on a fish species is an indication of poor host suitability as some insect species are known to complete development faster when conditions are not favourable (Howe, 1965; Toye, 1970). This is confirmed by the lower number of progeny and shorter developmental period recorded on *Synodontis* spp. in the current study. Osuji (1974), Ezenwaji (1989), Ezenwaji and Obayi (2004) and Zakka *et al.* (2009; 2013) all attributed developmental period of *D. maculatus* to host suitability due to its evolutionary trend, physical form of the fish or its nutritional composition. Though, the length of development of *D. maculatus* was significantly different in all the fish substrates, such differences were not noted for *N. rufipes*. This insect species appear not to be very responsive in this regard, to the host fish species used in this study.

The current study recorded highest weight gain of both insects on *Clarias* followed by *Tilapia* and lastly on *Synodontis.* This is in agreements with the findings of previous workers (Osuji, 1975) who concluded that the nutrients derived from the host fish substrates is an important factor in determining the egg size which in turn determines the weight of larva and weight of adult. It was also reported that food substrates influences many life history parameters of insects, such as fecundity, length of developmental period and longevity (Coombs, 1981).

The results of the present study recorded more females developed than males of both *D. maculatus* and *N. rufipes.* In contrast to the present results Azab *et al.* (1972) reported that the sex ratio of *D. maculatus* was 1:1. The tilt in sex ratio towards female may enhance rapid build-up of insect population, implying that the stored smoked fish could be seriously damaged by these insect species when infestation occurs.

In conclusion, the laboratory study showed that the type of fish substrate affects the progeny production and length of developmental period of *D. maculatus* and progeny production and live weight of *N. rufipes*. However, host fish species used in this study has no influence on the sex ratio of both insect species. Both insect species performed better on *Clarias* spp. and *Tilapia* ssp. than on *Synodontis* spp. Generally, *D. maculatus* produced higher number of progeny than *N. rufipes* and therefore expected to cause higher degree of damage. Therefore, there is need to emphasize prophylactic measures against infestation of stored smoked fish by these insect species.

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