STUDIES ON *EXOCHOMUS FLAVIPES* THUMP

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ABSTRACT

The population of *E. flavipes* on cassava plantations in the field appeared to be directly related to the population of *Phenacocus manihoti* (cassava mealy bug). In the months of July and August, when no *P. manihoti*, was found on the cassava plants, *E. flavipes* was found on *chromolina* species in association with aphids.

Morphometric studies showed that there is a distinct difference in body size between the four larval instars; and between male and female. Laboratory studies indicated that in a no choice test, both *P. manihoti* and aphids were consumed in numbers which were not significantly different at 5% level. In a free choice test the number of *P. manihoti* eaten, was significantly greater than that of aphids eaten, at 1% level. The number of ants of the family, formicidae, sonsumed, were significantly less at 1% level than the number of aphids and P. manihoti eaten.

INTRODUCTION

Exochomus flavipes (Thumb) belongs to the family, *Coccinellidae*, which are predatory on other insects. They have been employed as agents of biological control in many parts of the world. Kapur (1942) had reported the use with success of *Cryptolaemus montrouzierei* (Mule), a very small coccinellid, as a control agent against *Planococcus citri* (Risso) a serious citrus pest in California and India. In Nigeria E. flavipes has been discovered to be a promising Biological control agent (Akinlosotu, 1980).

The related species, *Exochomus flaviventris*, *Exochomus concaciis*, and *Hyperaspis senegalensis* have been used in Congo, in the biological control programme of this cassava mealybug (Fabre, 1981a). Cassava mealy-bug is a serious pest of cassava, *Manihoti esculenta*, a major food staple for about 600 million people, throughout the tropical regions of the world (IITA, 1985). As a possible agent for the biological control of the mealy-bug and other insect pests, an extensive study of different aspects of *E. flavipes* is essential.

The literature survey shows that apart from the work done by Kapur (1942), and scattered references on related species quoted above, there is very little work done on this insect pest predator in Nigeria.

The information given in this study are on the morphology and morphometrics of the different stages of *E. flavipes*, a seasonal field survey, and a laboratory food preference study of the insect.

MATERIALS AND METHODS

Maintenance of E. flavipes culture: A continuous culture of *E. flavipes* was obtained by breeding male and female insects collected from the field on *M. esculenta* cuttings, which were grown in polythene bags. The cassava cuttings infested with *P. manihoti*, were placed in a rectangular wooden cage, (51cm x 27cm) fitted with metalic mosquito netting. They were weeded and watered regularly, and maintained at a temperature of 27°C — 30°C. *E. flavipes* was bred through five generations in the laboratory.

2. Procedure for morphological and morphometric study

Twenty specimens each of eggs, larval instars, pupae and adults were taken from the laboratory culture.

Different parts of morphological importance in each of these stages were dissected out and removed under the binocular microscope in 0.9% saline solution. The parts removed for study are listed on Tables 1-3. These parts were dehydrated through increasing grades of alcohol (30%, 50%, 70%, 90%, 98% and absolute), and cleared in xylene. The mouthparts and senti (which are hair projections from the body surface) were mounted with Canada balsam immediately after dehydration, but the aedeagus was stained and mounted in polyvinyl lactophenol.

The morphometrics of pre-imaginal stages and adults were determined by examining the various parts listed on Tables 1-3, under the binocular microscope equiped with occular micrometer. The measurements were taken in millimeters (mm).

3. Field survey of adult E. flavipes and associated insects on Cassava Plantation and surrounding vegetations

Three cassava plantations and surrounding vegetations in Ibadan, about 1.5 kilometer from each other were sampled twice weekle for 5 months, from April to August, for E. flavipes and other insects. On every sampling day, 150 plants of cassava and surrounding plants were randomly selected on each site. The leaves and stems were examined and insects found on them removed for identification, using known keys (Donal et. al., 1970; Richards and Davies, 1977). Climatic readings for the period of survey were also obtained.

Laboratory Study of Feeding Preference of E. Flavipes

Three insects, *P. manihoti*, ants (family formicidae) and aphids (Homoptera) found in association with *E. flavipes*, were used for the study. To determine the prefered prey of *E. flavipes* two types of study, the no choice test, and the free choice tests were carried out with modification to Van den berg *et al* method (1987).

No choice test: 40 each of *P. manihoti*, ants and aphids were alternatively offered to one *E. flavipes* adults. Each species was offered for a period of 24

TABLE I SHOWING THE MORPHOMETRIC OF DIFFERENT REGIONS OF ALL THE LARVAL INSTARS OF *E. FLAVIPES*

N = 20

	1st Instar Larva		2nd Instar Larva		3rd Instar Larva		4th Instar Larva	
(mm)	Range (mm)		Range (mm)		(Range (mm)		(Range (mm)	SD
Head Length	0.16-0.24	0.19 + 0.03	0.17-0.26	0.20 + 0.03	0.32-0.52	0.42+0.07	0.34-0.55	0.37+0.10
Head Width	0.20-0.28	0.25 + 0.04	0.32-0.48	0.40 + 0.05	0.48-0.64	0.56 + 0.05	0.94-1.32	1.12 + 0.06
Thorax Length	0.32-0.48	0.43 + 0.14	0.56-0.72	0.63 + 0.04	1.16-1.60	1.36 + 0.17	1.64-2.80	2.15 + 0.33
Thorax Width	0.40-0.52	0.46 + 0.05	0.56-0.64	0.61 + 0.03	0.96-1.40	1.14 + 0.13	1.40-2.00	1.82 + 0.16
Abdomen Length	0.40-0.60	0.49 + 0.06	0.60-0.80	0.73 + 0.14	1.44-2.2	1.61 + 0.27	2.48-3.40	3.12 + 0.28
Abdomen Width	0.40-0.52	0.46 + 0.04	0.42-0.53	0.46 + 0.04	0.50-0.68	0.61 + 0.05	1.40-2.40	2.00 + 0.30

TABLE 2

MORPHONETRIC OF EGG, PREPUPA, PUPA AND ADULT OF *E. FLAVIPES*

(mm)	Range (mm)	x		SD
Egg length	0.64 — 1.08	0.92	+	0.07
Egg width	0.28 — 0.44	0.38	+	0.05
Pupal length	3.47 — 4.14	3.76	+	0.33
Pupal width	2.12 — 2.64	2.46	+	0.20
Prepupal length	3.13 — 4.14	3.90	+	0.33
Prepupal width	2.09 — 2.62	2.39	+	0.22
Adult length (Male)	3.32 — 4.72	4.15	+	0.44
Adult width (Male)	3.28 — 4.00	3.51	+	0.35
Adult length (Female)	3.68 — 5.24	4.82	+	0.42
Adult width (Female)	3.00 — 4.40	3.80	+	0.32

hours. The number of prey eaten at the end of every 24 hours was recorded. The adult *E. flavipes* was fed 5 times with each species of insects. The feeding preference of a total of 50 male and 50 female adults were thus studied.

Free Choice Test: Two hundred each of *P. manihoti*, ant and aphids were put together in the breeding cage along with one adult *E. flavipes* for 5 days. The number and type of insects eaten after every 24 hours by *E. flavipes* were recorded. A total of 50 male and 50 female *E. flavipes* adults were studied. Both tests were carried out at a laboratory temperature of 27°C to 30°C and relative humidity of 75% to 90%.

RESULTS

Fig. 1&2 shows the relationship between the insects collected during the survey period to the temperature and rainfall. The number of *E. flavipes* decreased from 1800 + 19 in April to 04 + 02 in August on the cassava plantation. The population of *P. manihoti* also decreased from over 3000 in April to Zero in August. Ants population was constant around 1900 + 100 between the months of April and July before dropping to 900 + 20 in August. The number of C. cuprina was constant at 320 + 50 from April to August. *E. flavipes* was only found on cassava plantations from April to July. Towards the end of July until the end of August, these insects were found on *Chromolina* species in association with aphids.

TABLE 3
MORPHOMETRIC OF HEAD REGION ADULT *E. FLAVIPES* N = 20

	MALE 0		FEMALE 0	
(mm)	Range (mm)	- x SD	Range (mm)	- SD
Head and prothorax length	1.68 — 2.68	2.68 + 0.22	2.00 — 2.60	2.31 + 0.18
Head and prothorax width	1.00 — 1.60	1.26 + 0.16	1.16 — 2.00	1.44 + 0.22
Frons length	0.70 — 1.00	0.82 + 0.10	0.73 — 1.20	0.99 + 0.15
Frons width	0.50 — 0.80	0.57 + 0.08	0.70 — 1.00	0.82 + 0.13
Clypeus length	0.31 — 0.46	0.39 + 0.04	0.30 — 0.52	0.43 + 0.06
Clypeus width	0.44 — 0.55	0.47 + 0.04	0.40 — 0.63	0.51 + 0.07

Table 4

Number of prey eaten by *E. flavipes* in the no choice test and the free choice test.

Prey	No of Prey Eaten in No Choice test by		No of Prey Eaten in Free Choice test	
	Male E. flavipes	Female E. flavipes	Male E. flavipes	Female E. flavipes
P. manihoti				
Mean	95.9	133.2	53.1	57.4
Range	78-112	116-148	40-61	52-63
Aphis				
Mean	56.9	78.3	14.4	14.9
Range	52.66	67-93	9-20	10-22
Ant-forminidae				
Mean	5.2	3.3	3.3	2.0
Range	1-11	1-9	1-11	1-11

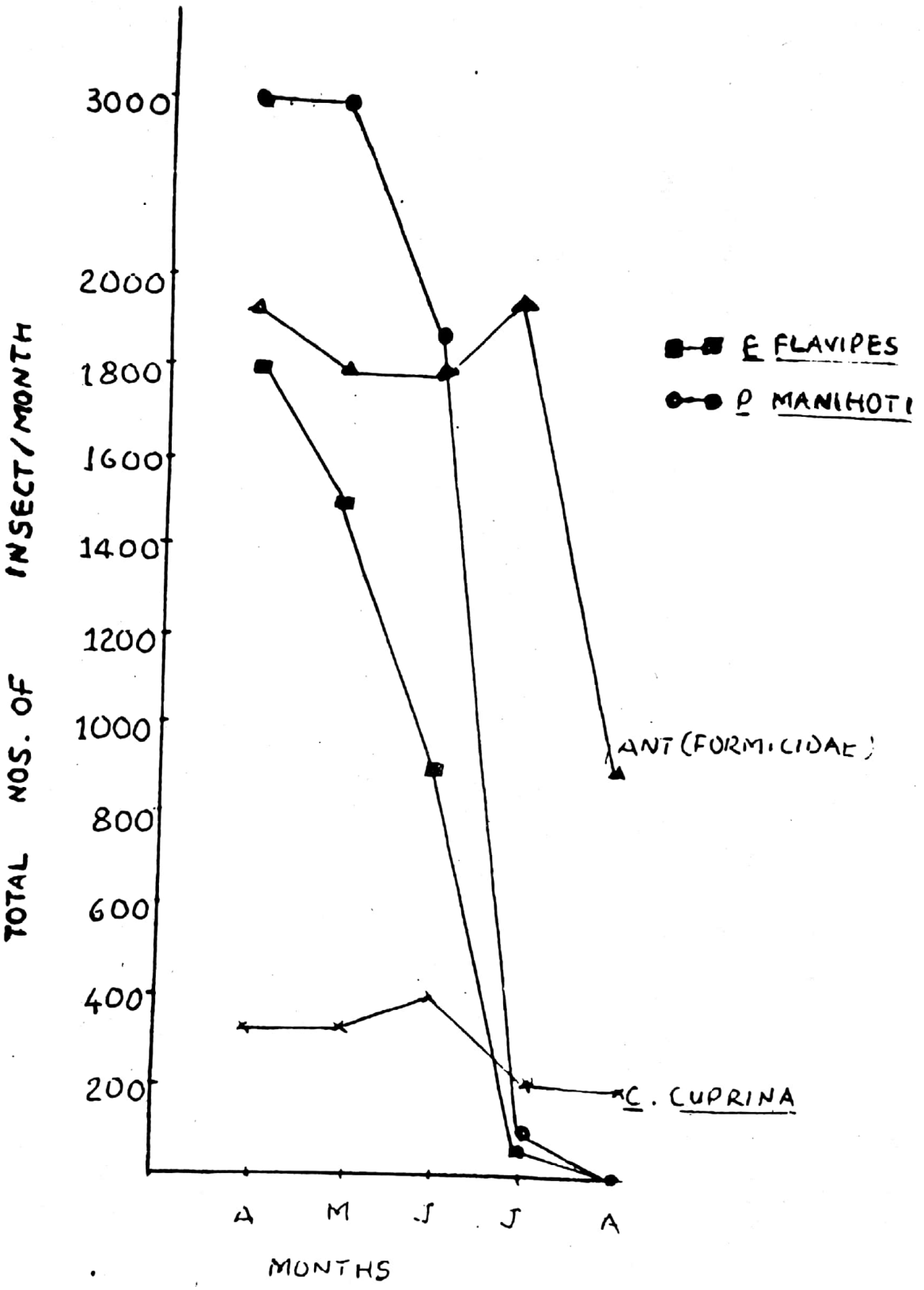

Fig 1: Total monthly collection (April to August) of insect found on M. esculenta plants.

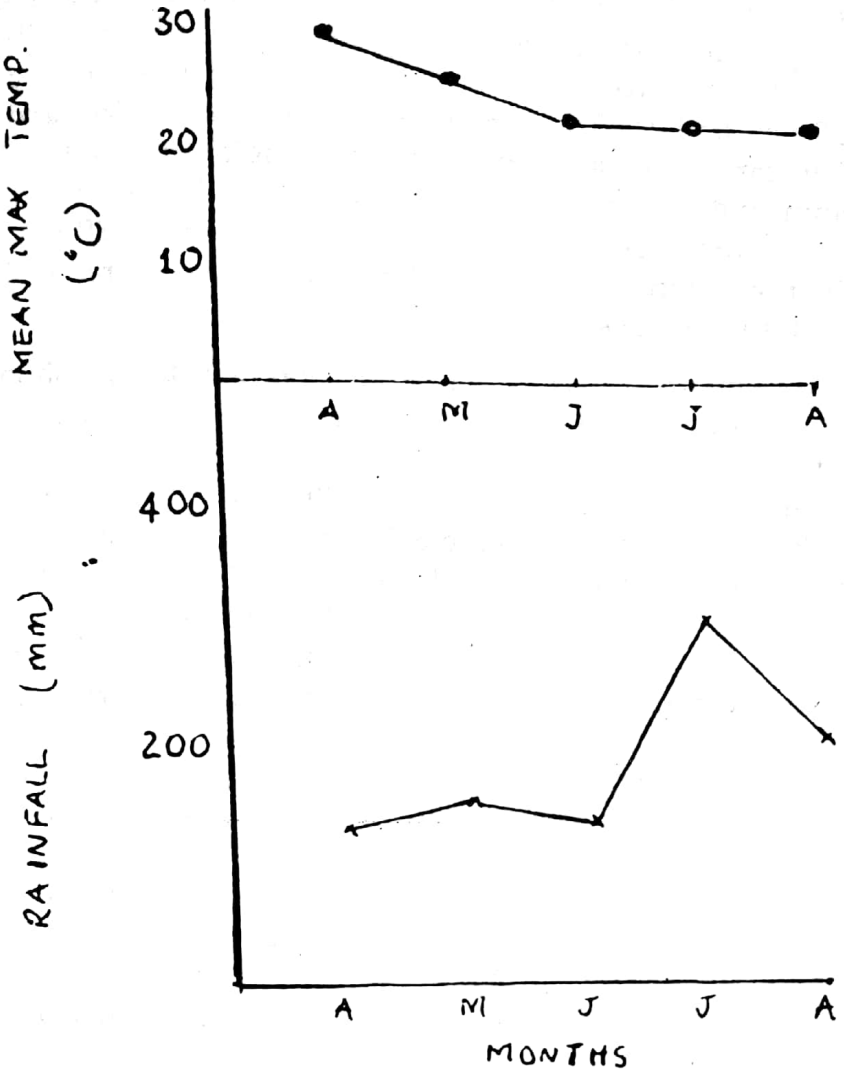

Fig. 2 Mean max. temp. (^{o}c) and Rainfall (mm) obtained during the months of survey.

Morphometric measurements were carried out on *Exochomus flavipes* to observe the relationship between their sex, developmental stage and size. Tables 1-3 shows the morphometric mean measurements. In Table 1, the 1st instar larval were: 0.19mm + 0.03mm and 0.25mm + 0.04mm for head lenght and head width respectively; 0.43mm + 0.14mm and 0.46mm + 0.05mm for lenght and width of thorax respectively; 0.49mm + 0.06mm and 0.46mm + 0.04mm for length and width of the abdomen respectively.

The mean measurements of the 2nd larval instars were 0.20mm + 0.03mm and 0.40mm + 0.05mm for length and width of head respectively; 0.63mm + 0.04mm and 0.61mm + 0.03mm for length and width of thorax respectively; 0.73mm + 0.14mm and 0.46mm + 0.04mm length and width of abdomen respectively.

Measurement taken from the 3rd larval instar, the length and width of the head were 0.42mm + 0.07mm and 0.56mm + 0.05mm respectively; 1.36mm + 0.17mm and 1.14mm + 0.13mm for the length and width of the thorax respectively; 1.61mm + 0.27mm and 0.61mm + 0.05mm for that of the abdomen.

In the 4th larval instar the measurement of the length and width of head were 0.37mm + 0.10mm and 1.12mm + 0.06mm respectively; for the thorax, the length and width measurements were 2.15mm + 0.33mm and 1.82 + 0.16mm respectively and finally the length and width of the abdomen were 3.12mm + 0.23mm and 2.06mm + 0.30mm respectively.

Morphometric measurements of eggs, prepupa and adults are shown in Tables 2 and 3. Table 2 shows that the egg has a mean length of 0.092mm + 0.07mm and a mean width of 0.38mm + 0.05mm.

The prepupa has a mean length of 3.90mm + 0.33mm and a mean width of 2.39mm + 0.22mm, while those of the pupa are 3.76mm + 0.33mm and 2.46mm + 0.20mm respectively. Adult male has a mean length of 4.15mm + 0.44mm and mean width of 3.51mm + 0.35mm. For adult female the mean length is 4.82mm + 0.42mm and mean width is 3.80mm + 0.38mm. The measurements of the different parts of the head region of the male and female adults are shown in Table 3.

The measurements of the length and width of the head were 2.68mm + 0.22mm and 1.26mm + 0.16mm for male respectively and 2.31mm + 0.18mm and 2.31mm + 0.18mm and 1.44mm + 0.22mm for female respectively. For the Frons the respective mean length and width measurements are 0.82mm + 0.10mm and 0.57mm + 0.08mm for the male and 0.99mm + 0.15mm and 0.82mm + 0.13mm for the female. For the clypeus mean length and width are respectively 0.39mm + 0.04mm and 0.47mm + 0.04mm for the male and 0.43mm + 0.06mm and 0.51mm + 0.07mm, for the female.

Results of food preference study of E. flavipes are shown in Table 4. In the no choice test, the mean number of *P. manihoti*, aphids and ants consumed in 5 days were respectively, for the males, 95.9 + 09, 56.9 + 05, and 5.2 + 02; and for the female 133.2 + 16, 78.3 + 09 and 3.3 + 02.

In the free choice test the number of *P. manihoti*, aphids and ants consumed respectively, were 53.1 + 06, 14.4 + 07 and 3.0 + 02 for the males and for the females they consumed 57.4 + 05 P. manihoti, 14.9 + 03 aphids and 2.0 + 01 ants

DISCUSSION

The population study during the period of the survey (April to August) of *E. flavipes* on cassava plantation is directly related to the number of *P. manihoti* found on the plant, since the number of *E. flavipes* decreases with decrease in number of *P. manihoti*. Rainfall appears to be the determining factor for the abundance of *P. manihoti*. By the months of July and August no cassava mealy bug could be found on the cassava plantations. This is probable because these sedentary bugs are easily washed away by the rains. *E. flavipes* however has an alternative prey in the field. These are aphids, found on *Chromolina* species.

Consequently *E. flavipes* begins to appear on *Chromolina* species at this time, when the population of *P. Manihoti* becomes very low.

Although female *E. flavipes* appear generally larger in size than the males, there is no significant difference in the morphometric measurements of all the parts under study. A more reliable feature for differentiation of male and female would be the differences in colour of the froms and clypeus and the genitalia. Colour differences in male and female *E. flaviventris* has also been observed by Fabres (1981b).

The number of hair-like projections on the body as well as the sizes and shapes of these projections are characteristics for each of the larval instar and are therefore useful in the identification of the different larval instars. The four larval instars can also be identified by differences in their size as the morphometrics measurements of the length and width of the head, of thorax and of abdomen of the different instars do not overlap.

Predatory coccinellids have a wide range of preys in the field (Hagen, 1962), Exochomus spevies have also been found feeding naturall and in the laboratory on a large variety of prey (Hunter et. al., 1912; Geyer, 1947; Rao, and Ghani, 1972; Fabres, 1981). In the present study, when given no choice, the number of *P. manihoti* and aphid consumed were not significant at 5% level. In the free choice study where these two species were put together, the number of *P. manihoti* consumed was significantly greater than that of aphids eaten, at 1% level, indicating a selective preference for *P. manihoti* as prey. In both tests, significantly less ants were eaten by *E. flavipes* at 1% level. The possession of hard cuticles and the fact that they move about rapidly, could account for the small number of formicidae eaten by *E. flavipes*. P. manihoti on the other hand are soft-bodied and are sedentary, hence they are easily used as prey than males at 5% level.

P. manihoti is a serious pest of cassava all over the tropics. Exotic agents like *Aponagurus lopezi* and *Hyperaspis notata* are being experimented on by I.I.T.A. in Nigeria as possible biological control agents for *P. manihoti* (IITA, 1983). The present study shows that serious attention should also be given to studies on *E. flavipes* a local predator, as a possible biological control agent for *P. manihoti*.

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