THE USE OF BANANA FLAVOUR ESSENCE, FORMALIN AND ORDINARY WATER IN PITFALL TRAPS IN THE STUDY OF THE DIEL ACTIVITIES OF INSECTS FROM A FALLOW PLOT IN AWKA, NIGERIA

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ABSTRACT

A study was carried out to access the insect fauna of a fallow plot in Awka, Nigeria, in relation to their diel activities and to report any differences in the pitfall catches as a result of differences in the fluid used. The fluid used in the three sets of six traps installed bimonthly at the sites for 12 hours in each case were 5% formalin, water with 0.01% banana flavour essence and ordinary water. Using Student t-test, statistical differences existed in the diurnal and nocturnal activities of the Sminthurididae, Poduromorpha, Diptera, Acantholepsis, Paratrechina sp. and Camponotus, at probability level P<0.05, with more nocturnal catches obtained in all cases for water with banana flavour essence. Similarly statistical differences also existed in the trapping of Poduromorpha, Entomobryomorpha, Acantholepsis and Camponotus sp., for pitfall traps containing water. For pitfall traps with 5% formalin statistical differences, existed in the trapping Sminthurididae Poduromorpha, Diptera, Acheta lefevrei, Acantholepsis sp., Hymenoptera (other than formicids), and orthopteran larvae, with more nocturnal catches recorded for the pitfall traps with banana flavour essence, possibly indicating the attractive properties of this particular flavour essence. The Analysis of Variance (ANOVA) test also showed that statistical differences existed in the diurnal and nocturnal catches of insects obtained using the three killing agents. The Fisher's Probability Least Significance Difference (F-LSD) also established statistical differences in the catches made using banana flavour essence and water and also with ordinary water and formalin, with the nocturnal catches being higher than the diurnal catches. The F-LSD also confirmed that the total nocturnal catches were significantly higher than the total diurnal catches obtained using all the three killing agents. An approximate ratio of 1:2 was also obtained in the catches in relation to diurnal and nocturnal activities respectively.

Keywords: Pitfall traps, Diel activities, Insects, Fallow plot, Killing agents, Awka

INTRODUCTION

Pitfall traps have been used in diverse situations in the study of epigaeic forms especially the arthropods. The pitfall traps have been used with or without preservatives (Ewuim, 1996) The use of preserving fluids in pitfall traps e.g. 5% formalin, 70% alcohol or picric acid solution depends on the goal of the investigator (Ewuim, 2004) Studies on surface – dwellers such as Collembola, ants and beetles using pitfall traps containing preservatives have also been reported (Ewuim, 1996; 1998; Ewuim and Ezenwugo, 1997; Ewuim, *et al.,* 1997; Badejo, *et al.,* 1997

Preservatives used in pitfall traps may be attractive or repellent on arthropods. Ewuim (2004), for example, have implicated 3-5% ethylene glycol and formaldehyde solutions as being mainly attractive while picric acid solution is neutral, but water and alcohol may be repellant. It also appears that methylated spirit seems to be neutral for ants (Ewuim and Nwuba, 2002).

Pitfall traps have also been used for investigation on seasonal incidence of adults insects, their spatial pattern of distribution, the relative member of species in different types of vegetation, and even the daily activity rhythms (Ewuim, 1998). It has been observed that the level of activity of insects is controlled by its diurnal cycle (Lewis and Ewuim, 1998), and by the prevailing climatic conditions (Southwood, 1996). Hitherto, even though some studies have been carried out in both tropical and temperate countries, there is however the need to investigate further the insect fauna in this part of the world and in relation to their diel activities.

In this paper, the diel activities of epigaeic insects in fallow plots will be studied using pitfall traps having either water with .01% banana flavour essence, 5% formalin or ordinary water. Asymmetrical relationship between nocturnal and diurnal activities in these insects will be statistically established.

MATERIALS AND METHODS

Sampling Site: The investigation was carried out in a fallow plot behind the Amaku General Hospital, Awka. Awka is the capital of Anambra State of Nigeria and situated in the lowland rain forest zone of Southern Nigeria (Charter, 1970). The town is located between latitude 5^0 and 6^0 25′N and longitude 7^0E and 8^0E and stretches for 8 km in an East-West direction along the Enugu-Onitsha expressway to

about 5 km in a North-South orientation. In the lowland rainforest zone in Nigeria, the wet season starts in late. February or March and ends in October or early November with a bout or short dry spell in August (Badejo 1995), an observation which is applicable to Awka (Ewuim, 2004). The daily average ranges of rainfall and humidity in Awka falls between 0.00 – 13.60 mm or higher and 44.50 – 96.00% which may record slightly lower or higher values (Ewuim, 2004). In Awka the daily average for mean aerial temperatures falls between 27.25 – 38.00^{0}C while that of mean soil temperature falls between 26.00 – 38.00^{0}C respectively (Ewuim, 2004) with possible higher or lower values of these physical variables depending on habitat and year. The Awka is about 12, 007 hectares in dimension. The sampling site was located about ½ km away from Enugu – Onitsha expressway and covers about 3 hectares of land. The foristic features of the fallow plot include few tree species like *Gmelina* sp. and *Elaeis guineensis* (Jacq) while the herbaceous vegetation includes *Centrosema pubescens, Chromolaena odorata* (L.) *Sida actuta* (Burm. f) and *Panicum maximum* (Jacq).

Sampling Method: In the fallow plot sampling was carried out between the months of Augusts and November 2002 using pitfall technique. The traps consisted of plastic containers 6 cm deep and 4.50 cm in diameter with each of the three sets of traps positioned 2 cm apart. Each of these three sets was also positioned in 6 different locations in a triangular manner in the plot at a distance of 4 cm in each case.

Each trap was sunken into the soil until each rim flushes with, with the ground level. Each set of traps were set at 6 am in the morning and collected at 6 pm in the evening with these set of traps replaced in the same position immediately at 6 pm the same day only to be collected at 6 am the following day. Precaution was taken not to disturb the soil markedly to avoid "digging –in-effects". Each killing agent was poured up to two-thirds the size of each container.

At the laboratory, the sorting of the contents of each container into various taxonomic groups were carried out with the aid of calibrated Petri dish, fine brush and stereomicroscope. A chemical analysis of three fluids used as killing agent was carried at the Project and Development Agency (PRODA), Enugu, Nigeria in order to determine their percentage components. The insects and their larvae were identified using Insect of Nigeria – Check List and Bibliography by Medler (1980). The identification of specimens was verified in the Department of Crop Protection, Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The voucher specimens were also kept as reference point for further studies. Analysis of Variance (ANOVA) and Fisher's Probability Least Square Difference (F-LSD) tests were used for testing whether or not statistical differences existed between the day and night captures for all the treatment groups.

RESULTS

The percentage composition of the three fluids used for insect trapping is presented on Table 1, based on the chemical analyses carried out. Banana flavour essence had 48.95% water, 33.10% of essence (ester) and 17.95% propylene glycol while the 5% formalin was made up of 87.50% water and 12.50% formalin solution.

Table 1: Percentage composition of the three fluids in the traps

Selected killing agents	Contents	Percentage
Banana flavour Essence	Water	48.95
	Essence (ester	33.10
	Propylene glycol	17.95
Water	Water	100.00
5% formalin	Water	87.50
	Formalin	12.50

Table 2 shows the diurnal and nocturnal catches of the insect fauna obtained during the sampling period using pitfall catches containing 0.01% banana flavour essence in water. From the result of the Student t-test, there were statistical differences in the total diurnal catches and the total nocturnal catches obtained using 0.01 % banana flavour essence, ordinary water and 5 % formalin at t-values of 3.2133, 2.0841 and 3.000394 respectively at 5 % probability level.

Table 2: Diurnal and Nocturnal catches of insects obtained during sampling period using banana flavor essence, formalin and water

Insecta	Killing Agent used					
	Banana		Water		Formalin	
	D	N	D	N	D	N
Sminthurididae	3	24	5	12	12	41
Poduromorpha	64	154	20	92	43	112
Entomobryomorpha	10	6	-	4	8	9
Diptera	22	85	2	6	25	72
Coleoptera					1	
Staphylinidae	-	-	-	-		5
Coleoptera (others)	6	8	-	-	7	4
Dermaptera	2	3	-	1	6	5
Orthoptera						
Acheta lefevrel	19	32	8	9	22	59
Orthoptera (others)	3	3	2	3	3	3
Homoptera	4	5	-	-	10	12
Hemiptera	13	46	7	8	36	55
Aphididae	17	14	2	6	11	14
Hymenoptera	26	23	2	2	4	20
Formicidae						
***Acantholepsis* sp.**	72	217	10	44	62	162
***Pheidole* sp.**	6	6	-	2	20	15
***Paratrechina* sp.**	33	103	1	5	18	27
***Camponotus* sp.**	48	132	16	40	46	102
Insect Larvae						
Acheta lefevrei	-	-	1	-	3	1
Orthoptera (others)	5	12	-	2	5	15
Diptera	-	-	1	-	-	-
Coleoptera	1	7	1	2	11	15
t –value +	**3.213+**		**2.084 +**		**3.00394 +**	

+ Significant at 5% probability level; t –table = 2.021

Table 3: Comparison of diurnal and nocturnal catches of insect group with significant t - values

Insect Groups	Bimonthly Diurnal and Nocturnal catches							*Killing Agent	t value +	p-value
	I	II	III	IV	V	IV	VII			
Sminthurididae	0,3	0,3	0,3	1,4	1,4	0,4	1,3	B	-10.500+	<0.0001
Poduromorpha	13,20	11,25	9,19	12,36	6,13	4,15	9,24	B	-4.003+	0.0018
Diptera	2,10	1,10	1,6	4,10	2,18	7,18	5,13	B	-4.735+	0.0005
***Acantholepsis* sp**	18,52	26,26	3,14	7,38	5,24	6,31	7,32	B	-3.750+	0.0028
***Paratrechina* sp**	4,22	3,6	2,7	4,26	4,7	8,19	8,16	B	-3.129+	0.0087
***Camponotus* sp.**	2,19	16,16	7,16	3,14	12,19	3,19	5,19	B	-4.419+	0.00087
Poduromorpha	2,17	4,12	4,12	3,18	1,6	5,14	1,13	W	-6.423+	<0.0001
Entomobryomorpha	0,0	0,0	0,1	0,1	0,1	0,1	0,0	W	-2.828+	0.0152
***Acantholepsis* sp.**	1,7	1,2	1,3	1,12	1,5	2,9	3,6	W	-3.631+	0.0034
***Camponotus* sp.**	0,9	3,3	2,4	6,7	2,4	1,6	2,7	W	-2.1679+	0.0079
Sminthurididae	0,2	0,2	2,3	4,6	1,5	3,11	2,12	F	-2490+	0.0284+
Poduromorpha	1,7	6,12	2,12	14,33	10,25	5,14	4,9	F	-2.496+	0.0281
Diptera	1,3	7,5	2,4	4,20	4,12	4,21	3,7	F	-2.277+	0.0419
Acheta lefevrei	1,3	1,6	4,5	2,9	5,16	7,12	2,8	F	-2.810+	0.0157
Hymenoptera	0,4	0,2	1,3	0,4	0,0	1,4	2,3	F	-3.639+	0.0034
***Acantholepsis* sp.**	16,19	3,22	14,20	8,27	5,29	13,26	3,19	F	-5.516+	0.0001
Orthoptera (nymph)	0,2	1,0	1,2	1,2	1,2	1,2	0,5	F	-2.449+	0.0306

**Samples in the first row represent diurnal catches while those in the second row represent the nocturnal catches; *Killing agents used: B- banana flavour essence: W- ordinary water , F- 5% formalin; +Calculated t –values significant at 5% probability level at t >2.179 or when p- value < 0.05*

Table 3 shows a comparison of the bimonthly diurnal and nocturnal catches of the insects collected during the sampling period using the Student t-test. From the result significant differences failed to exist in the diurnal land nocturnal catches of other insect groups except Sminthurididae, Poduromorpha, Diptera, *Acantholepsis* sp., *Paratrechina* sp., and *Camponotus* when 0.01% banana flavour essence was used as the killing agent, with more nocturnal activities recorded in all instances. In the use of ordinary water significant differences also existed in the nocturnal and diurnal catches of Poduromorpha, Entomobryomorpha, *Acantholepsis* sp., and *Camponotus* sp with more diurnal catches of Poduromorpha, Entomobyomorpha, *Acantholopsis* sp. and *Campoudus* sp with more diurnal activities also recorded. In the use of 5% formalin as killing agent however the insect groups which showed significant differences in their day and night captures included Sminthurididae, Poduromorpha, Diptera, *Acheta lefevrei* Hymenoptera, *Acantholepsis* sp., and nymphs of Orthoptera, with more nocturnal activities also recorded.

Table 4 shows the result of the ANOVA carried to determine whether or not statistical differences exist in the diurnal and nocturnal catches for the three fluids used. There was a significant effect of treatments (i.e. with the diurnal catches being significantly different from the nocturnal catches) for the traps containing flavour essence. There was also a significant effect of blocks with all the total diurnal catches obtained during the sampling period being significantly different from the nocturnal catches. The result of the Fischer's Least Significance Difference Test (F-LSD) is presented in Table 5.

The results show that there were significant differences between the pitfall catches of banana flavour essence and ordinary water, and between those of water and formalin. The total diurnal catches of the insects were also significantly different from those of the nocturnal catches obtained from the three fluids used.

Table 4: Analysis of variance (ANOVA) test to determine the significant difference in the diurnal and nocturnal catches obtained using the three killing agents

Sources of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F – Value	p-value
Treatments	2	10645.234	5322.616	4.895 +	0.0089
Blocks	1	8452.174	8452.174	7.773+	0.0061
Interaction	2	1472.217	736.109	0.677	0.5099
Residual	132	143534.696	1087.384		

Table 5: Fischer's Least Significance Difference (F-LSD) Test for the Treatments Investigated in Relation to Catches Made Using the Three Killing Agents

Treatment	Mean differences	Critical difference	Probability (p) value
B vs W	19.891	13.601+	0.0045
B vs F	2.848	13.601	0.6794
W vs F	-17.043	13.601+	0.0144
TD vs TN	-15.652	11.105+	0.0061

B- Pitfall catches of traps with .01% banana flavour essence; W- Pitfall catches of traps with ordinary water; F- Pitfall catches of traps with 5% formalin; TD- Total nocturnal catches of the three sets of traps; + Critical differences significant at 5% probability level

DISCUSSION

The pitfall catches made in this study, suggested rhythmic activity among insect (Davis *et al.,* 1990, Ewuim, 1998). The level of activity also showed diurnal cycle (Southwood 1996, Ewuim 1998).

There was also evidence that suggested these insects to be largely nocturnal in their activity (Ewuim, 1998), hence their increased activity was reflected in the night catches. The trapping of the various insect taxa in difference proportions was also suggestive of the differences in their relative abundance (Ewuim 1998).

The statistical difference existing in the use of pitfall traps containing water with 0.01% v v banana flavour essence in the trapping of the Sminthuridídae, Poduromorpha, Diptera, *Acantholepsis, Paratrechina,* and *Camponotus,* when the diurnal and nocturnal catches were compared, indicated more nocturnal catches, as a reflection of the increased activity of these insects at nights. It may also be a reflection of the favourable nature of the habitat. Past cultivation at this site might have favoured the activities of some of these insect taxa, as observed for *Paratrechina* in earlier studies in similar habitats (Ewuim, 1996, 1997; Ewuim and Ezenwugo 1997; Ewuim 1998).

It was also established that the members of Diptera, which ordinarily are not surface-active forms might have been attracted by the banana flavour and formalin. We may further suggest that propylene glycol has attractive properties for insects as observed in their preponderance in the banana flavour essence pitfall catches.

The attractive powers of propylene glycol invariably exceeded that of formalin. In an earlier study, Adis (1979 had implicated a related preservative, ethylene glycol, as having attractive properties. These observations were also in line with the results obtained by Weeks and McIntyre (1997) using propylene glycol solution in pitfall traps. Week and McIntyre (1997) observed that propylene caught more insect species than did live pitfall traps. It was therefore obvious that the presence of propylene glycol in the banana flavour essence incidentally influenced the catches observed in the traps.

In the comparison of the diurnal and nocturnal catches, the statistical differences observed in the trapping of Entomobryomorpha, Poduromorpha, *Acantholepsis* and *Camponotus* with higher nocturnal catches recorded in all the cases using pitfall traps containing ordinary water (Table 3) is possibly an indication of the higher activity – density of these group at night, even though water may be repellant (Aids, 1976; 1979 Ewuim and Nwuba, 2002).

In the comparison of the diurnal and nocturnal catches the statistical difference in the trapping of Sminthuridídae Poduromorpha, Diptera, Hymenoptera (other then formicids) and Orthoptera (nymphs), *Acantholepsis* and *Acheta, lefevrei* with more nocturnal catches made in all the cases is suggestive of increased nocturnal activity of these insect taxa an the efficiency of formalin as a killing agent. Formaldehyde solutions (3.5%), for example are however known to have attractive properties (Adis, 1976; Ewuim and Nwuba, 2002). In fact, 5% formalin also had more insect groups that showed significant differences in their day and captures, with nocturnal captures being higher in all the instances.

The approximate night-day capture ratios of 2:1 obtained in this study is also suggestive of higher locomotary activities of these insects at night and an asymmetrical day to night response of these insects (Ewuim, 1998), and in relation to environmental cues in their diel activity in this fallow plot. There is also no doubt that the activity-density of these insects can serve as an appropriate index for measuring their biological rhythms, which is circadian using the pitfall technique (Ewuim, 1998).

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