ASPECTS OF THE ECOLOGY OF SPITTLEBUGS (HOMOPTERA: CERCOPIDAE) IN NSUKKA, SOUTH EAST, NIGERIA

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ABSTRACT

Species type and pattern of distribution of spittlebugs was studied from 6th March to 15th December 2009 within the University of Nigeria, Nsukka campus. Three spittlebug species namely, Deois flavopicta, Aphrophora saratogensis and Philaenus spumarius were identified within the University campus. Whereas A. saratogensis was most abundant in September, D. flavopicta occurred most in October while P. spumarius was most abundant in November. The population of nymphs was found to increase with increasing rainfall and declined as the dry season began. A total of thirty-two (32) host plant species consisting of grasses, herbs, shrubs and trees were identified as habitats for the three spittlebug species. Whereas D. flavopicta and A. saratogensis inhabited only grasses and herbs, P. spumarius inhabited a mixture of trees and shrubs. Although no obvious effect of the activities of D. flavopicta and A. saratogensis was noticed on host plants, there was flaking, deflowering and fruiting, as well as drying up effects on Ricinus communis during heavy invasion by larvae of P. spumarius.

Keywords: Ecology, Spittlebugs, Spittle mass, Abundance, Adult, Nymphs

INTRODUCTION

The order, Homoptera, includes nine main families out of which the Spittlebugs belong to the family, Cercopidae (Ross, 1965). They are xylem sap sucking insects comprising about 2,380 species in the World (Hodkinson and Casson, 1991). The nymphs produce froth masses in which they live and which protect them from natural enemies and desiccation due to high temperatures (Marshall, 1966; Whittaker, 1970; Kuenzi and Coppel, 1985). They are geographically distributed in the Meadows of temperate and tropical zones while relatively few species have been reported in the Holarctic region (Nilakhe, 1985, Dietz *et al*., 2008).

The Meadow Spittlebug, *Philaenus spumarius* appears to be one of the most common insect species in the world. It has been reported from either Palearctic or neoarctic regions (Drosopolous and Asche, 1991). Its distribution spans from North Lapland to Mediterranean in Europe (Berry, 1983; Halkka and Halkka, 1990; Yurtsever, 1999), North Africa and Afghanistan (Dlabola, 1974), Japan (Haper, 1974), Iran (Yaghmaee, 2008), South America (Hoffman, 1983) and different parts of America from Louisiana region as far as Minnesota towards East of America (Weaver and King, 1954; Ohio Pest Management, 2008).

In many parts of the world, spittlebugs have been identified as serious pests of pastures and economic plants (Dietz *et al*., 2008). They are considered the most damaging pests attacking pastures in tropical America because of their broad distribution and capacity of outbreak (Valerio, 1988). Like cicadas and one subfamily of leafhoppers, they feed on plant xylem sap (Horsfield, 1978; Pires *et al.,* 2000). This complex native insects attack wild and cultivated grasses from Southern United States to Northern Argentina. They are major pests of sugarcane and occasionally turf grass and rice in

Brazil (Nilakhe, 1985). In the United States of America whereas *Philaenus leucophthalmus* causes stunting in clovers; *Aphrophora parallela* and *A. saratogensis* are pests of pine (Dietz *et al*., 2008). Similarly, whereas *Machaerota planitiae* attacks cotton in India, *Clovia punctata* and *Poophilus costalis* have been reported to cause typical leaf yellowing of rice in both India and Taiwan (Nayar *et al*., 1992). Furthermore, the spittlebugs, *Locris rubers* and *Prophilus constalis* have been reported as endemic pests of sorghum, maize, pearl millet, rice, sugarcane and grasses in Northern Nigeria and some other countries of West and Central Africa (Ajayi and Oboite, 2000).

However, despite the reported existence and devastating effects of the activities of spittlebugs in some parts of the world including Northern Nigeria, little or nothing is known about them in Nsukka, Southeastern Nigeria. Therefore the present research effort was aimed at;

(a) identification of the different spittlebug species inhabiting the University of Nigeria, Nsukka Campus;
(b) documentation of the habitats and distribution pattern of the different species within their chosen habitats.

MATERIALS AND METHODS

Study Area and Meteorological Data: This study was conducted within the delimited boundaries of the University of Nigeria, Nsukka Campus situated at the point of intersection of longitude 7°25^{I}E and latitude 6°51^{I}N. The campus is located on a broad dry valley surrounded by grass covered residual hills. The extension of these dry valleys on the Nsukka plateau stands at a maximum elevation of 443m and a minimum elevation of 207m above sea level (Ofomata, 1978). The natural vegetation is dominated by a hilly savannah and an arable land dispersed with grass-pastures and this is located on 871 hectares of land in Nsukka town with a pleasant and healthy climate. Additionally, 209 hectares of arable land are available for experimental agricultural farm, with evergreen and deciduous trees dispersed (Igbozurike, 1978).

The meteorological data for the study area from January 01 to December 31, 2009 was obtained from the Department of Soil Science, University of Nigeria, Nsukka. The weather data obtained were for the amount of rainfall, temperature and relative humidity (Table 1). The area has two distinct seasons in the year on the basis of the total monthly proportion (percentage) of the total annual rainfall. The rainy season began in April and ended in October of the same year. These months had on average about 8 – 21% of the total annual rainfall in the year per month. The rest of the months in the year, namely January, February, March, November and December, were classified as dry season months because on the average each of the months had less than 6% of the annual rainfall. This was a clear departure from earlier reports which showed that these months had less than 1% of the annual rainfall (Inyang, 1978; Ejere and Onyia, 2003), hence the choice of the actual period of data collection to cover the period of observed moisture within the study area. However, the observed minimal fluctuation in monthly rainfall is typical of most tropical environments (Sexton *et al.,* 1971; Sherbrooke, 1975; Vitt, 1982; Vial and Stewart, 1985).

Field and Laboratory Methods: Daily observation and collection of spittlebug species was done from 6th March to 15th December, 2009. Collections were made between 6.30 am and 12 Noon and from 2.00 pm to 5.00 pm (local time) each day in designated areas of the University campus due to the obvious appearance of spittle mass balls, dripping of water from trees and the hopping of the adults on low grasses and trees while feeding. Samples were collected manually, anaesthetized with chloroform in insect bottles and taken to the laboratory for analysis. The spittlebug species were identified using the keys developed by Ross (1965) and BugGuide.Net (2009).

Morphometric measurements of the larval and adult stages of the spittlebug species identified were made using a dissecting microscope fitted with an ocular micrometer. Measurements taken were body length, head length and width, length of legs, wing buds,

Table 1: Monthly percentage of annual rainfall, mean monthly temperature and relative humidity at University of Nigeria, Nsukka from January – December 2009

Months	Rainfall (mm)		Temperature (°C)	Mean Relative Humidity (%)
	Total monthly rainfall	Percentage (%) of annual total		
Jan	53.59	2.9	26.65	71.3
Feb	2.19	0.12	24.9	67.4
Mar.	0.00	0.00	28.45	72.8
Apr.	180.6	9.78	26.65	76.2
May	283.69	15.36	26.31	74.2
Jun.	152.37	8.25	24.95	74.7
Jul.	248.17	13.44	24.9	74.8
Aug.	260.33	14.09	24.14	75
Sept.	175.76	9.52	24.2	74.7
Oct.	387.10	20.96	24.3	74.9
Nov.	103.18	5.59	24.55	63.8
Dec.	0.00	0.00	25.8	65.4
Total	1846.98	100		

Table 2: Morphometric measurements (mm) of the various spittlebug stages

Stage / species	Body length(BL)	Head length(HL)	Head width(HW)	Wing length(WL)	Leg length(LL)	Mouth part(MP)
			1ST Instar			
D. flavopicta	-	-	-	-	-	-
A. saratogensis	1.0	0.5	-	-	1.0	0.7
P. spumarius	1.5	0.7	1.0	-	1.2	1.1
			2nd Instar			
D. flavopicta	-	-	-	-	-	-
A. saratogensis	2.0	0.7	1.2	-	-	1.2
P. spumarius	4.5	1.6	2.4	1.3	-	2.1
			3RD Instar			
D. flavopicta	-	-	-	-	-	-
A. saratogensis	4.0	2.0	-	2.4	-	1.1
P. spumarius	8.0	1.7	-	3.0	-	1.6
			4TH Instar			
D. flavopicta	9.8	1.3	2.3	3.6	3.1	1.8
A. saratogensis	9.0	1.2	2.4	3.4	-	2.5
P. spumarius	10.0	2.0	3.0	3.3	-	3.0
			5TH Instar			
D. flavopicta	-	-	-	-	-	-
A. saratogensis	-	-	-	-	-	-
P. spumarius	13.0	3.0	3.5	5.0	4.5	3.8
			Adult Stage			
D. flavopicta	13.0	2.0	3.0	9.0	8.0	1.8
A. saratogensis	13.0	1.2	3.0	11.8	1.5	4.1
P. spumarius	17.0	4.0	5.0	13	11.0	5.0

antennae and mouth parts. All the measurements were converted into millimeters (mm). Voucher specimens were kept in 70% Ethanol in the Museum of Natural History, Department of Zoology, University of Nigeria, Nsukka.

Samples of the different plant species inhabited by spittlebugs were collected and identified using the keys of Hutchinson and Dalziel (1963) and Lyman (1965). Voucher specimens were kept in the Herbarium, Department of Botany, University of Nigeria, Nsukka. Similarly, the heights of the various plant species were measured using a meter rule. The activities as well as the positional location of the various developmental stages of spittlebug species on the plant species were recorded.

RESULTS

Description of Spittlebug Species in University of Nigeria, Nsukka Campus: A total of three (3) different spittlebug species were identified inhabiting the University of Nigeria, Nsukka Campus. These are *Deois flavopicta*, *Aphrophora saratogensis* and *Philaenus spumarius*.

Adult *Deois flavopicta* is black in colour with yellow-orange patches on the head, pronotum, mesocutellum and the wings (Figure 1A and B). It is elongated in shape and measures about 13 mm in length in both male and female (Table 2). The head is conical in shape and measures about 2 mm in length and 3 mm in width. It bears a pair of short black antenna, circular black compound eyes and a sucking mouth part that measures about 1.8 mm in length.

The thorax bears three pairs of black legs which averaged 8mm in length. The hind legs bear a spine on the tibia and three rows of circular spines which end in two claws. It also has a liquid-swollen pad at the centre of the claws. The abdomen bears 7-8 segments, with the last segment bearing a fork-like ovipositor in the female, while in the male it is pointed and bent backwards. A typical specimen of the 4th nymphal stage is as shown in Figure 1 C.

Adult *Aphrophora saratogensis* is stout, elongated and wedge-shaped. It is completely brown in colour without any patch or design on the wings (Figure 2 A) and has a total body length of about 13 mm (Table 2).

The head is triangular, measuring about 1.2 mm and 4 mm in length and width respectively. It also bears 3-4 small circular crystalline bodies at the tip, a red-brown elliptical compound eyes and a sucking mouthpart of about 4.5 mm in length.

The thorax bears six legs measuring 1.5 mm in length, which bear three rows of spines. Whereas the first row bears 13 black alternate spines, the second which is less obvious, has 7 spines and the third has 14 much smaller spines. The legs end in two black claws with a swollen liquid pad in the middle.

The last segment of the abdomen is expanded at the end. In the female it is modified to form an ovipositor opening while in the male it forms an expanded but elongated anal end. The wings completely cover the entire body when at rest and while feeding. A typical specimen of a 3rd nymphal stage feeding on the leaf of *Emelia* spp and a typical froth mass of the 4th nymphal stage on the grass, *Bracharia horizontalis* are as shown in figure 2 (B and C).

The meadow spittlebug, *Philaenus spumarius* is strong, wedge-shaped and oval, with a sharp acute end on the posterior part of its wings (Figure 3 A). Representatives of the 4th nymphal stage as well as a cluster of the 3rd to 5th nymphal stages are as shown in figure 3 (B and C). Adults average 17.0 mm in total body length (Table 2). The wings are dark gray-brown in colour with yellow-orange or white patches or designs on the head, the two sides of the wings and on the whole wings. The head measures about 4 mm in length and 5 mm in width, respectively. It bears big elliptical black compound eyes which are positioned at the sides of the head. Similarly, the pronotum, mesocutellum as well as the vertex of the head are very large. The antenna is black, stumpy and located between the two compound eyes on the upper base of the clypeus. The mouth part is thick and measures about 5mm in length with a black labrum end.

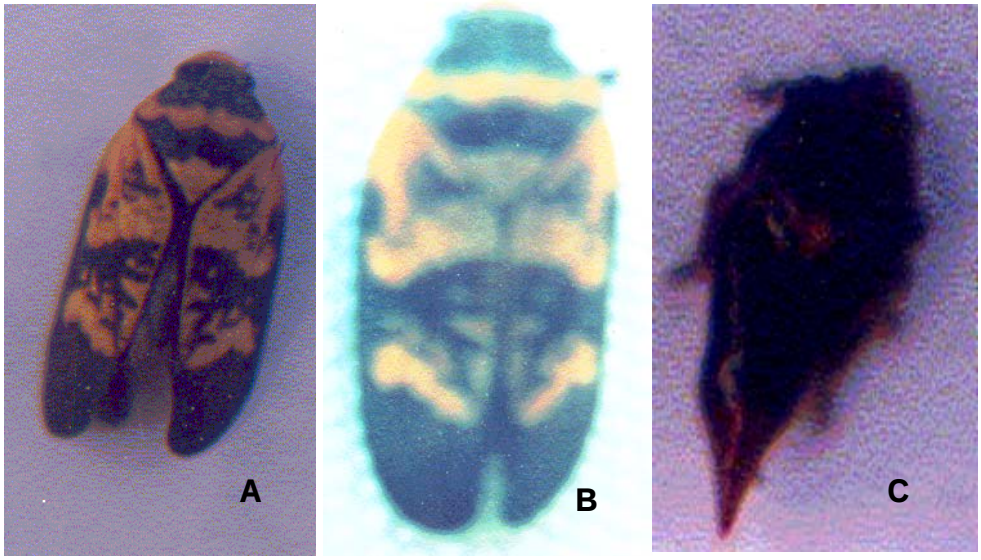

Figure 1: Specimens of some developmental stages of *Deois flavopicta* (A) Female, (B) Male, (C) 4th nymphal stage.

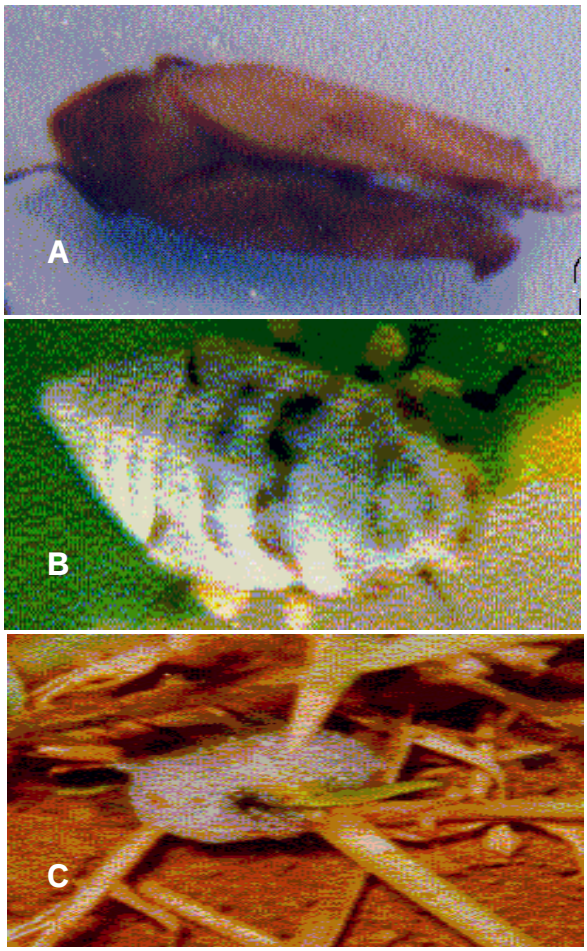

Figure 2: Developmental stages of *A. saratogensis.* (A) Adult of *A. saratogensis* (B) 3rd nymphal stage feeding on the leaf of *Emelia* spp. (C) Froth mass of the 4th nymphal stage on the grass, *Bracharia horizontalis*

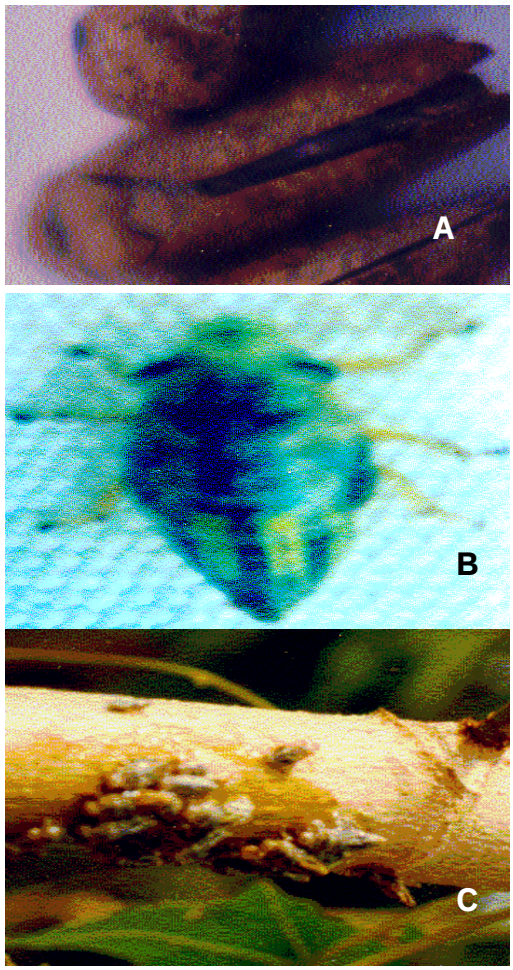

Figure 3: Developmental stages of *Philanaeus spumarius.* (A) Adult specimen of *Philanaeus spumarius.* (B) 4th nymphal stage (C) A cluster of 3rd – 5th nymphal stages on the shrub, *Ricinus communis*

Table 3: Monthly abundance of the spittlebug species from 6th March to 15th December 2009

Species of spittlebug	March	April	May	June	July	August	September	October	November	December
D. flavopicta	-	-	-	-	-	30	650	950	45	-
P. spumarius	500	200	70	30	-	500	100	700	900	700
A. saratogensis	100	80	20	23	10	10	700	-	-	-

Table 4: Plant species inhabited by spittlebug species within University of Nigeria, Nsukka campus

Spittlebug Type	Plant species	Vegetative Type	Height of Plant
P. spurmarius	***Delonix regia***	Tree	>100cm
	Ricinus communis	Shrub	>100cm
	Terminalia ivorensis	Tree	>200cm
	Terminalia catapa	Tree	>200cm
	Citrus sinensis	Tree	>150cm
	Parkia biglobosa	Tree	>200cm
	Vernona amygdalina	Herb	>30cm
	Phylantus amuriancis	Tree	>100cm
	Lantata camara	Climber	>100cm
	Lonchro capus cayensis	Climber	<70cm
	Samanea saman	Shrub	>100cm
	Astonia boonei		
	Blighia sprida	Tree	
D. flavopicta	***Bracharia horizontalis***	Grasses	>20cm
	Hyperthelia dissoluta	Grasses	30cm
	Paspalun virginatus	Grasses	>20cm
A. saratogensis	***Diocorea bubiflora***	Grasses	0-6cm
1st Instar	***Acalipher***		
2nd Instar	***Acalipher***		
3rd Instar	***Sida acuta***		
	Cassia	Herb	>50cm
	Rauwolfia vomitoria	Herb	50cm
	Diocorea bubiflora	Herb	30cm
	Fleurya aestuans	Grass	<50cm
	Cissus sp	Herb	30cm
	Centros ema	Herb	50cm
	Chromoleona odorata	Herb	>30cm
	Richardia brasiliensis	Herb	>50cm
	Casuarina	Herb	
4th Nymphal	***Sida acuta***		<50cm
	Diocoren bubiflora	Herb	<50cm
	Cissus sp	Grass	>50cm
	Paspalum sp	Herb	30cm

The thorax is massive bearing three pairs of legs. The hind pair bears rows of roundly arranged black spines and two black claws. The leg measures 11mm in length and folds on its sides while feeding or at rest.

The abdomen is small and has pointed ends measuring 8mm in length. It is light brown to gray in colour and segmented. The females possess an expanded, sharp fork-like ovipositor on the last segment of the abdomen. The females are also bigger than the males in size and are found to be more abundant in the population.

Monthly Abundance of Spittlebug Species: The monthly abundance of the various spittlebug species from 6th March to 15th December, 2009 is as shown in Table 3. Whereas *P. spumarius* was collected in all the months with the exception of July, *A. saratogensis* was found only from March to September, and *D. flavopicta* was only collected from August to November. Similarly, while *A. saratogensis* was most abundant in September, *D. flavopicta* occurred most in October, and *P. spumarius* was more abundant in November.

In addition, the monthly abundance of the spittlebug species was examined in relation to the meteorological data of the study area. It was observed that their abundance varied with the amount of moisture in the area. The three species showed high abundance in those months with high amount of rainfall (Figure 4) and high relative humidity (Figure 5). It was also observed that those months with relatively lower temperature range recorded high abundance of the spittlebug species (Figure 6).

Habitat Preferences, Distribution and Activities of Spittlebug Species: A total of 32 plant species were found inhabited by various stages of spittlebug species in the University of Nigeria, Nsukka Campus (Table 4). The spatial distribution of the various plant species did not portray any established pattern as the spittlebugs were found on them anywhere they occurred. Whereas *D. flavopicta* and *A. saratogensis* inhabited only grasses and herbs, *P. spumarius* inhabited a mixture of trees and shrubs.

Both the nymphal and adult stages of *D. flavopicta* were found feeding on the shoot of *Paspalum vaginatus*, from about 0-6 cm above the soil surface. Moulting of the nymphs was observed on the stem as well as behind the leaf epidermis. Matured adults were observed to migrate to the upper parts of the stem of *Hyperthelia dissoluta* about 20-30 cm, on the bracts occupied with water, or on the dry apical flowers. Similarly, mating among adults was observed at a height of about 70 cm and above, especially on the dry apical flowers.

Nymphal and adult stages of *Aphrophora saratogensis* were found feeding on different plant species. However, in some cases both stages were found feeding on the same plant species such as in *Acalipher spp*, *Casuarina equisitifolium*, and *Diocorea bubiflora*. More often, the 1st and 2nd nymphal stages were found feeding either on the uppermost softer and greenish part, the leaf internodes or the apical main stem of the Acalipher plant. Similarly, the adults were observed feeding in close proximity with the 1st and 2nd nymphal stages presumably as a means of camouflage from predators. Contrariwise, the 3rd and 4th nymphal stages were found always alone on very green and matured plants. They may cluster at a height of about 40-50 cm high on the stem or beneath the leaf epidermis as in *Sida acuta,* or sometimes on the roots as in *Bracharia horizontalis*.

Nymphal and adult stages of *Philaenus spumarius* were found to feed and moult on such plant species as *Ricinus communis*, *Vernona amygdalina*, *Terminalia ivorensis*, *Lonchrocarpus cayensis*, *Samanea saman* and *Astonia boonei*. The 1st and 2nd nymphal stages fed mainly on the uttermost parts of the stem of young plants, the leaf petioles, or in between the internodes and nodes of younger branches. Similarly, the 3rd, 4th and 5th nymphal stages were found to inhabit and feed on matured green stems and branches of the plants. However in few cases, they were found to feed in-between internodes of apical buds and stems with a dense leaf covering that provides shade from the sun, in order to prevent drying up.

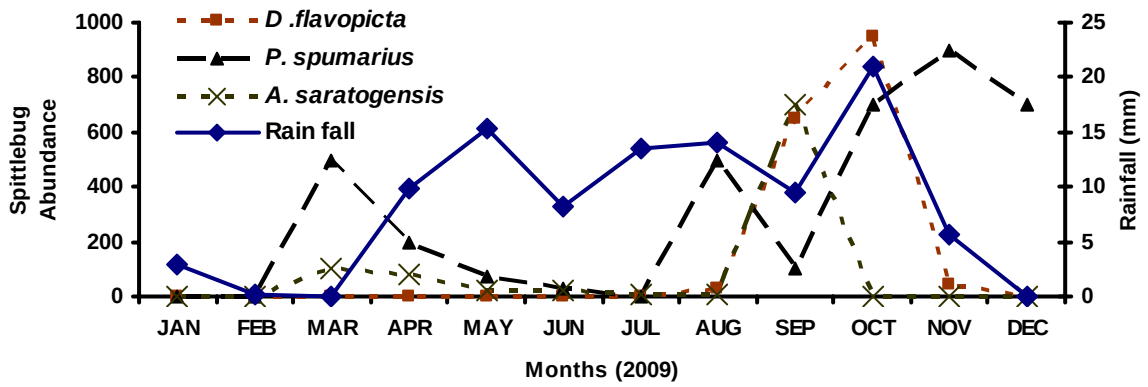

Figure 4: Effect of rainfall on the monthly abundance of spittulebug species in Nsukka.

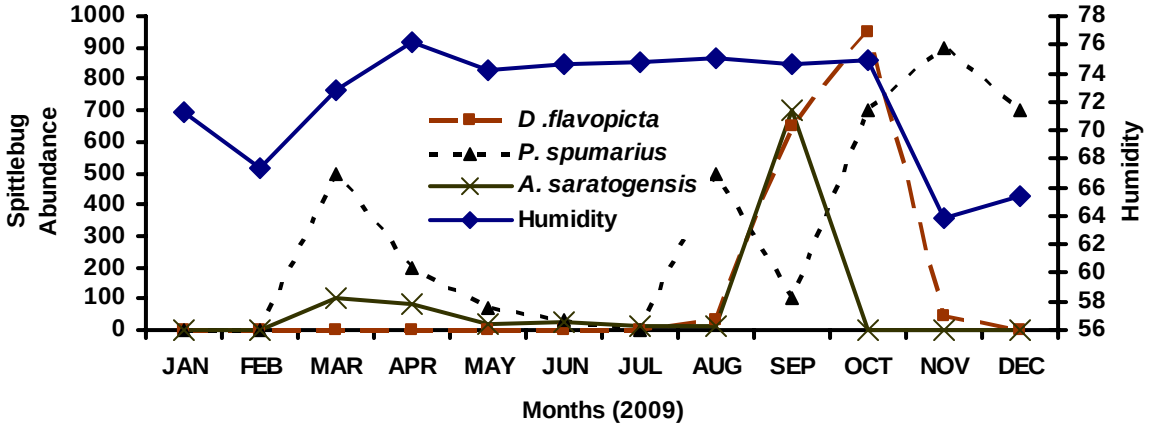

Figure 5: Effect of Relative humidity on the monthly abundance of spittlebug species in Nsukka

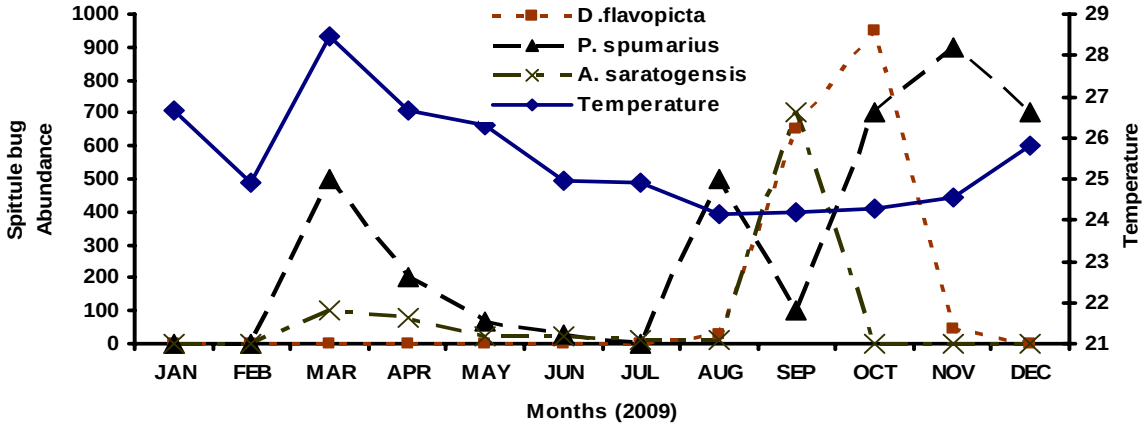

Figure 6: Effect of temperature on the monthly abundance of spittlebug species in Nsukka

DISCUSSION

Data presently accumulated and reported here-in on the morphology and morphometry of the three spittlebug species, *D. flavopicta, A. saratogensis* and *P. spumarius,* largely corroborate earlier findings. The body lengths obtained for male and female of the three species in the present study (13 mm, 13 mm and 17 mm) respectively, fall within the range (3 – 27mm) obtained earlier for spittlebug species (Dietz *et al.,* 2008; Yaghmaee, 2008). Similarly, the measurements of the various body parts (Table 2) are in conformity with those earlier obtained for the species (Ross, 1965; Dietz *et al.,* 2008; Yaghmaee, 2008). This further attests to the worldwide distribution of spittlebug species (Hodkinson and Casson, 1991; Marshal and Williams, 2004; Dietz *et al.,* 2008).

The habitat preferences of the three spittlebug species are very remarkable. Whereas *A. saratogensis* prefers to inhabit shrubs and grasses not more than 5 cm in height; *D. flavopicta* inhabited only grasses with a height of 20 – 30 cm while *P. spumarius* inhabited mainly trees greater than 100 cm in height (Table 4). Although the predisposing factors underlying this observation are not at once obvious, there is the likelihood that such may be due to host plant specificity, nature of canopy as well as the absence of perceived predation or interference by humans. Similarly, the distribution of the nymphs on the plants can at best be described as patchy as a result of their inter- and intra-plant foraging patterns. Generally their density was dependent on the shade as well as the nature of plant cluster within the study area.

In addition, the monthly abundance of the various spittlebug species (Table 3) adequately fits into the pattern of rainfall experienced during the year within the study area. Their high abundance during periods of abundant rainfall (Figure 4), high relative humidity (Figure 5) and lower temperatures (Figure 6), further shows that the species largely depend upon water availability to survive in their environments (Pires *et al*., 2000). Similarly, the observed population peak recorded for *D. flavopicta* in October corroborates an earlier report for the same organism in Brasilia, Brazil (Fontes *et al*., 1995).

The occurrence of *D. flavopicta* in non-cultivated portions within the study area is also remarkable. There is the need to fully study the occurrence of this spittlebug species in other areas within the Southeast, Nigeria. This is more so because in Central-West region of Brazil, *D. flavopicta* has been reported to be the predominant spittlebug species inhabiting cultivated pastures (Pires *et al.,* 2000). Also it has been reported that their natural hosts are three species of *Paspalium* (*P. anenoarum, P. erianthum and P. plicatulum*) in Brazil (Nilakhe, 1985), while within the study area it was observed only on *P. vaginatum* and *Bracharia horizontalis* (Table 4).

The observed negative effect as a result of overcrowding of nymphs and adults of *P. spumarius* on *Ricinus communis* resulting in softening and flaking of stem, deflowering and drying up of the plant further attests to the fact that spittlebugs are major pests of pasture and economic plants (Valerio *et al.,* 2001; Dietz *et. al.,* 2008).

However, there is the need to carry further researches in order to fully ascertain the biological activity vis-à-vis the economic importance of these small but very important insect species within the confines of Southeast Nigeria..

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