COMPARATIVE STUDIES ON THE ABUNDANCE AND DISTRIBUTION OF VARIOUS SENSILLA ON THE ANTENNAE OF *Blatta germanica* and *Blatta orientalis*.

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ABSTRACT

This research was conducted on the comparative studies on the abundance and distribution of various sensilla on the antennae of cockroaches viz: *B. germanica* and *B. orientalis* in Nasarawa Burkullu, Nigeria from September to December, 2017. Twenty cockroaches (10 males and 10 females) were collected from different parts using sweep net and hand picking. Heads of sexes were detached and separately boiled in 10% potassium hydroxide (KOH) solution to dissolve chitin. The chitin free left and right antennae were carefully separated from the head capsule, washed, dehydrated, stained in safranin solution, cleared and mounted separately on each slide. Observations were made on the length of antennae, antennal segments, abundance and distribution of various types of sensilla in all the antennae. Results show that, the size of antennae varied among the species and between sexes. Males had the longest antennae in *B. orientalis* while contrary to these females had longest antennae in *B. germanica*, in both left and right antennae, respectively. Similar variation was also observed among the segments of antennae of the same sex. Three types of sensilla Viz; trichoid, basiconic and chaetica sensillae, the highest distribution were found on the flagellum and the least on the scape. Females have the highest distribution of sensillae compared to males.

Keywords: Sensilla, Cockroaches, Antenna, Trichoid

INTRODUCTION

Cockroaches are brown or black-bodied insects. Their sizes range from ½ to 3 inches (0.6-7.6 cm) and have long antenna, legs and legs and flat extension of the upper body wall that conceals head. Cockroaches are nocturnal omnivores that live in damp places throughout the world. Cockroaches are the most abundant and obnoxious non-biting insect pests in residential buildings, hospitals, hostels, hotels and restaurants (Piper and Antonelli, 2012). They are generally distributed in our environments found in kitchens, public latrines, ware houses etc (Jordan and Verma, 2005).

Antennae have sensory receptors that help in monitoring the environment. The antennae of cockroaches play an important role in the host orientation, food selection and ovipositor site selection. It is generally agreed that the sensilla on insects antennae are not randomly distributed (Zacharuk, 1985).

The antennae of cockroach bear different types of sensilla that are responsible for mechanical and chemical stimuli. These sensilla are very important in the life of insect in general because they help the insect to detect their food materials, their mates and in selection of their favorable habitats and as well as to avoid their enemies and harmful substances. In other words, these sensilla make the cockroach aware of its environment, (Ocheing *et al.* 2000).

Sensory receptors (sensilla) of cockroaches are mostly found on the antenna, mouthpart and tarsi part of the leg. They are trichoid sensilla as tactile (touch) organ and gustatory (taste) receptors, tympanal organs for sound receptors, stretch receptors registered tension on soft tissue e.t.c. (Gullan and Granston, 1994).

MATERIALS AND METHODS

(i) Study Area

The study was conducted at Nasarawa Burkullu town, Bukkuyum local government of zamfara state (latitude 12° 08' 00''N and longitude 5° 28' 00'' E). The study area has both dry and wet seasons. The dry season reaches its peak between March and April/May, while the wet season has its peak between July/August. The harmattan season is always accompanied by dust. The state experiences a short rainy season (June & above) and a long dry season (October-May). The rainfall (Wet season) starts from April to June and ends around September. The rainfall is usually erratic and associated with dry spell. The mean maximum and minimum temperature are about 40℃ and 15℃ (NIPOST, 2009). Bukkuyum is mainly populated by Hausa-Fulani and a combination of other languages among which are Yoruba, Igbo, Dakarkari, Nupe, e.t.c.

(ii) Collection of Experimental Insects

The cockroaches were collected by net/ picked by hand from different locations (such as refuse dumps, toilets, kitchens, parlours and bedrooms) from July-December, 2017. The collection was made at night, cockroaches being nocturnal insect. Cockroaches caught was placed in a sterile specimen bottle and transported to Science Laboratory Technology of the

College of Agriculture and Animal Science, Bakura where they were transferred to a killing jar containing chloroform and then examined under dissecting microscope. The sexes and species of cockroaches were identified by comparing them with samples preserved in the museum and by using standard taxonomic keys.

After identification, the insects collected were placed into a bottle containing about 20 to 25% formaldehyde solution to act as preservative.

(iii) Preparation of slides

The head of each cockroach of each species was separated from the body with the aid of forceps, and put in a boiling test tube containing 10-15% solution of potassium hydroxide (KOH) and boiled for a period of 13-15 minutes by using a spirit lamp, aimed to dissolve the chitinuos covering of the antennae, in order to make the structures and sensilla present in them more clearer and transparent. After the boiling, the heads were then washed thoroughly in a cavity block containing some water, following Chapman *et al.* 1978 and Pedro *et al.* 2015.

The head capsule of male *B. germanica* was then picked and placed on a glass slide. The left and right antennae were then separated from head capsule using a dissecting microscope and placed in different cavity blocks marked accordingly. Similar process was repeated for the female *B.germanica* as well as male and female *B. orientalis.* These were then subjected to dehydration and staining.

(iv) Dehydration /staining

For the purpose of dehydration, different grades of alcohol of 30, 50, 70, 90, 95 and 100% were prepared using absolute alcohol and distilled water, following Chapman and Thomas, (1978) and Pedro *et al*. (2015).

For dehydration, the left and right antennae of males and females of both species were passed through different grades of alcohol to remove water. First, the left and right antennae of male *B. germanica* were put in 30% alcohol for about 10 minutes, and then they were immersed in 50% alcohol for also 10 minutes. After 50% alcohol, they were later then kept in 70 and 90% alcohol for about 10 minutes. After dehydration in 90% for about 10 minutes, specimen was then kept in 90% safranin solution for staining. After staining, then were again passed to 90% alcohol, then specimen were transferred to 95 and 100% alcohol to have complete dehydration. Similar procedures were done for the antennae of female as well as male and female *B. orientalis*.

3.5 Clearing

To clear the excess amount of stain from the dehydrated antennae, they were transferred into cavity blocks containing xylene and left for 10 minutes. After clearing, the antennae were then put on the separate slides for mounting following Pedro *et al*. 2015.

3.6 Mounting

Each of the dehydrated stained and cleared left and right antenna was then placed on a glass slide separately. A drop of mounting medium viz, as glycerine (for temporary mounting) was dropped over the cleared antennae and mouthparts, and a cover slip was then gently used to cover them, (Pedro *et al*., 2015).

Morphology of antennae, the number, and type of the sensilla distributed over the antennae of male and female of both species were studied and recorded.

3.7 Statistical Analysis

Sensilla on the antennae were identified, counted and measured. Measurements in mm obtained from occular micrometer and Duncan New Multiple Range Test was used to calculate the means and standard error to determine association and significant differences between the parameters tested at 5% or $P<0.05$.

RESULTS

Antennal Length

A total of 20 cockroaches were studied, all were identified as *B. germanica* and *B. orientalis* 10 males and 10 females. The results show that, the mean length of the left antennae of male and female of *B.germanica* was 12.60 mm (ranging from 10- 17 mm) and 18.80 mm (ranging from 15- 22 mm) respectively. Similarly, the mean length of right antennae of male and female of the same species has been 8.00 mm (ranging from 6-10 mm) and 13.00 mm (ranging from 10-17 mm), respectively. While the mean length of the left antennae of male and female of *B. orientalis* has been 33.20 mm (ranging from 20-37 mm) and 22.20 mm (ranging from 13-28 mm) respectively. While the mean length of right antennae of male and female of *B. orientalis* has been 37.00 mm (ranging from 16- 53 mm) and 22.60 mm (ranging from 12- 36 mm) (Table 1).

Antennal Segments

The mean number of segments in the flagellum of the left and right antennae of both species observed vary significantly. The left antennae of male and female of *B. germanica* have a mean of 64.60 and 73.80, while the right antennae of male and female of *B. germanica* have a mean of 57.40 and 65.80. Similarly, the left antennae of male and female of *B. orientalis* have a mean of 149.40 and 132.20, while the right antennae of male and female of *B. orientalis* have a mean of 154.80 and 131.80, respectively. Observation shows that the numbers of antennal segment in the left and right antennae of females are higher than their females in *B. germanica* while contrary to *B. orientalis* (Table 1).

Antennal Sensilla

Sensory organs or sensilla are distributed in all the antennal segments viz: scape, pedicel and flagellum (Apical, Medial and Basal). Trichoid sensilla distributed on the left antennae of

male and female *B. germanica* were 255.60 and 291.60, while the right antennae of male and female had 238.40 and 270.20 sensillae, while the left antennae of male and female of *B. orientalis* had 324.20 and 346.00, while the right antennae of the male and female of the same species have 304.00 and 326.20 sensillae respectively. The mean numbers of chaetica sensilla distributed on the left antennae of male and female of *B. germanica* were 116.00 and 151.40, while the right antennae of male and female had 100.80 and 136.20, while the left antennae of male and female of *B. orientalis* have a mean of 165.40 and 172.00, while the right antennae of male and female of female of the same species had 153.00 and 154.60 respectively. Similarly, basiconic sensilla distributed on the left antennae of male and female of *B. germanica* were 458.00 and 501.00, and the right antennae of male and female had 438.20 and 476.00 while basiconic sensilla distributed on the left antennae of male and female of *B. orientalis* have a mean of 548.00 and 584.80, and the right antennae of male and female of the same specie had 528.00 and 565.00 respectively (Table 2 & 3).

Table 1: Antennal length and Number of antennal segments of *B.germanica* and *B.orientalis.*

Specimen	**Antenna**	**Mean length (mm) of antennae**		**Mean No. of antennal segments (Range of antennal segment)**	
		Male	**Female**	**Male**	**Female**
B.germanica	Left	12.60 (10-17)	18.80 (15-24)	64.60 (60-71)	73.80 (69-81)
	Right	8.00 (6-10)	13.00 (10-17)	57.40 (54-61)	65.80 (61-71)
B. orientalis	Left	33.20 (20-37)	22.60 (13-28)	149.40 (135-154)	132.20 (96-144)
	Right	37.00 (16-53)	22.60 (12-36)	154.80 (131-179)	131.80 (91-161|)

Table 2: Distribution of various sensilla on the antennae of adult male and female cockroaches, *B.germanica.*

	Regions	Mean No. of Antennal Sensilla						Total No. of Sensilla	
		Trichoid		Chaetica		Basiconic			
		Male	Female	Male	Female	Male	Female	Male	Female
FLAGELLUM	Apical left	49.60	59.00	53.00	67.80	240.60	256.80	343.60	383.60
	Apical right	44.60	52.80	48.60	64.60	234.40	249.40	327.60	366.60
	Medial left	154.60	166.00	30.00	39.00	148.80	158.20	332.60	363.20
	Medial right	148.40	157.80	26.40	34.40	143.00	149.20	317.80	342.00
	Basal left	37.00	43.00	20.00	27.00	34.60	42.00	91.60	112.00
	Basal right	32.80	40.20	15.60	23.40	30.00	38.00	78.40	101.60
	Pedicel left	9.00	13.00	6.60	10.00	20.40	26.00	36.00	49.00
	Pedicel right	7.80	10.80	5.20	8.20	18.60	24.00	31.60	43.00
	Scape left	5.40	10.80	5.20	8.20	18.60	24.00	31.60	43.00
	Scape right	4.80	8.60	5.00	5.60	12.20	15.00	22.00	29.20

Table 3: Distribution of various sensilla on the antennae of adult male and female cockroaches, *B.orientalis.*

	Regions	Mean No. of Antennal Sensilla						Total No. of Sensilla	
		Trichoid		Chaetica		Basiconic			
		Male	Female	Male	Female	Male	Female	Male	Female
FLAGELLUM	Apical left	68.60	73.60	74.80	68.60	266.80	278.60	410.20	420.80
	Apical right	62.80	69.60	72.40	64.40	262.40	273.60	397.60	407.60
	Medial left	173.60	174.00	45.00	46.20	192.20	202.60	410.80	422.80
	Medial right	168.20	168.80	42.00	41.20	186.20	197.00	396.40	407.00
	Basal left	55.00	59.80	23.60	27.20	42.00	47.00	120.60	134.00
	Basal right	52.00	54.40	21.20	23.00	38.20	43.80	111.40	121.20
	Pedicel left	12.60	18.60	12.40	17.00	27.00	32.40	52.00	68.00
	Pedicel right	10.20	16.40	9.60	15.40	23.60	30.00	43.40	61.80
	Scape left	14.40	20.00	9.60	13.00	20.00	24.20	44.00	57.20
	Scape right	10.80	17.00	7.80	10.60	17.60	20.60	36.20	48.20

DISCUSSION

The antennae were found to vary in sizes in the different sexes and also within the same sex. The mean length and number of segments indicate that male *B. orientalis* has longer antenna and more segmented than *B. germanica*. The antennae are significantly similar in males and also in females. Similar finding were recorded by Omar (1995) on the study of distribution and abundance of sensilla on the antennae and mouthparts of grasshopper (Zonocerus variegatus) due to the bigger size of the species.

In both males and females, the numbers of antennal segments vary between the left and right in *B. germanica*. There was significant difference ($P<0.05$) among the antennal segments of male than in female in *B. orientalis* and in females than in males in *B. germanica*. Antennal segments of males *B. oreintalis* differed significantly from the rest with highest number of antennal segments, while the other antennal segment of *B.oreintalis* may be due to its longer antenna.

Medial left of females differed significantly with high number of trichoid sensilla, followed by medial right, and also apical left of females differed significantly with high number of basiconic sensilla, followed by apical right, while the other regions didn't differ significantly of both species, *B. orientalis* has more sensilla distribution than *B. germanica*. Similar observation was observed by Kang and Chen (1992) where they observed that, the females showed significantly more number of sensilla than the male cockroaches.

The distribution of sensilla on the antennal segments varies between males and females and also between left and right of each antenna. On the female antennae, trichoid, chaetica and basiconic sensilla were more on the flagellum (basal, medial and apical) with higher concentration, followed by pedicel and the scape, as compared to the male with fewer sensilla. The number also varied within the segments of antennae with highest concentration in the apical and medial segment of the flagellum. This is similar to Ocheing *et al.*, (1998), who observed the distribution of sensilla basiconic was observed over the entire antennal flagellum with a concentration in the apical and medial segments of the flagellum.

The antennae of both species, was found having trichoid, chaetica and basiconic sensilla. On the female antennae of all the samples, basiconic was more in number compared to males. Chaetica and trichoid sensilla were less in number than the basiconic and are found scattered on the flagellum, pedicel and scape. Basiconic sensilla which are more abundant on the tip and middle segment and found fewer on the scape. Trichoid and chaetica sensilla are less in occurrence than the basiconic sensilla. Similar observations were made by Muazu (2008), who recorded that, all types of sensilla on the antennae, Basiconic being more numerous 1203.50 and 1393.16 in males and 1693.16 and 1096.72 in females cockroach of *P. americana*, while the chaetica and trichoid sensilla were found scattered on the scape, pedicel and flagellum.

Trichoid sensilla are more on medial segment; this may suggest that middle portion of antennae is more sensitive to mechanoreception and olfaction compared to other segments; this is in consistence with work of Prakash *et al*. (1994) and Ocheing *et al*. (1998).

The diversity in structural organization of antennae of insects may possibly be related to the different sensory functions like olfaction, contact chemoreception, thermoreception, hygroreception, and mechanoreception (Schaller, 1982; Chapman, 1972). Chapman (1982) and Bland (1989) attributed the dimorphism of insect antennal sensilla number either to the different feeding habits of sexes, or to the attraction of male and female pheromones.

The antennae in all the insects found were filiform and compose of three distinctive parts; the scape, pedicel and flagellum, which is in conformity with Imm's (1977) that, higher insect antennae are really three segmented.

The antennae also have chaetica, trichoid and basiconic sensilla, this is in conformity with the work of Bell and Adiyodi (1982) and Mustapha (1984) they described the possible physiological roles of sensilla trichoidea and basiconica as olfactory sensilla.

From this investigation it can be concluded that, there are variations on antennal sensilla distributions in the male and female of *B. germanica* and B. orientalis in which basiconic, trichoid, chaetica sensilla types were observed been at different segments and regions. It was observed that, *B. orientalis* has the highest number of sensilla distribution than B. germanica, both in terms of antennal length, number of segments and sensilla distribution. And also females have highest number than the males of the same sensilla distribution.

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