



SEASONAL DISTRIBUTION OF COCKROACHES' SPECIES IN ABRAKA, DELTA STATE, NIGERIA



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Abstract: The aim of this study was to determine the seasonal distribution of identified pest species of cockroaches in Abraka, Delta State. There by proffering efficient control/intervention strategies for their control. Collection was carried out actively by hand picking and careful use of swat sticks and brooms and passively by trapping methods from different parts of the households. Adults and the different stages of instars were identified using standard taxonomic entomological keys based on their morphological characteristics. The collection was done in Abraka Delta State, Nigeria during the wet season (July 2014-October 2014) and dry season (November 2014-February 2015). A total of 7835 cockroaches were caught, 6 species of which *P. americana*, *P. fuliginosa*, *B. orientalis*, *B. germanica* and *Parcoblatta spp.* had population of 1885 (24%), 1867 (24%), 1756 (22%), 949 (12%), 844 (11%) and 534 (7%), respectively. There was no statistical difference ($P > 0.05$) in the distribution of cockroaches in the wet and dry seasons. There was high abundance of individual species in the Central site (50%), while the North-East, West-South and South-East had 28, 14 and 7%, respectively. Although more cockroaches were found in the Central site, higher species diversity occurred in North-East site when compared to other locations. The species were evenly distributed as the abundance and index (H) increased. This study has attested that there was no significance difference ($P > 0.05$) in the seasonal distribution of cockroaches in Abraka. Successful control of cockroaches requires a holistic approach.

Keywords: Abraka, cockroaches, distribution, dry season, species, wet season

Introduction

Cockroaches are insects of the order Blattaria or Blattodea with over 4500 species identified (Hassan, 2016). Majority of these species live in tropical and subtropical area and are not pest (Vazirianzaden *et al.*, 2009). About 25-30 species are synanthropic in nature associating themselves with human habitat, of these less than 1% that is only 4-5 are regarded as global pest (El-Sherbini, and El-Sherbini 2001). Cockroaches have been in existence for over 350 million years (since Denovian), and have changed very little over the years. Fossilized cockroaches from 250 million years ago look very much the same as cockroaches today (Jirage, 2018).

Cockroaches are omnivorous scavengers that survive on a wide variety of organic matter (plants, vegetables, and fruits) but prefer food sources such as sweets, cheese, meat products, starches, and grease, (Rivault *et al.*, 1993) they feed on little and to a large extent contaminate stored food products, where they leave a persistent characteristic odour which then has to be thrown away (Jirage, 2018). The adult cockroaches have the ability to survive without food for several weeks.

Generally, Cockroaches like warm moist environment with abundant food; moist and wet decaying places are their natural habitat, as they are found in basements, sewers, toilets, kitchen and drainages (Jirage, 2018; Bassam, 2013). Previous study mentioned that cockroaches move freely from buildings to buildings through drains, sewers and latrines, they live in groups and are attracted to humidity warmth and darkness which is common in toilets, bathroom, and in some rare cases kitchen (Etim *et al.*, 2013). They have the ability to breed all year long in suitable environmental conditions. These features of cockroaches together with their nocturnal activity make them widespread, as seen in home and residential areas. The unprecedented increase of cockroach population over decades in public places all over the world has been documented in Korea (Kim and Zong, 1974), Tokyo (Sualiman *et al.*, 1989), Malaysia (Lee and Yap, 2003), Iran (Hanafi-Bojd and Sandaghani, 2001; Fathpour *et al.*, 2001; Salezadeh *et al.*, 2007; Vazirianzaden *et al.*, 2009; Thailand (Chamavit *et al.*, 2011), Bulgaria, (Sevdan *et al.*, 2013) Palestine (Bassam, 2013), Manilla (Glen *et al.*, 2016) and Pakistan (Hafsa *et al.*, 2017) In Africa same has been documented in Morocco Bouamamma and Sorlanzo, 2010) Egypt (El-Sherbini and El-

Sherbini, 2001) Ghana (Yeliferi *et al.*, 2005; Tetteh-Quarcoo *et al.*, 2013) Ethiopia Haji *et al.*, 2014; Feleke *et al.*, 2016; Kinfu and Erko, 2008) South Africa (Oteng, 2003; Mpuchane *et al.*, 2006). Outstandingly in Nigeria, Cockroaches are abundant in most homes in, where they are actually called "landlords". The health risk arising from their infestation has hitherto been underestimated considering the dearth of entomological and epidemiological information available. However, there are recent documents of their population in Arkilla, Sokoto (Bala and Sule, 2012) Ekpoma, Edo (Tatfeng *et al.*, 2005) Abraka, Delta (Ojianwuna, 2014) Anatigha, Calabar (Etim *et al.*, 2013; Iboh *et al.*, 2016) Jos, Plateau Ejimadu *et al.*, 2015) Markudi, Benue (Omudu and Eyumah, 2008; Omudu and Akosu, 2013) Anambra Oyindo *et al.*, 2011). Previous study expected that more than 40% of cockroach population will be found in rural areas because of inadequate solid waste disposal, accumulated waste, poor housing standards and inadequate water supplies (Wang *et al.*, 2008; Gholam *et al.*, 2013).

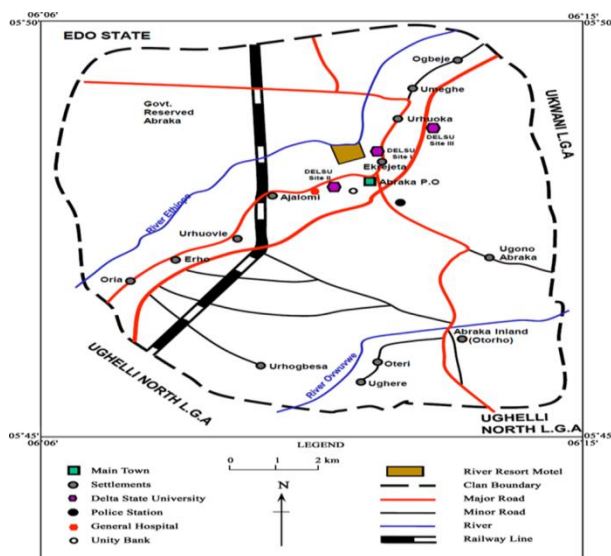
Reports from Hahn and Ascerno (2005) revealed that correct identification of suspected cockroaches is important as there are many insects that look similar (e.g. long-horned beetles, crickets, leaf-footed bugs and ground beetles). These insects are flattened from top to bottom with antennae as long as the length of their body; some species have two pairs of wings folded flat over their oval shaped bodies When looking at a cockroach from above, its head is hidden from view. It has six strong legs usually covered with spines. Most species rarely fly but they walk very fast. The colour usually varies from light brown to black and the length varies from 2 – 3 mm to over 80 mm in length. The majority of these species are not pests but live in the wild, playing important roles as they feed on dead vegetation recycling dead matter.

There is paucity of knowledge on the seasonal distribution of cockroaches especially in temperate regions similar to Abraka, thus this work was designed to determine the seasonal distribution of identified pest species of cockroaches in Abraka Delta State; thereby improving the awareness of dangers posed to public health by the presence of cockroaches and design more efficient control/intervention strategies for their control.

Material and Methods

Study area

Abraka lies between the latitude of 5°50 North of the equator and longitude 6°15 east of the Greenwich meridian. It is bounded by Orhionwon Local Government Area, by the Agbor plains, Ukwani and Ughelli North Local Government Area to the west, east and south, respectively. Abraka is located on the south bank of the river Ethiope and is an agglomeration of several communities that make up the linearly aligned arrangement along the new and old Sapele-Agbor high way as shown in Fig. 1. The study town Abraka was divided into 4 sites based on the Google map navigational system and the linear aligned arrangement of the town, the West-South site was made up of Urhouvie, Erho, Oria and Otoroh; Ekrejeta, Abraka P/O and Ajalomi comprised the Central site; the South-eastern site Abraka town comprised of Ugono, Abraka in-land, Ughere and Urhuagbesa and the South-eastern site comprised of Ogbeje, Umeghe, Urhuoka and Okierhirhe. Housing units sampled were selected randomly after reading/explaining and accepting the details of the sampling procedures to the participating occupants. Also houses previously fumigated with insecticides were secluded out. The findings were communicated and oriented for the practicing of proper housekeeping and personal hygiene, all information obtained at each course of the study was kept confidential.



Source: Ozabor and Wodu (2016)
Fig. 1: Map of Abraka, the study area

Environmental conditions

The climate is equatorially hot 23-37°C and relatively humid of 55-70%. Abraka experiences heavy and torrential rainfall amount throughout the year. The annual rainfall amount of Abraka is 3,098 mm with mean monthly rainfall ranging from

25.8 mm in December to 628.9 mm in September. Abraka also experiences double rain maxima and August break. The biome is rainforest, which has been decimated and replaced with farmlands and secondary forest. However, lush, dense and swamp primary forest flanks the river banks (Efe and Aruegodore, 2003)

Sanitary conditions in some parts of Abraka are mostly underdeveloped with faecal disposal and hand dug wells for water supply very elementary, the majority of the population dwellings outside the vicinity of the campus still rely on pit latrines for faecal disposal. Nevertheless, the mishandling of refuse including the use of deformed, rusty, overflowed uncovered punctured bins and the untimely collection of refuse has also attributed to the increases of the proliferation of synanthropic insects such as mosquitoes, houseflies and cockroaches which have been implicated as possible disseminators of pathogenic organisms.

Sample collection

Cockroaches were collected both actively and passively from the different parts of the households, cockroaches were collected physically by hand picking, careful use of swat sticks and brooms Cockroaches were also collected by trapping using traps modified adopted from Jirage (2018) with slight modifications, these traps were placed in the bedrooms, dining, parlors, toilets, kitchens, and kitchen stores by 06:00 P.M and collected by 07:00 A.M the next morning. Alternatively, when it becomes difficult to get samples, spraying with insecticides to move them from their hiding places and those temporarily dosed by the pyrethroids were then hand-picked and placed in containers The collection which lasted for 9 months, encompassed both the wet season (July 2014-October 2014 and March 2010) and dry season (November 2014-February 2015).

Cockroach identification

Collections made were transported to the laboratory immediately. The sex, stage of development and species of cockroaches were identified using standard taxonomic entomological keys based on their morphological characteristics (Hathorne and Zungoli, 1999; Choate, 2000; Roth, 1999; Piper and Antonelli, 2012; Pratt *et al.*, 1967; Center for Disease Control (CDC) and Prevention, 2011).

Statistical analysis

Significant difference of the distribution of the cockroaches in both dry and wet season was determined using one-way ANOVA, at $P < 0.05$. The diversity was determined using the Shannon-Weiner diversity index and the evenness was determined using Shannon Weiner diversity (H) and evenness H/H_{max} . were used to determine species richness in the various locations.

Results and Discussion

This study inspected 556 housing units in Abraka town for the presence of cockroaches and a total of 7835 cockroaches were caught, an average of 14 cockroaches per housing unit.

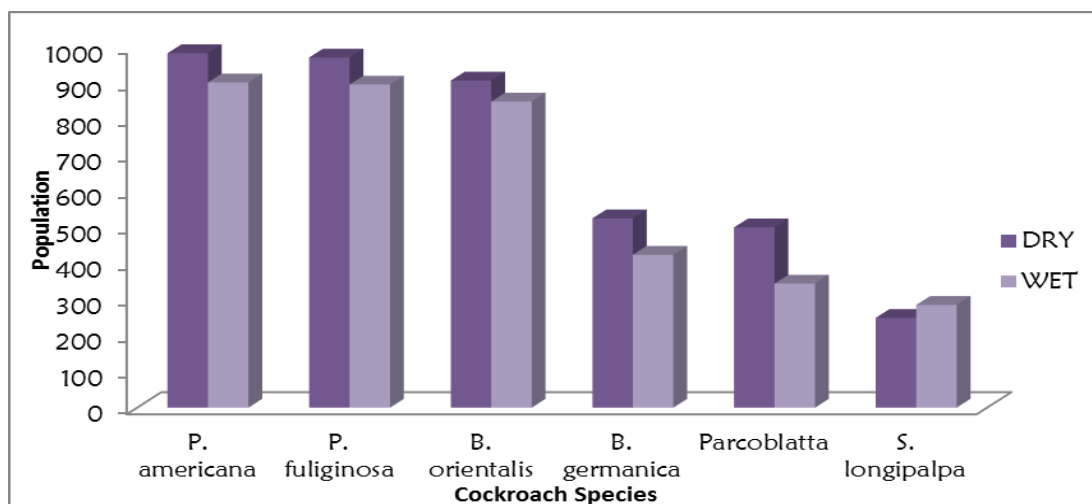


Fig. 2: The frequency of occurrence of both dry and wet season in Abraka town

The relationship between the wet and dry season distribution of cockroaches is shown in Fig. 2. Although same species of cockroaches were encountered, the occurring frequencies of the dry season were higher compared to that of the wet season. Species of cockroaches encountered during the dry season were same during the wet season; when compared statistically there was no significant difference ($P > 0.05$). However, *S. longipalpa* showed a higher occurring rate during the wet season than the dry season.

The six species of cockroaches obtained in this study are *P. Americana*, *P. fuliginosa*, *B. orientalis*, *B. germanica*, *Parcoblatta spp.* and *S. longipalpa*. There was no significant difference ($P > 0.05$) in the distribution of the different species of cockroaches; the percentage prevalence is represented as a pie chart in Fig. 3.

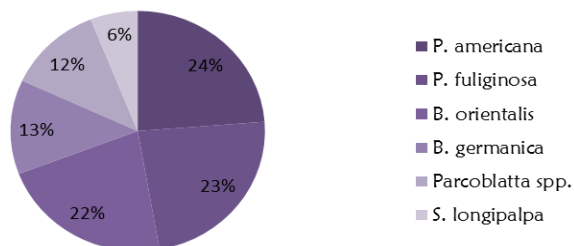


Fig. 3: Pie chart showing the percentage prevalence of the species of cockroaches obtained

There was high significant difference ($P < 0.05$) in the occurrence of cockroaches during the dry season in Abraka as shown in Table 1. Species of cockroaches encountered during the dry was same during the wet season; there was also high significant difference ($P < 0.05$) in the distribution of cockroaches in Abraka town with relation to sites as shown in Table 2.

Species of cockroaches encountered during the dry was same during the wet season; however there was no significant difference ($P > 0.05$) when both seasons (wet and dry) were analysed as shown in the figure below

The abundance, diversity and evenness of the distribution of cockroaches in the various sites in Abraka are shown in table 3. Although more cockroaches were found in the Central site, higher species diversity occurred in North-East site when compared to other locations. The species were evenly distributed as the abundance and index (H) increases.

Table 1: Frequency of occurrence of cockroaches in Abraka town during the dry season

Species	West-South (%)	Central (%)	North-East (%)	South-East (%)	Total (%)
<i>P. americana</i>	136(29)	503(51)	287(29)	57(6)	983
<i>P. fuliginosa</i>	141(15)	493(51)	266(27)	71(7)	971
<i>B. orientalis</i>	113(12)	437(48)	278(31)	79(9)	907
<i>B. germanica</i>	9(2)	364(369)	141(27)	11(4)	525
<i>Parcoblatta spp.</i>	121(24)	186(37)	115(23)	78(4)	500
<i>S. longipalpa</i>	84(34)	78(31)	79(23)	8(4)	249
Total	604(15)	2061(50)	1166(28)	304(7)	4135

Table 2: Frequency of occurrence of cockroaches in Abraka town during the wet season

Species	West-South (%)	Central (%)	North-East (%)	South-East (%)	Total
<i>P. americana</i>	111(12)	496(55)	243(27)	52(6)	902
<i>P. fuliginosa</i>	130(15)	443(49)	257(29)	66(7)	896
<i>B. orientalis</i>	95(11)	437(52)	246(29)	71(8)	849
<i>B. germanica</i>	9(2)	265(65)	143(34)	7(2)	424
<i>Parcoblatta spp.</i>	104(30)	96(28)	74(22)	70(20)	344
<i>S. longipalpa</i>	64(22)	137(48)	77(27)	7(3)	285
Total	513(14)	1874(51)	1040(28)	273(7)	3700

Table 3: Cockroach species abundance, diversity and evenness of the distribution in Abraka town

Site	Abundance (No. of individuals)	Shannon–Wiener diversity index (H)	Evenness (H/H _{max})
West-South	1117	1.647	0.8656
Central	3935	1.665	0.8806
North-East	2206	1.669	0.8840
South-East	577	1.558	0.7919

There are several suppositions that certain change in environmental conditions alters the distribution of insects such as population and distribution. However few studies are available on this field. Environmental temperature plays a vital role in determining the capability of various organisms' survival in a given habitat. When organisms are able to survive utmost temperature, it increases their chances to colonise that habitat. Heat Shock Proteins (HSP), are found in many organisms such as mammals and bacteria which allows cells to recover during extreme conditions at cellular level (Luttershmidt and Hutchison, 1997). Insects, such as termites,

have the ability to acclimate to their environmental temperature and are closely related to the cockroaches, so they should possess the tendency to acclimatize to their environment. Previous studies have shown a positive correlation between the temperature sensitivity of many animals including cockroaches and their environmental temperature (Tsuji and Mizumu, 1973; Hu and Appel, 2004; Slabber *et al.*, 2007).

This study investigated cockroach specie distribution almost all year round, though environmental temperature may affect the distribution of some outdoor species, cockroaches are highly adapted for diverse land environment.

The outcome of this study indicates that the seasonal changes do not influence the distribution and occurrence of cockroaches in the study area as there was no significant difference ($P > 0.05$) when the occurrence of cockroaches in the dry season and wet season were analysed. This could be as a result of the temperature, relative humidity and availability of food source. As previously reported by Efe and Aruegodore (2003), the climate conditions of the study area correlates with the climate conditions that are favourable for the development and growth of cockroaches' pest species as they generally like warm and moist environment with abundant of food all year round. Observations of the cockroaches' species diversity and distribution in Lahore (Hafsa *et al.*, 2017) and Alabama and Georgia (Snoddy, 2007), concludes that cockroaches were not noticeable within the cold months (January –March) with temperature range of 9 - 21°C and a relative humidity of 68% but the population increased in late May and reached their zenith within August-September. Their study did not positively coincide with ours as their study area Alabama, Georgia and Lahore do not share same environmental conditions (temperature, relative humidity and lush vegetation) with Abraka our study area.

As observed by Hahn and Ascerno (2005), the american cockroach, the most predominant cockroach encountered in this study, prefers warm and humid environments, usually with temperatures exceeding 27.8°C and it is occasionally found in homes, although more common in restaurants, grocery stores, bakeries and other sites where food is prepared. The smoky brown cockroaches also shares same ecological niche and temperature attributes as the american cockroach. According to Rust and Reiersen (2007), the oriental cockroach often called a water bug occurs in single-family dwellings that are surrounded by vegetation, and outside locations where people feed pets. It prefers temperatures less than 29°C and at night, it migrates into buildings in search of food. They also observed that, the brown banded cockroach prefers temperature that exceeds 26°C preferring to stay in warmer areas such as radios, televisions, microwaves and general electrical appliances. They further added that, the German cockroach favors warm, humid atmospheres, especially areas where temperatures are around 21 - 24°C. They are able to live and breed in the numerous cracks and crevices and hiding places present in most kitchens, bathrooms and living areas. *Parcoblatta spp.* are known to hibernate at temperatures less than 10°C and prefers temperature not exceeding 30°C.

Species of cockroach encountered in Abraka town seem to have a wide range. Worthy of note is that all housing unit sampled were all infested with pest species of cockroaches and these species were both observed in the wet and dry season. It is also important that there was similar occurrence frequency amongst the species in both seasons. *S. longipalpa* showed slight variations as it occurred more in the wet season than in the dry season. This may be due to the temperature preference of this species as it has been observed to be in doors staying in house hold electrical appliances as observed by Hahn and Ascerno (2005); Rust and Reiersen (2007).

Species observed in this study have been frequently observed in residential areas and buildings in both urban and rural areas worldwide. These species of cockroaches are known to reproduce faster and thrive in habitats with availability and abundance of diverse food materials, suitable refuge and lack of comprehensive control efforts. Species specific prevalence shows that out of a total number of 7,835 cockroaches caught *Periplaneta americana* (1885, 24%), *Periplaneta fuliginosa* (1867, 24%), *Blatta orientalis* (1756, 22%), *Blattella germanica* (949, 12%), *Parcoblatta spp.* ((844, 11%), *Supella longipalpa* (534, 7%).

However, findings of Bala and Sule (2012) in Arkilla, Sokoto State, documented 2 identified species, whereas, findings by Hanafi-Bojd *et al.* (2005) in Iran, revealed that out of 7251 cockroaches caught *Blattella germanica* was the most abundant comprising 96.73% of all cockroaches trapped and the other species identified in order of abundance were the Turkestan cockroach (*Blatta lateralis*) (2.21%), the american cockroach (0.98%), the brown-banded cockroach (*Supella longipalpa*) (0.07%), and the oriental cockroach (0.01%). Previous reports from Thailand by Chamavit *et al.* (2011), also corresponds with our results, from a total of 920 cockroaches collected from 6 open air shopping markets 897(97%) were identified to be *Periplaneta americana* and 253 (2.5%) were identified to be *Periplaneta brunnea*. Prior reports from Makurdi, Benue by Omudu and Akosu, 2013, showed that *Periplaneta americana* (50.6%) were more abundant than the other species (*Blatta germanica* (34.7%) and *Supella longipalpa* (14.7%). *P. americana* was also the most abundant species of cockroaches collected from different refuse dumps in Onitsha metropolis (Onyindo *et al.*, 2011) and within households in Abraka (Ojianwuna, 2014).

With respect to sites, there was significant difference ($P < 0.05$) in the occurrence of cockroaches across sites; results also showed that more samples of cockroaches were obtained from Central site communities. This may be a direct reflection of food remnants that may be available in the kitchen at homes belonging to these communities. This result corroborates with that of Oteng, 2003 who relates this to the ever present outdoor food vending sites in Botswana their study area. Several studies have linked adverse housing conditions in residential apartments to an increase in cockroach infestation (Omudu and Akosu, 2013; Gholam *et al.*, 2013)

With significant difference of cockroaches higher in the Central area where most of the houses sampled are hostels occupied by students of the Delta State University Abraka Campus correlates with that of (Adeleke *et al.*, 2012; Omudu and Eyumah, 2008; Omudu and Akosu, 2013; Onyindo *et al.*, 2011; Gholam *et al.*, 2013). In addition to poor sanitation and lack of proper maintenance, Nigerian Universities are known to be largely crowded. Also the students cook and eat in the room which substantially provides a wide range of food items, and increase the amount of waste generated and escalated the breeding of cockroaches in Central site.

Abraka North-East site consist of mixed communities, that is, it makes up some part of the rural setting and most part of the urban setting. Houses sampled in this site are habited by students and middle income earners. This site makes up part of the urban section of Abraka town (Efe and Aruegodore, 2003). The water supply in parts of the rural area is very poor and elementary and some still rely on hand dug wells for water. The rest rooms facilities are poorly managed and this has led to the proliferation of insects such as mosquitoes, houseflies as well as cockroaches in this area, hence the record of high prevalence. The student hostels toilet facilities are usually shard amongst occupants of the hostel which is not located within the occupant's room but outside, this as well as led to the propagation of cockroaches in this site. According

to our survey result this site had the highest diversity index and evenness this could be as this site had a mixture of both urban and rural setting.

The West-South and South-East site of Abraka share similar characteristics residents in this area are more or less low income earners they consist of subsistence farmers and petty traders and still rely on pit latrines that are detached from the main house. Low amount of cockroach recovered from this region in this study coincides with the low number of houses sampled and also could be the houses are far apart and not as congested and disorderly as houses of Abraka Central and North-East area. Also Hathorne and Zungoli (1999), surveyed residents opinions on the entrance source of cockroaches revealed that entrance through neighboring resident was largely chosen, which reflects why the infestation rate of cockroaches obtained was low.

Effective control is easily achieved in a temperate climate than in humid and warm areas. The key to control is cleanliness, which may be difficult in houses where there are children and domestic animals. In isolated homes, control is easier to achieve than in apartments where cockroaches may have easy access from adjacent quarters. Reinfestation occurs from outdoors in warm areas, or along heating ducts and water pipes in apartments, or from groceries or luggage brought from cockroach infested areas. IPM approach for the elimination of cockroaches in homes should rely on "change the situation that promotes cockroaches" which highlights the reduction of food and water sources which can be done by practicing proper housekeeping including sanitation measure, exclusion and removal of hiding places, the use of baits and insecticides to reduce the infestation level and monitor the population (Adeleke *et al.*, 2012; Yahaya and Clement, 2010). Cockroaches may even sometimes be found in very clean houses, but are unlikely to establish colonies. The severe health implications' arising from cockroaches' infestation justifies the need to provide hygiene education to the populace to be able to link cockroach infestation to health and diseases.

Conclusion

The most important outcome of this study is that it discovered and documented that seasonal factors do not affect the distribution of cockroaches in Abraka town, due to the equatorially hot climate, relative humidity, and heavy/torrential rainfall throughout the year these attributes plus other factors like the mishandling of refuse including deformed rusty, overflowed, uncovered punctured bins and the untimely collection of refuse and the fact that Abraka severely lacks good sanitary and drainage hygiene services, with many piles of fecal matter in nearby residential areas has led to the proliferation of cockroaches in the study area.

Hence, the control of cockroaches' infestation can be achieved efficiently by knowing the biology and behavior. The use of integrated pest management that incorporates cultural practices, good sanitation, and proper management of solid and liquid waste should be encouraged. Proper use of environmental sensitive insecticides by skilled workers should also be promoted. With the environmental and public health consideration and importance due to the risk of high infestation rate of cockroach especially in Abraka town, there is need to educate the populace of good sanitation procedures at home level which include general cleanliness, proper discarding of leftover food, timely washing of dishes and rinsing of cans or bottles before disposal and the use of cockroach-proof garbage bins and outside the home, control should include proper management of landfills, use of proper disposal facilities and proper sanitation. This study has proved that to effectively control the proliferation of cockroaches in Abraka town there is need for constant practices that includes

good sanitation, proper management of solid and liquid waste and the use of environmental sensitive insecticides.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

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