COCKROACH (INSECTA: BLATTARIA) INFESTATION OF HOMES IN SELECTED COMMUNITIES IN KUMASI, GHANA

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ABSTRACT

Outbreak of cockroaches in some communities in the Kumasi metropolis in recent times is believed to be on a steady increase. The study was therefore undertaken to determine cockroach infestation of homes in some ten selected communities in the Kumasi Metropolitan area in the Ashanti Region of Ghana using sticky traps. Twenty (20) houses in each community were randomly selected for the study. A trap was set up in three areas: living room, kitchen, and bedroom, for each house. Sampling was done over a period of four (4) months. Out of the two hundred (200) houses sampled, at least one cockroach species was captured in one hundred and sixty houses (80%). A total of 2,421 cockroaches were caught by 420 traps out of the 600 traps set. The kitchens recorded the highest number of 1,207 cockroaches (49.86%) whilst the bedrooms recorded the least, 400 cockroaches (16.52%). Three (3) different species of cockroaches were trapped in the ten selected communities during the study. These were Blattella germanica (L.), Periplaneta americana (L.) and Leucophaea (Rhyparobia) maderae (Fab.). According to the surveys of this study, B. germanica is the most abundant cockroach species in the Kumasi Metropolitan Area, with Santasi having the highest infestation of cockroaches (15.04%) and KNUST with the least (2.31%). The kitchens were the major habitats of these insects in the sampled communities.

INTRODUCTION

Cockroaches are among the most ancient winged insects, the earliest fossils dating back to about 400 million years (Grimaldi, 1997). They are considered one of the most successful groups of animals because they are very adaptable (Bell et al., 2007). One reason for this success may be related to their diet- they are scavengers and will eat almost anything organic (Jarratt, 1999; Pennapa et al., 2011). Cockroaches are more common in warm climates. As a group, they prefer moist, warm habitats (Pennapa et al., 2011) because they are basically tropical insects and will do their best to find a home that is both warm and moist (Tatfeng et al., 2005). They are mainly nocturnal in nature (Salehzadeh et al., 2007) and escape when exposed to light.

There are about 4,500 species of cockroaches in the world, of which 30 species are associated with human habitations (Pennapa et al., 2011).
About four species are well known as pests (Schal and Hamilton, 1990; Valles et al., 1999). Cockroaches are the most common insect pests infesting homes, food service establishments and other structures (Brenner et al., 1987). Many cockroach species have been described in several parts of the world. Of these, the German cockroach, *Blattella germanica* (L.), is the most troublesome because of its predominance in houses as well as places of food manufacturing (Kwon and Chon, 1991).

They feed on human and pet foods and in doing so leave offensive odour (Brenner et al., 1987). Cockroaches generally feed on a wide variety of materials including wastes of human beings, garbage (Brenner et al., 1987) and therefore cause a plethora of household problems like contaminating food and spreading germs (Rivault et al., 1993). Cockroaches travel through filthy environments and the hairs and spines on their bodies pick up disease causing organisms. They then passively transport microbes on their body surface (cuticle) including those that are potentially dangerous to humans particularly in environments such as hospitals (Rivault et al., 1993; Elgderi et al., 2006). They have been shown to be linked with allergic reactions in humans (Bernton and Brown, 1964; Kutrup, 2003).

Among the best known pest species are the American cockroach [*Periplaneta americana* (L.)] which is about 30 mm (1.2 ins) long, the German cockroach [*Blattella germanica* (L.)], about 15 mm (0.59 in) long, the Asian cockroach (*Blattella asahinai* Mizukubo), also about 15 mm (0.59 in) in length and the Oriental cockroach (*Blatta orientalis* L.) about 25 mm long (0.98 in) (Bell et al., 2007).

Outbreak of cockroaches in some communities in the Kumasi metropolis in recent times is believed to be on a steady increase. Consequently, Akoto (2001) reported of cockroaches invading the sleeping quarters of 25 Junior Doctors at the Doctor’s flat, Komfo Anokye Teaching Hospital (KATH) in Kumasi. However, empirical data to support this assertion on cockroach abundance in the metropolis is scanty. Thus, the supposed exponential rise in numbers coupled with the difficulty in identifying the different species of cockroaches necessitated the study.

The study was therefore undertaken to determine cockroach infestation of homes in some selected communities in the Kumasi Metropolitan area of the Ashanti Region of Ghana. The study investigated Cockroach abundance and species diversity in the selected communities, abundance in different areas of a household (bedroom, kitchen and sitting room), as well as methods of cockroach control in the localities.

**MATERIALS AND METHODS**

**Study Area**

Kumasi is a city in the south-central part of Ghana. It is located between latitudes 6°36’N and 6°45’N and longitudes 1°37’W and 1°40’W. It is situated in the moist semi-deciduous forest zone of Ghana with an average temperature range of 21-33°C across the year and an annual rainfall of 1400 mm (www.kma.ghanadistricts.gov.gh). Ten (10) communities: Atafua, Ohwimase, Santasi, Bantama, Manhyia, Asafo, Kentikrono, Kwame Nkrumah University of Science and Technology (KNUST), Atonsu and Old Tafo (Fig. 1), were selected at random for the study.

A six sided hard cardboard box 15 cm x 10 cm x 3 cm was constructed and used as trap. White glue was used to join the edges together and black cellophane tape was used to seal the edges. A rectangular slit of dimension 1 cm x 5 cm was made on all the sides except the base. The inside surface was covered with a very sticky adhesive (Atraprat). Food bait of groundnut paste mixed with fried fish powder was placed in the centre of the sticky adhesive to lure cockroaches into the box. The traps were positioned to attract cockroaches as they moved to and from their hiding places and feeding areas.

Twenty (20) houses from each community were sampled for cockroaches. Three (3) traps were set in each of the sampled houses. One trap was placed in each sitting room, bedroom and
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kitchen of each household. These were known places in homes where cockroaches found food and hiding places. Sampling was carried out for a period of four (4) months. The traps were inspected every morning and trapped cockroaches were collected and identified using morphology as well as standard taxonomic keys (Choate et al., 2006; Pratt, 1988) supported by coloured pictures of some common species of cockroaches.

A questionnaire was administered together with coloured pictures of the common species of cockroaches to a representative from each of the sampled houses. Questions posed in the questionnaires administered included: Do you usually see cockroaches in your house? In which part of your house do you see them? Are they a nuisance? If yes, how? How many kinds of cockroaches have you identified in your house? Have you seen any cockroach apart from the ones in the picture? How do you control the cockroaches?

Species diversity and species evenness

Species diversity and evenness were determined using the Shannon’s diversity index (Magurran, 1988).

SHANNON’S INDEX OF DIVERSITY

Shannon’s index of diversity,

\[ H' = -\sum_{i=1}^{S} p_i \ln p_i \]

where \( S \) is the number of species, \( p_i \) the relative abundance of each species was calculated as the proportion of individuals in...
the community: \( \frac{n_i}{N} \)

- \( n_i \): the number of individuals species \( i \)
- \( N \): the total number of individuals

### Species evenness index

The species evenness index (E) was calculated using the formula

\[
E = \frac{H'}{H_{\text{max}}}
\]

where \( H_{\text{max}} \) is the maximum possible value of \( H \), and is equivalent to \( \ln S \). Thus \( E = H'/\ln S \)

Statistical Analysis

The Kruskal-Wallis one-way Analysis of Variance (ANOVA) was conducted to compare cockroach abundance between the communities, the different areas in the household and between the species. This type of ANOVA was used because the data was not normally distributed. It was conducted with the GenStat Software at a significance level of 5%. Subsequently, the Least Significant Different test (LSD) and Standard Error Bars were used to ascertain differences between means at \( \alpha = 0.05 \).

### RESULTS AND DISCUSSION

#### The number of positive traps

Out of the 600 traps used in the study, 420 (70\%) trapped cockroaches. These traps caught a total of 2,421 cockroaches.

#### Cockroach species

Three cockroach species were identified in the study (Table 1). These were *Blattella germanica* (L.), *Periplaneta americana* (L.) and *Leucophaea (Rhyparobia) maderae* Fabr. which belong to different genera. Cockroach abundance differed significantly among the species (\( P < 0.001 \)). *L. maderae* was the least abundant, accounting for 0.41\% of all species identified, although it was found in seven of the ten communities investigated (Table 1). The significant difference in cockroach abundance between the species may be attributed to the differential reproductive abilities of the species. According to Gordon (1996), the German cockroach has a rapid reproduction and its populations build quickly. It has been stated by Piper and Antonelli (1997) that the German cockroach produces more eggs and has more generations per year (three to four) than other cockroaches. A female may produce four to eight egg cases during her lifetime, each containing 30–48 eggs. *Blattella germanica* was the most abundant species in all the communities.

This finding agrees with that of Tachbele et al. (2006) who found in an Ethiopian study that *B. germanica* was the most abundantly distributed cockroach species. Out of the 1929 *B. germanica* that were caught, Santasi recorded the largest number (305) whilst KNUST recorded the least number (46) (Fig. 2). Thus, the following order indicates the level of abundance from lowest to highest for *B. germanica* trapped in the communities: KNUST < Kentinkrono < Ohwimase < Atonsu < Asafo < Old Tafo < Bantama < Atafua < Manhyia < Santasi (Table 1). *P. americana* was the second most abundant cockroach species trapped in each community. Asafo recorded the largest number (86) whilst KNUST recorded the least number (46) (Fig. 2). For *L. maderae* it was identified that the largest number trapped was 2 each at Atafua, Asafo and Atonsu, whiles Santasi, Kentinkrono and KNUST communities did not record this species (Table 1). The low numbers of *L. maderae* recorded may be due to its low fecundity, which determines the number of eggs laid, and, consequently, the number of offspring produced. The life span of *L. maderae* from egg to adult is about two and half years and the number of nymphs produced at one time ranges from 25 to 32 (Anon, 1953).
Table 1: Abundance of Cockroaches caught in the studied communities

<table>
<thead>
<tr>
<th>Community</th>
<th>B. germanica</th>
<th>P. Americana</th>
<th>L. maderae</th>
<th>Total cockroach Abundance &amp; (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Abundance (%)</td>
<td>Mean Abundance (%)</td>
<td>Mean Abundance (%)</td>
<td></td>
</tr>
<tr>
<td>Santasi</td>
<td>15.25 15.81 2.95 12.24 0.00</td>
<td>0</td>
<td>364(15.04)</td>
<td></td>
</tr>
<tr>
<td>Atafua</td>
<td>14.00 14.52 3.70 15.35 0.10</td>
<td>20</td>
<td>356(14.7)</td>
<td></td>
</tr>
<tr>
<td>Manhyia</td>
<td>14.25 14.77 1.20 4.98 0.05</td>
<td>10</td>
<td>310(12.81)</td>
<td></td>
</tr>
<tr>
<td>Asafo</td>
<td>10.40 10.78 4.30 17.84 0.10</td>
<td>20</td>
<td>296(12.23)</td>
<td></td>
</tr>
<tr>
<td>Old Tafo</td>
<td>10.50 10.89 2.85 11.83 0.05</td>
<td>10</td>
<td>268(11.07)</td>
<td></td>
</tr>
<tr>
<td>Bantama</td>
<td>11.95 12.39 1.30 5.39 0.05</td>
<td>10</td>
<td>266(10.99)</td>
<td></td>
</tr>
<tr>
<td>Obwimasi</td>
<td>6.10  6.32  3.80 15.77 0.05</td>
<td>10</td>
<td>199(8.22)</td>
<td></td>
</tr>
<tr>
<td>Atonsu</td>
<td>6.20  6.43  1.60 6.64 0.10</td>
<td>20</td>
<td>158(6.53)</td>
<td></td>
</tr>
<tr>
<td>Kentinkrono</td>
<td>5.50  5.70  1.90 7.88 0.00</td>
<td>0</td>
<td>148(6.11)</td>
<td></td>
</tr>
<tr>
<td>KNUST</td>
<td>2.30  2.39  0.50 2.08 0.00</td>
<td>0</td>
<td>56(2.31)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>96.44(79.68%)</td>
<td>24.10(19.91%)</td>
<td>0.50(0.41%)</td>
<td>2421(100)</td>
</tr>
</tbody>
</table>

Fig. 2: Abundance of different species of Cockroaches trapped in each community
Relative abundance of Cockroaches in the study communities (Degree of infestation)

Generally, cockroaches were abundant in the communities. This substantiates the finding of Abdel-Gahny et al. (2008) that cockroaches are abundant in houses. Out of the 2,421 cockroaches trapped, Santasi recorded the largest number of 364 (15%) whereas KNUST recorded the least number of 56 (2.3%) (Table 1). However, cockroach abundance did not differ significantly within the various communities (P = 0.676) although there was significant differences in cockroach abundance among the species (p < 0.001).

Number of infested homes

Out of the two hundred (200) houses sampled for cockroaches in the ten selected study communities, 160 houses (80%) yielded positive results for at least one cockroach species. Santasi recorded the largest number of infested households (19) (95%) whilst Kentinkrono recorded the least number of infested households (13) (65%) (Table 2). There was no significant difference in the percentage number of houses infested in each community (P =0.401).

The results indicated that Santasi had the largest number of trapped cockroaches. This was because the area was still a developing one and due to the large number of uncompleted houses with piles of wood for constructional purposes and piles of garbage might have provided adequate food as well as suitable habitat for hiding and breeding of the cockroaches. The results of the study conform to that of Hagenbuch et al. (1988) in Florida. Poor individual housing as well as no or low levels of sanitation or application of cockroach control methods might have also accounted for the differences in numbers. KNUST recorded the least number of cockroaches caught indicating that residents probably practiced high levels of individual housing sanitation as well as cockroach control methods.

Species abundance of cockroaches in kitchen, bedroom and sitting room

The total number of cockroaches trapped in the kitchen (1207) was more than those trapped in the bedrooms (400) and sitting rooms (814) for all the communities (Table 3). B. germanica was found to be the most abundant cockroach species in each of the sampled community; kitchens (80.12%), bedrooms (76.75%) and sitting rooms (80.47%) (Fig. 3). L. maderae was found in kitchens and sitting rooms (0.58% and 0.37%, respectively) and none was found in the bedroom. L. maderae was trapped in the kitchens of Atafua, Ohwimase, Bantama, Asafo, Atonsu and Old Tafo whilst Manhyia, Asafo and Atonsu recorded L. maderae in the sitting rooms. Standard error bars (Fig. 3) indicated that differences exist among the different species for all the different areas trapped, at α = 0.05.

Table 2: Percentage of Houses Infested with Cockroaches in the community

<table>
<thead>
<tr>
<th>Community</th>
<th>Number of Households Infested</th>
<th>Percentage of Households Infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atafua</td>
<td>17</td>
<td>85</td>
</tr>
<tr>
<td>Ohwimase</td>
<td>17</td>
<td>85</td>
</tr>
<tr>
<td>Santasi</td>
<td>19</td>
<td>95</td>
</tr>
<tr>
<td>Bantama</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>Manhyia</td>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td>Asafo</td>
<td>18</td>
<td>90</td>
</tr>
<tr>
<td>Kentikrono</td>
<td>13</td>
<td>65</td>
</tr>
<tr>
<td>KNUST</td>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td>Atonsu</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>Old Tafo</td>
<td>14</td>
<td>70</td>
</tr>
</tbody>
</table>

Out of the three species trapped, both *B. germanica* and *P. americana* were found in kitchens. Majority of the trapped cockroaches were *B. germanica* and they were mostly found in the kitchen where food was easily available (Table 3). The large numbers of *B. germanica* could also be due to their high reproductive capacity as well as their small size that enabled them to hide in very tiny crevices. This finding correlates with that of Lee (1995) who reported that the German cockroach (*B. germanica*) accounted for 100% of all cockroach infestations in the kitchens of most general hospitals in the Republic of Korea. The low number of *P. americana* might be due to their relatively large size, resulting in increased exposure to physical eradication or risk of being easily spotted by predators.
Species diversity
The diversity of cockroaches in the ten communities ranged from 0.29 at Manhyia to 0.69 at Ohwimase (Table 4). Ohwimase recorded the highest species evenness of 0.76 whereas Santasi recorded the least of 0.31 (Table 4). Atafua, Ohwimase, Bantama, Manhyia, Asafo, Atonsu and Old Tafo had the same species richness of 3.0 whilst Santasi, Kentikrono and KNUST recorded species richness of 2.0 (Table 4).

The higher the Shannon Index of Diversity (H) for a particular community, the more diverse that community is and the better the species interaction. Ohwimase recorded a species diversity index of 0.69 indicating that it was more diverse in species than any of the other communities. This meant that the species were more stable and were better able to compete with each other for food and space than the other communities. Manhyia recorded the least species diversity index of 0.29 indicating that species found there interacted less with each other in terms of competition for food and space. Ohwimase again recorded the highest species evenness of 0.76 indicating that the species there were more uniformly distributed than the other communities. Santasi recorded the lowest species evenness value of 0.31 indicating that the species there were not uniformly distributed. Though Atafua, Ohwimase, Bantama, Manhyia, Asafo, Atonsu and Old Tafo all recorded a species richness value of 3; they recorded different values for species diversity and species evenness respectively. The same species richness values were recorded for Santasi, Kentikrono and KNUST. This was due to the distribution and relative abundance of species in each community. It should also be noted that even though a larger number of *B. germanica* seems to be the most abundant cockroach in house infestation, a large population of *P. americana* were easily seen, mostly outdoors, scurrying around the drainage system.

Response to Questionnaire
All 200 respondents (100%) confirmed seeing cockroaches in their houses. The German and American cockroaches were mostly seen around the kitchens, bedrooms and sitting rooms. One hundred and thirty-one (65.5%) of the respondents agreed that cockroaches were found in their homes because it was a conducive environment for them whilst 69 (34.5%) had no idea why there were cockroaches in their houses. Ninety-seven (97), representing 48.5%, thought that cockroaches entered their houses through openings (doors, windows, cracks etc), 51 (25.5%) reported that cockroaches entered with baggage brought from their friends houses whilst 52 (26.0%) had no idea how cockroaches entered their houses. Using the pictures of the different species of cockroaches, the results proved that 84 (42.0%) of the respondents had seen a German cockroach, 44 (22.0%) had seen an American cock-

### Table 4: Cockroach species diversity, evenness and richness of sampled communities

<table>
<thead>
<tr>
<th>Community</th>
<th>Shannon diversity index</th>
<th>Shannon species evenness</th>
<th>Species richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohwimase</td>
<td>0.69</td>
<td>0.76</td>
<td>3</td>
</tr>
<tr>
<td>Asafo</td>
<td>0.64</td>
<td>0.44</td>
<td>3</td>
</tr>
<tr>
<td>Kentikrono</td>
<td>0.57</td>
<td>0.4</td>
<td>2</td>
</tr>
<tr>
<td>Atonsu</td>
<td>0.57</td>
<td>0.62</td>
<td>3</td>
</tr>
<tr>
<td>Atafua</td>
<td>0.54</td>
<td>0.59</td>
<td>3</td>
</tr>
<tr>
<td>Old Tafo</td>
<td>0.54</td>
<td>0.59</td>
<td>3</td>
</tr>
<tr>
<td>KNUST</td>
<td>0.47</td>
<td>0.52</td>
<td>2</td>
</tr>
<tr>
<td>Santasi</td>
<td>0.44</td>
<td>0.31</td>
<td>2</td>
</tr>
<tr>
<td>Bantama</td>
<td>0.35</td>
<td>0.38</td>
<td>3</td>
</tr>
<tr>
<td>Manhyia</td>
<td>0.29</td>
<td>0.32</td>
<td>3</td>
</tr>
</tbody>
</table>
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Roach, 12 (6.0%) had seen *L. maderae*, 10 (5.0%) had seen both American cockroach and *L. maderae*, 33 (16.5) had seen both German cockroach and American cockroach, 7 (3.5%) had seen both German cockroach and *L. maderae* and 10 (5.0%) had seen all the three species, German cockroach, American cockroach and *Leucophaea maderae*.

**Methods of Controlling Cockroaches**

The assessment revealed that 77 (38.5%) of the respondents controlled cockroaches by spraying them with insecticides whilst a significantly low percentage (Standard error bars - 5%), 14 (7.0%), used camphor (Figure 4). All the control measures of the respondents using various control measures were found to be significantly different (*P* < 0.05).

Despite a high percentage of the respondents using insecticides or one form of controlling cockroaches, each household still recorded the presence of cockroaches. The continuous occurrence of cockroaches in the communities therefore, might be due to misuse of the insecticides or the various control methods. The insecticides might have not penetrated far enough into the hiding places of the cockroaches to kill them. The presence of cockroaches could also be due the development of resistance by these insects as a result of using one chemical for a long time.

Fifty six of the respondents (28.0%) confirmed that they knew cockroaches spread diseases, 45 (22.5%) reported that they knew cockroaches destroy household items, 26 (13.0%) reported that they knew cockroaches contaminated food, 42 (21.0%) reported that they had no knowledge about cockroaches and 31 (15.5%) reported that they knew cockroaches spread diseases and contaminate food. These diverse ideas of the inhabitants of the study area gave some leeway for the development of the insect. This is because most of the inhabitants appeared not to be aware of the danger posed by the presence of the cockroaches in their homes and or had little knowledge about their control.

**CONCLUSION**

The study has revealed that cockroaches abound in the Kumasi Metropolis as all the study sites recorded at least one of the three (3) different species of cockroaches found in the Metropolis. *Blattella germanica* is the most abundant cockroach species in the Metropolis with Santasi having the highest infestation of cockroaches (15.04%) and KNUST with the least (2.31%). The kitchens were the major habitats of the cockroaches.

![Fig. 4: Cockroach control methods used by respondents](image-url)
REFERENCES


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