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RESEARCH ARTICLE OPEN ACCESS

# Distribution and prevalence of Periplaneta Americana in urban households of Ramadi, Iraq

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**Abstract**
**Objective:** Cockroaches (order Blattodea) comprise over 4,000 species worldwide, of which approximately 20 to 30 are recognised as significant domestic pests. In the Arab region, cockroaches are among the oldest known insects, exhibiting remarkable resilience and adaptability. Certain species demonstrate synchronised life cycles and are widely distributed, maintaining close biological associations with humans, animals, and food sources.
**Methods:** Between November 2024 and April 2025, cockroach specimens were systematically collected from household kitchens across 32 municipal districts in Ramadi, western Iraq. A total of 1,150 specimens were obtained and identified to the species level. Each specimen was also categorised by life stage (nymph or adult). Statistical analyses were conducted to evaluate differences in species distribution across the study areas.
**Results:** Periplaneta americana was the most prevalent species, accounting for 68.01% of the total specimens, followed by Blatta orientalis (19.22%) and Blattella germanica (12.77%). In all three species, nymphs constituted the majority: 62.87% in P. americana, 61.54% in B. orientalis, and 60.65% in B. germanica. The differences in species distribution were statistically highly significant ($P \leq 0.01$).
**Conclusion:** This study examines the spread of Periplaneta americana in Ramadi and the environmental factors driving its presence. Its dominance and high nymph count indicate ideal conditions for reproduction. Effective control, via integrated pest management, can reduce disease transmission, allergies, and improve sanitation and public health by minimising infestation-related risks.

**Keywords**: Distribution, Periplaneta Americana, Ramadi City

## Plain English Summary

This study explored where and how commonly American cockroaches (Periplaneta americana) are found in homes across Ramadi, Iraq. Researchers collected over 1,100 cockroaches from kitchens in 32 neighbourhoods and found that P. americana made up about 68% of all samples, much more than other species. Most of the cockroaches were in the nymph stage, showing that they were actively reproducing. The study also looked at kitchen and home cleanliness. Homes and kitchens that were dirty or had open drains had higher cockroach infestations. Clean homes and well-sealed kitchens had fewer cockroaches. These findings suggest that sanitation and structural design play a big role in controlling infestations. The authors recommend improving hygiene and infrastructure, like sealing drains and fixing moisture problems, to reduce cockroach-related health risks in urban areas.

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## Introduction

The American cockroach (Periplaneta americana) is one of the largest and most common species of cockroaches found in urban environments worldwide. Originally native to Africa, it has since spread globally, particularly thriving in warm, humid climates. This species is highly resilient and well-adapted to human environments, frequently inhabiting sewers, basements, kitchens, and other moist areas with access to food and shelter. P. americana is considered a significant public health pest due to its potential to mechanically transmit pathogens, contaminate food, and trigger allergic reactions in sensitive individuals (1).

Widespread all over the world, especially in tropical and subtropical regions, this cockroach is an invasive species that migrates easily through cargo shipments, adapting to complex urban environments. It lives in residential buildings, warehouses, food establishments, and health facilities. Its abundance is due to its ability to reproduce rapidly and its tolerance to diverse environmental conditions, which makes it difficult to control (2).

This semi-metabolic insect has three life stages: egg, nymph, and adult. In adulthood, females can produce fertile offspring whether mated or not, and all fertile offspring are diploid. The difference is that the offspring of pupae are all females, while almost half of the offspring of mated females are male. The American cockroach lays from 12 to 16 eggs at a time. Mature eggs are expelled sequentially and individually encapsulated with secretions produced by the apical glands, forming an egg sac. The developmental threshold temperature of the eggs is 15.8 °C, reaching an effective cumulative temperature of 415.8 ± 38.5 °C, the day before hatching.

Newly hatched first-phase nymphs must undergo 6-14 moults before they turn into adult insects. It has been observed that the American cockroach has 9-14 nymph stages when it is bred alone at room temperature. This intra-species variation in neoplastic numbers is a common phenomenon in semi-metabolic insects and is influenced by environmental and genetic factors (3). This study aimed to assess the spatial distribution, population density, and life-stage structure of domestic cockroach species, particularly Periplaneta americana, across all 32 municipal districts of Ramadi, Iraq, and to evaluate the influence of environmental and housing sanitation factors on infestation levels.

## Materials and Methods

*Study Area*

Research was conducted across all 32 municipal districts of Ramadi, western Iraq, using the most recent municipal boundary map to ensure full spatial coverage of the study area.

*Study Design and Period*

A cross-sectional field survey was implemented between November 2024 and April 2025 to investigate the spatial distribution, population density, and environmental correlates of the American cockroach (Periplaneta americana).

*Sampling Strategy*

Within each district, residential buildings were stratified by age category, modern, medium, and old, and kitchen areas were systematically sampled in randomly selected homes. This approach yielded a total of 1,150 specimens, encompassing both nymph and adult stages.

*Data Collection*

For each collection point, a standardised data-entry form captured GPS-referenced location, housing characteristics (construction materials, age), and immediate environmental conditions (sanitation level, moisture). A parallel household questionnaire recorded practices related to waste disposal, food storage, and other factors potentially influencing infestation.

*Statistical Analysis*

All data were coded and analysed using SPSS version 25.0 (4). Descriptive statistics summarised infestation density by district and housing type. Chi-square ($\chi^2$) tests were applied to compare infestation rates across categorical variables, with statistical significance defined at $\alpha = 0.05$.

## Results

Analysis of cockroach species distribution in Ramadi city

Figure 1 shows that the American cockroach (*Periplaneta americana*) is the most widespread, with 68.01% of the total cockroaches collected, followed by the Oriental cockroach (Blatta orientalis) with 19.22%, and finally the German cockroach (Blattella germanica) with 12.77%. This indicates that the environment in Ramadi city is more suitable for the reproduction of the American cockroach than other species.

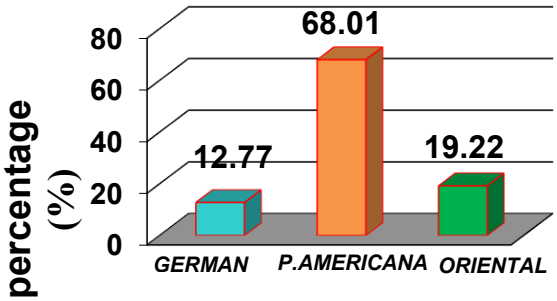


**Figure 1: Distribution of Cockroaches**

Table 1 shows the distribution of life stages (nymphs and adults) for each species. The German cockroach represents 60.65% of its individuals in the nymphal stage (39.35%) in the adult stage. The American cockroach represents 62.87% of its individuals in the nymphal stage (37.13%) in the adult stage. The Oriental cockroach represents 61.54% of its individuals in the nymphal stage (38.46%) in the adult stage. This indicates that most of the cockroaches in the study were in the nymphal stage, indicating that environmental conditions were favourable for ongoing reproduction. When analysing statistical significance (P-value), all P-values were less than 0.01 ($P \leq 0.01$), meaning that the differences in distribution between the different species are highly statistically significant. Therefore, the differences are not random, but rather reflect a clear trend in the distribution of cockroaches.

**Table 1. Population density of cockroach insects by type of cockroach**

| Types of Cockroaches | Total Number | Complete Number (%) | Nymph Numbers | p-value |
|---|---|---|---|---|
| German | 216 (12.77%) | 85 (39.95%) | 121 (60.65%) | 0.0017 |
| American | 1150 (68.01%) | 427 (37.13%) | 723 (62.87%) | 0.0001 |
| Oriental | 325 (19.22%) | 125 (38.46%) | 200 (61.54%) | 0.0001 |
| Total | 1691 | 637 (%) | 1054 (%) | 0.001 |
| p-value | 0.0001 | - | - | - |

** (P≤0.01): High significance

*Distribution of Samples by Kitchen Nature*

Table 2 shows the distribution of 96 samples studied based on the nature of the kitchen. They were classified into three categories: kitchens with tight drains: Twenty-three samples (23.96%); unclean kitchens- 43 samples (44.79%); and regular kitchens- 30 samples (31.25%). The statistical significance (P-value) is a P-value = 0.0385, which is less than 0.05, indicating that the difference between the different categories is statistically significant ($P \leq 0.05$). This means that there is a clear effect of the nature of the kitchen on cockroach prevalence, rather than just random variation. The interpretation of this table is that the prevalence of cockroaches is higher in unclean kitchens (44.79%), which provide an ideal environment for cockroaches due to the availability of food and water, which increases their reproduction and survival rate. It indicates that poor hygiene is one of the main factors leading to the spread of cockroaches in residential environments, and regular kitchens come in second place (31.25%). Although this category may be cleaner than the previous one, the presence of damp places and exposed food sources may lead to a moderate spread of cockroaches. The lowest spread rate is in kitchens with tight drains (23.96%). This result confirms the importance of good engineering design for kitchens, as tight drains prevent cockroaches from entering through sewage pipes, which are one of the main entrances for cockroaches into homes.

**Table 2. Number and percentage of samples studied by kitchen nature**

| Nature of the kitchen | Number | Percentage (%) |
|---|---|---|
| Sewer Hermetic | 23 | 23.96 |
| Not clean | 43 | 44.79 |
| Regular | 30 | 31.25 |

| | | |
|---|---|---|
| Total | 96 | 100 |
| P-value | | 0.0385* |

*Distribution of Samples According to Housing Cleanliness*

Ninety-six samples were classified according to the level of housing cleanliness into three categories: (27) very clean housing samples (28.12%), (41) unclean housing samples (42.71%), and (28) moderately clean housing samples (29.17%). The results indicate that the highest percentage of cockroaches was found in unclean housing, while the lowest percentage was found in very clean housing. Statistical Significance Analysis (P-value) The P-value = 0.0494, which is less than 0.05, indicates that the relationship between cockroach prevalence and housing cleanliness is statistically significant ($P \leq 0.05$). This means that the differences between the different categories are not random, but rather reflect a real relationship between the level of cleanliness and cockroach prevalence. From this, we conclude that the prevalence of cockroaches is higher in unclean housing (42.71%). Providing suitable conditions for cockroach breeding, such as food scraps, moisture, and hiding places, these results confirm that poor hygiene is one of the main factors that increase the likelihood of cockroach infestations in homes. Housing with moderate cleanliness ranked second (29.17%). Although these housings are not completely dirty, some environmental factors, such as the presence of damp areas or infrequent garbage disposal, may contribute to the spread of cockroaches. The lowest rate of cockroach infestation was found in very clean housing (28.12%). Very clean housing provides an unsuitable environment for cockroach breeding, as food is stored tightly, garbage is disposed of regularly, and ventilation is good, which reduces humidity.

**Table 3. Distribution of 96 Residential Dwellings by Cleanliness Category**

| Cleanliness of Dwelling | Houses (n) | Percentage (%) |
|---|---|---|
| Very clean | 27 | 28.1 |
| Moderate | 28 | 29.2 |
| Unclean | 41 | 42.7 |
| Total | 96 | 100.0 |

$\chi^2$ test; $P = 0.0494$ (significant at $P \leq 0.05$)

**Discussion**

The American cockroach prefers humid, warm environments, making it more prevalent in areas with adequate infrastructure, such as sewers and abandoned buildings. The Oriental cockroach is better adapted to dark, humid places but is less prevalent than the American cockroach due to its slower reproduction. The German cockroach is often found indoors, such as in restaurants and homes, which explains its lower prevalence compared to other species. We conclude that the American cockroach is the most prevalent in Ramadi due to its high adaptability to open and semi-enclosed environments. All recorded species showed a higher proportion of nymphs compared to adults, indicating high reproductive activity in the area. The results are strongly statistically significant, confirming these differences and can be used in studies of pest control in urban environments.

Cockroaches are one of the insects that are vectors for disease transmission. They are widespread worldwide and are one of the most common pests in homes and food storage areas. This research was conducted using a systematic review method that aimed to examine the literature describing the factors affecting cockroach density. From the results of several studies, it was found that the factors affecting cockroach density are temperature, humidity, environmental sewage pipes, and vector control efforts, whether in residential areas or storage warehouses. Temperature has a positive relationship with cockroach density. The higher the temperature, the higher the cockroach density. Humidity has a negative relationship with cockroach density. The wetter the area, the more cockroaches are present. Environmental sanitation, including environmental cleanliness, food storage areas, keeping food scraps/organic materials away from the ground, and basements/subterranean areas dry, should be maintained, and cockroach access to food areas should be minimised. Cockroach control efforts can be implemented through environmental management and chemical control (5).

Environmental and hygienic factors emerged as critical determinants of infestation intensity. Unclean kitchens exhibited the highest cockroach densities, owing to abundant food residues, moisture, and shelter sites that facilitate both

survival and reproduction. “Regular” kitchens, though cleaner, still maintained moderate infestation levels, suggesting that even intermittent dampness and accessible food can sustain populations. Kitchens with sealed, sewer-controlled plumbing recorded the lowest infestation rates, underscoring the value of sound engineering design in blocking primary ingress routes. Housing-level sanitation likewise influenced cockroach burdens. Although overall infestation rates did not correlate strictly with hygiene rating, dwellings exhibiting structural decay, peeling paint, and water damage showed higher infestation, pointing to the role of habitat suitability beyond simple cleanliness metrics. These observations align with broader evidence that urbanisation and human-modified environments create refugia for cockroaches, decoupling their persistence from external climatic constraints (6).

The role of the environment and sewage systems in cockroach populations is crucial, as these factors significantly influence their populations and associated health risks. Research indicates that urbanisation creates favourable conditions for cockroach survival, allowing them to thrive in human-modified habitats. This overview will explore the environmental impacts, health implications, and importance of sanitation in cockroach population management. Environmental Impacts: Urbanisation provides microhabitats that support cockroach populations, regardless of climatic conditions, and they are often found in densely populated urban areas, suggesting a direct relationship between human habitation and the spread of this pest. (7)

Recent molecular investigations have identified nearly 400,000 genetic markers in P. americana, of which 20 highly polymorphic loci, harbouring 7–35 alleles each, offer powerful tools to dissect population structure and dispersal dynamics (8). Integrating such genetic insights with spatial-ecological data could refine our understanding of local demographic processes and optimise targeted control measures. Research has shown that of the 96 residential homes sampled, the American cockroach accounted for 88.5% of the 3,289 crickets caught, highlighting its urban prevalence. The cleanliness of these homes was rated on a scale from bad to good, yet no significant association was found between sanitation levels and the number of cockroaches that were caught (9).

## Conclusion

Periplaneta americana is the most abundant cockroach in Ramadi, with ongoing reproduction evident across all species. Infestation levels rise in poorly maintained or structurally degraded homes and fall where sewer inlets are sealed. Improving sanitation and infrastructure, alongside targeted control measures, should help curb urban cockroach populations.

## List of Abbreviations

| | |
|---|---|
| P. americana: | Periplaneta americana (American cockroach) |
| B. germanica: | Blattella germanica (German cockroach) |
| B. orientalis: | Blatta orientalis (Oriental cockroach) |
| GPS: | Global Positioning System |
| SPSS: | Statistical Package for the Social Sciences |
| $\chi^2$: | Chi-Square (statistical test) |
| IPM: | Integrated Pest Management |
| °C: | Degrees Celsius |
| mm: | Millimetres |
| n: | Sample Size (number of subjects/homes/specimens) |
| %: | Percentage |
| DNA: | Deoxyribonucleic Acid |

## Declarations

*Ethics approval and consent to participate*

All procedures related to field collection and data gathering were conducted per ethical research standards and were approved by the Scientific and Ethical Committee of the College of Education for Pure Sciences, University of Anbar (237, 2024/12/25). No interventions involving vertebrate animals or human participants were performed in this study. Permission was obtained from household owners before sample collection, and confidentiality of household information was strictly maintained throughout the research.

*Consent for Publication*



*Availability of Data*

Data for this work is available from the authors and may be provided upon reasonable request.

*Conflicts of Interest*

None.

*Funding*

None.

*Authors’ contributions*

RRA: Conceptualisation, methodology, data collection, statistical analysis, and writing, original draft preparation.
HSI: Supervision, validation, interpretation of data, and writing, review and editing.
Both authors have read and approved the final version of the manuscript.

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