Nepalese Journal of Zoology

ISSN: 2705-4403 (Print); 2705-4411 (Online)
www.cdztu.edu.np/njz

Volume 9 | Issue 2 | December 2025

https://doi.org/10.3126/njz.v9i2.88088

Research article

Diversity, distribution and seasonal prevalence of cockroach species in urban environments of Dhaka, Bangladesh

Faria Farhana Rain[1] | **Abu Faiz Md. Aslam**[1*] | **Ayesha Siddika**[1]

[1] Department of Zoology, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh
*** Correspondence:** afmaslam@juniv.edu

Suggested citation: Rain, F.F., Md. Aslam, A.F. and Siddika, A. 2025. Diversity, distribution and seasonal prevalence of cockroach species in urban environments of Dhaka, Bangladesh. Nepalese Journal of Zoology, 9(2):7–12.
https://doi.org/10.3126/njz.v9i2.88088

Article history:
Received: 28 April 2025
Revised: 04 November 2025
Accepted: 06 November 2025

Publisher's note: The statements, opinions and data contained in the publication are solely those of the individual author(s) and do not necessarily reflect those of the editorial board and the publisher of the NJZ.

Abstract

Cockroaches are common urban pests in tropical regions, posing considerable economic and health threats by transmitting microbes, allergens, and a range of disease-causing pathogens. To study the diversity of cockroach species, a total of 1186 samples were collected from households, hospitals and outdoor environments of Dhaka, the capital city of Bangladesh. Based on standard morphological keys, a total of eight cockroach species were identified- *Periplaneta americana*, *P. brunnea, P. australasiae, Blatella germanica, Hebardina concinna, Pycnoscelus surinamensis, Balta notulata* and *Blaberidae* sp. Residential areas and hospitals were infested by *P. americana, P. brunnea, P. australasiae, B. germanica, H. concinna, Pyc. surinamensis*. Two species, *B. notulata* and *Blaberidae* sp. were found in environmental field areas only. Residential regions and hospitals had excessive infestations of *Blattella germanica*, followed by *Periplaneta americana. B. germanica* was the most dominant indoor species with highest diversity indices (2.86) in study areas. The seasonal prevalence of cockroach species was notable, with 45% of specimens collected during the summer, 43% during the monsoon, and only 12% in the winter. The prevalence of various cockroach species is affected by factors such as the availability of food, hygiene standards, and environmental conditions. Effective control strategies require a clear understanding of their biological characteristics and behaviors, strengthened sanitation practices, and the careful, strategic use of commercial insecticides.

Keywords: Cockroaches; Morphological identification; Diversity index; Seasonal prevalence; Dhaka

1 | Introduction

Cockroaches are among the most resilient and adaptable insects on the planet, thriving in diverse environments and often cohabiting with humans (Shahraki et al. 2013). In Bangladesh, a country characterized by its unique ecosystems and rapid urbanization, cockroaches exhibit notable diversity and abundance (Akter et al. 2017). Around 4000 species of cockroaches have been discovered globally, and out of those, thirty species have adapted to living alongside humans (Bonnefoy et al. 2008; Nasirian 2019). Recently, scientists have classified them into their own order known as Blattodea (Triplehorn & Johnson 2005).

Various forms of human dwellings, encompassing both hospitals and residential homes, are notably plagued by cockroach infestations (Shahraki et al. 2013). Densely populated households and under privileged living conditions serve prime breeding grounds for indoor species, particularly *Blatella germanica* (Lee & Lee 2000; Bonnefoy et al. 2008). Factors such as inadequate sanitation, lack of maintenance and excessive clutter exacerbate the proliferation of cockroach populations within these environments.

The hospitals, characterized by ideal temperature, humidity, and ample food supply, establish an environment that is suitable for cockroach infestations (Chamavit et al. 2011). These pests have been found in numerous locations within healthcare facilities, such as hospitals, patient rooms, wards, intensive care units, and surgical departments (Jalil et al. 2023). Importantly, cockroaches represent a considerable threat as potential vectors for pathogenic microorganisms in these environments. Studies alarmingly reveal that about 98% of cockroaches uncovered in medical facilities may carry pathogens either on their bodies or in their digestive tracts (Lemos et al. 2006; Spagna et al. 2007; Jalil et al. 2023).

Cockroaches are ill-reputed vectors of pathogens and allergens, influencing to several health concerns in humans, involving respiratory challenges and food contamination. The parasitic organisms detected in cockroaches integrate both helminths and protozoa (Pai et al. 2003; Zarchi & Vatani 2009; Akter et al. 2017). Among the helminths, significant species involve *Strongyloides stercolis*, *Ascaris lumbricoides*, *Trichuris trichura*, and numerous *Taenia* species. The protozoa exposed in these insects consists of *Cyclospora* species, *Entamoeba histolytica, Entamoeba coli*, *Balantidium coli*, and *Isospora belli* (Thyssen et al. 2004; Salehzadeh et al. 2007; Nyarango et al. 2008; El Sherbini & El Sherbini 2011). Moreover, cockroaches assist as vectors for medically considerable fungi, incorporating *Candida*, *Aspergillus niger*, Mucor, *Rhizopus* species, *Aspergillus fumigatus*, and *Penicillium* species, as reported by Tatfeng et al. (2005) and Salehzadeh et al. (2007). Besides, the bacteria connected with cockroaches hold *Klebsiella pneumonia*, *Salmonella* species, *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterobacter cloacae*, *Citrobacter freundi*, *Enterobacter aerogenes* and *Proteus mirabilis*, all of which are documented as potential pathogens (Chamvit et al. 2011; Wannigama et al. 2014).

Our earlier research focused on the DNA barcoding of cockroach species in Bangladesh (Rain & Aslam 2023). Studying cockroach diversity is important for understanding their ecological roles, pest management, disease transmission, and evolutionary adaptations, which can have implications for public health and biodiversity conservation. In Bangladesh, there is a lack of sufficient information regarding the inaugural effort to detail the diversity, abundance, and seasonal distribution of cockroach species. This study aims to explore the diversity, abundance and seasonal prevalence of cockroach species in the capital city Dhaka, Bangladesh.

2 | Materials and methods

2.1 | Experimental site

The research was conducted in the urban region of the Dhaka district of Bangladesh. For methodological convenience, Dhaka City was divided into five zones: central, eastern, western, northern, and southern. Within each zone, samples were obtained from one representative hospital, one representative residential building, and one outdoor site (field) across different seasons over the course of a year. The selection of hospitals, households, and outdoor sites was performed using a random sampling approach.

2.2 | Sampling and identification of cockroaches

Cockroach specimens were collected over a one-year period, from July 2023 to June 2024, employing a combination of sticky traps, food-baited pitfall traps, and manual collection techniques to maximize sampling efficiency. Collections were carried out across three habitat categories: households, hospitals, and outdoor environments (fields). About 300 traps were placed in both residential and hospital areas.

For households, sticky traps were installed in living rooms, bedrooms, bathrooms, and kitchens to cover the main activity areas of cockroaches. In hospitals, traps were placed in different functional zones, including general wards, storerooms, kitchen storage areas,

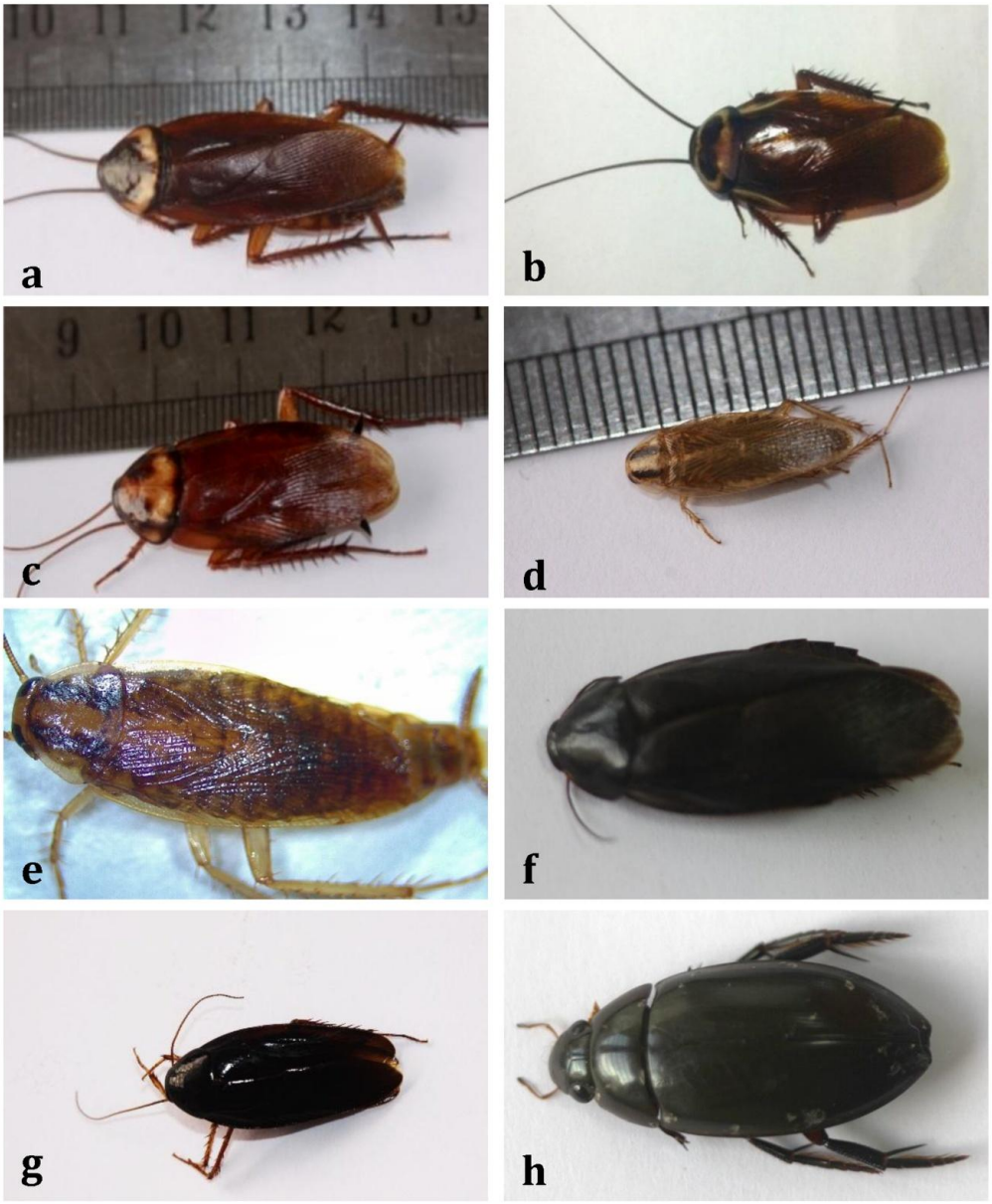

Figure 1. Identified cockroach species from Dhaka, Bangladesh, (a) *P. americana*, (b) *P. australasiae*, (c) *P. brunnea*, (d) *Blatella germanica*, (e) *Balta notulata*, (f) *Pycnoscelus surinamensis*, (g) *Hebardina concinna*, and (h) *Blaberidae* sp.

Table 1. Species and percentage of individuals collected cockroaches from different sites of Dhaka city

Species	Cockroach specimens collected from different sites					Total no. of Cockroaches (%)
				Households		
	Field (%)	Hospital (%)	Toilet (%)	Bedroom (%)	Kitchen (%)	
P. americana	10	10	32	27	16	178 (15%)
P. brunnea	6.98	4.23	9.92	18.07	7.12	81 (6.83%)
P. australasiae	2.33	3.49	14.88	4.82	4.53	58 (4. 89%)
Blatella germanica	60.47	79.96	26.45	44.58	72.17	805 (67.88%)
Hebardina concinna	10.08	0	4.13	6.02	0	23 (1.94%)
Pyc. surinamensis	6.20	1.29	8.26	0	0	25 (2.11%)
Balta notulata	4.5	0	0	0	0	10 (0.84%)
Blaberidae sp.	4.75	0	0	0	0	6 (0.51%)

and canteen spaces, to ensure representation of both patientcare and utility areas. Each site (household and hospital) was sampled once in a month using sticky traps during the study period.

In addition, manual hand collection was performed in the evening time of the third week of every study month in both households and hospitals to capture the cockroach specimens. For outdoor environments, food-baited pitfall traps were deployed in open field sites within each zone. These traps were set once per month and inspected the following day to recover captured specimens.

Prior to collection, oral consent was obtained from residents and hospital authorities to allow sampling within buildings. All collected specimens were preserved in the DNA Barcoding Laboratory, Department of Zoology, Jahangirnagar University and subsequently identified to species level using established taxonomic keys (Pratt & Littig 1969; Abdul-Hab 1980; Hagenbuch et al. 1988; Roth 1995; Choate 2009).

2.3 | Weather data collection

Average monthly temperature and humidity data were gained from the geography department, Jahangirnagar University and comparatively analyzed with population density of cockroaches.

2.4 | Data analysis

The data were analyzed to determine the relative abundance, species richness, and evenness of each cockroach species. The diversity of various cockroach species was assessed using the Shannon-Wiener diversity indices, following the methodologies established by the Shannon-Wiener function as described by Odum (1975). Additionally, the relative abundance of species was compared with average monthly temperatures, and the relationship between population density and temperature fluctuations was analyzed.

3 | Results

A total of 1186 cockroach specimens were collected from various locations within Dhaka City, including outdoor (field), households and hospitals. Through the applications of established taxonomic keys, eight distinct species of cockroaches were identified- *Periplaneta americana*, *P. brunnea*, *P. australasiae*, *Blatella germanica*, *Hebardina concinna*, *Pycnoscelus surinamensis*, *Balta notulata* and *Blaberidae* sp. (Fig. 1).

A total of 178 *Periplaneta americana* specimens were collected during our study period with the following distribution from 10% from outdoor fields, 10% from the hospital, 32% from the toilet, 27% from the bedroom, and 16% from the kitchen. In case of *Periplantea australasiae*, only 2.33% specimens were collected from

Table 2. Shannon-Wiener diversity index of different cockroaches collected from different sites from different seasons

Season	Species name	Total no of cockroaches	Relative abundance (pi)	Shannon index (lnPi)	PiXlnPi
Summer	*P. americana*	85	0.143098	-1.94423	-0.27821
	P. brunnea	40	0.06734	-2.698	-0.18168
	P. australasiae	23	0.038721	-3.25139	-0.1259
	Blatella germanica	418	0.707071	-0.34662	-0.24509
	Hebardina concinna	9	0.015152	-4.18965	-0.06348
	Pyc. surinamensis	4	0.006734	-5.00058	-0.03367
	Blaberidae sp.	5	0.008418	-4.77744	-0.04021
	Balta notulata	8	0.013468	-4.30744	-0.05801
			Total= 592		**H=1.02**
Monsoon	*P. americana*	49	0.117788	-2.13886	-0.25193
	P. brunnea	40	0.096154	-2.34181	-0.22517
	P. australasiae	32	0.076923	-2.56495	-0.1973
	Blatella germanica	261	0.627404	-0.46616	-0.29247
	Hebardina concinna	13	0.03125	-3.46574	-0.1083
	Pyc. surinamensis	18	0.043269	-3.14031	-0.13588
	Blaberidae sp.	0	0	0	0
	Balta notulata	3	0.007212	-4.93207	-0.03557
			Total= 416		**H=1.24**
Winter	*P. americana*	40	0.21978	-1.51513	-0.33299
	P. brunnea	10	0.054945	-2.90142	-0.15942
	P. australasiae	2	0.010989	-4.51086	-0.04957
	Blatella germanica	120	0.681319	-0.38373	-0.26144
	Hebardina concinna	1	0.005495	-5.20401	-0.02859
	Pyc. surinamensis	3	0.016484	-4.10539	-0.06767
	Blaberidae sp.	1	0.005495	-5.20401	-0.02859
	Balta notulata	1	0.005495	-5.20401	-0.02859
			Total= 178		**H= 0.956**

Table 3. Shannon-wiener diversity index of cockroach species collected from different locations of Dhaka, Bangladesh

Species name	Shannon-Wiener diversity index
P. americana	2.51
P. brunnea	2.11
P. australasiae	2.09
Blatella germanica	2.86
Hebardina concinna	1.03
Pyc. surinamensis	1.01
Blaberidae sp.	0.32
Balta notulata	0.16

Table 4. Seasonal prevalence of cockroach species collected from Dhaka, Bangladesh

Species	Summer (%)	Monsoon (%)	Winter (%)
P. americana	12.81	17.69	8
P. brunnea	7.84	6.36	5.33
P. australasiae	7.45	2.78	3.33
Blatella germanica	64.24	69.38	80
Hebardina concinna	2.87	1.19	1.33
Pyc. surinamensis	3.44	0.99	1.33
Balta notulata	0.96	0.99	0
Blaberidae sp.	0.382	0.59	0.66

field, 3.49%, from hospital, 14.88% from toilet, 18.07% from bedroom and 4.53% from kitchen, respectively. *Blatella germanica* exhibited the highest levels of infestation in hospital and kitchen environments with rated of 79.96% and 72.17% respectively. In case of *Hebardina concinna*, no evidence of infestation was detected in hospital, and kitchen. *Blaberidae* sp only found in field (4.75%). From this study, it was revealed that *B. germanica* was the most dominant species belonging to family Ectobiidae comprising of 67.88 % of the total catch followed by *P. americana* (15.01 %) belonging to family Blattidae. The kitchen area and hospitals are highly infested with *P. americana* and *B. germanica* (Table 1).

Shannon-wiener diversity index (Table 2) of Cockroaches was calculated to assess species diversity, environmental health, urban adaptation, and potential public health risks, aiding in ecological research and pest management strategies. The highest Shannon-Wiener diversity index was recorded for *Blatella germanica*, with a value of 2.86, followed by *Periplaneta americana* at 2.51. In contrast, *Blaberidae* sp and *Balta notulata* exhibited the lowest indices, measuring 0.32 and 0.16, respectively means they were not distributed properly in all habitats. This diversity index of *Blatella germanica* is 2.86 which is closer to 3, means species are distributed evenly in the habitat.

Pielou's evenness index was measured to evaluate the uniformity of species distribution, understand ecological stability, assess habitat disturbances, and improve pest management strategies in different environments. The index is derived from the ratio of the observed Shannon-Wiener index value to its maximum possible value, yielding results that range from 0 to 1 (Table 3). A value approaching 1 indicates a more equitable distribution of individuals within a community. In the current study, *Periplaneta australasiae* exhibited a value of 0.51, which is closer to 1 compared to other species. This suggests that *Periplantea australasiae* is more evenly distributed across the study area (Fig. 2).

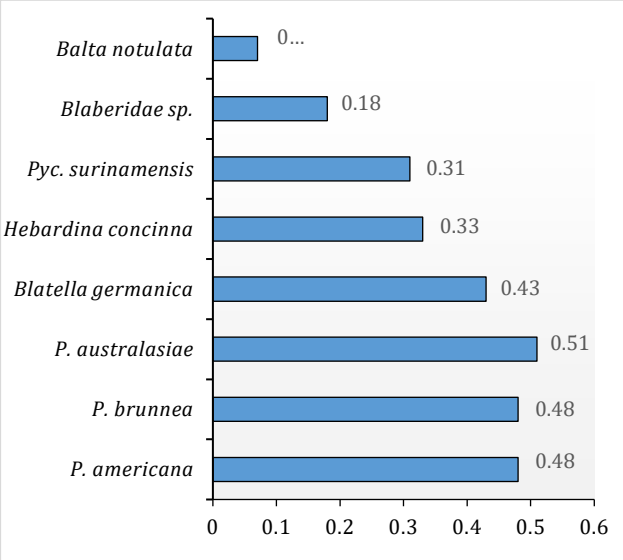

Figure 2. Pielou's evenness index for collected cockroach species from different sites of Dhaka City, Bangladesh

Seasonal prevalence of cockroaches was studied to identify population dynamics, assess environmental influences, and evaluate potential health risks associated with seasonal infestations. A total of 594 cockroach specimens were collected in the summer, contrasting sharply with the winter season, which yielded only 182 specimens, as shown in Table 4. Both species' richness and abundance exhibited a marked decline during the colder months of the study period. The summer season, characterized by peak activity, saw a predominance of cockroaches in indoor sheltered environments. This period is particularly conducive to the metamorphosis of nymphs into adults. During the summer, *Blatella germanica* was the dominant species, comprising 64.24% of the total population, whereas no instances of *Balta notulata* were observed during the winter season (Table 4).

4 | Discussion

A total of 1,186 cockroach specimens were collected from the capital of Bangladesh, Dhaka over a one-year period. Dhaka is highly populated city with diverse urban environments that serve suitable conditions for cockroach species. Cockroaches were collected from the random selection of hospitals, residential areas and fields. In both hospitals and residential areas, cockroaches are of certain public health importance as they carry various pathogenic microorganisms. Their presence is influenced by numerous environmental features, including temperature, humidity, and the abundance of food sources.

During this study, a total of eight cockroach species were identified as *Periplaneta americana, Periplaneta brunnea, Periplaneta australasiae, Blatella germanica, Hebardina concinna, Pycnoscelus surinamensis, Blaberidae* sp., and *Balta notulata*. Memona et al. (2016) identified four cockroach species from Pakistan, named as *Periplaneta americana*, *Blatella germanica*, *Blatta orientalis*, *Blatta lateralis*. Sarangan et al. (2020) identified 24 cockroach species from India. Recent research from Nigeria showed only *Periplaneta americana* cockroach species (Elijah & Lamidi 2023). This could be because of its preference for warm, humid environments of Nigeria (Auta & Yantaba 2019). Previously Odibo et al. (2019) documented four cockroach species from Nigeria. Debash et al. (2022) found only cockroach species named *Blatella germanica* from Ethiopia for one year sampling of cockroach specimen. Liu et al. (2024) sampled cockroach specimens all-round the year and found only two cockroach species, named *Blattella germanica* and *Periplaneta fuliginosa* from China.

The *Blatella germanica* (60.47%) was the most common among collected from the field, while *Hebardina concinna* (10.08%) placed as second from outside (field). *Balta notulata* and *Blaberidae* sp. were only collected from outside as they were absent in household and hospital areas. Six other cockroach species were found in both household and hospital areas. *P. americana*, *P. brunnea, P. australasiae*, and *B. germanica* were found in residential areas

(toilet, bedroom and kitchen). *P. americana*, *P. brunnea*, *P. australasiae*, *Blatella germanica* and *Pycnoscelus surinamensis* were collected from the hospital area. The highest cockroach infestation rate found in *Blatella germanica* while *P. americana* ranking second in both residential and hospital areas (Table 1). Abdullah et al. (2024) found highest infestation of cockroaches were found in the kitchen and toilets of residential areas. Elijah and Lamidi (2023) found *P. americana* was mostly dominant in household areas. Lee et al. (2003) found that residential areas were mostly infested with *B. germanica* followed by *P. americana*. The research of Memona et al. (2016) explained that residential areas and hospital areas were highly infested with *B. germanica* and *P. americana*. This research supports our findings. The current research identified that indoor cockroach species, specifically the *B. germanica* and *P. americana*, were predominantly found in bedrooms, kitchen, living room, hospital wards, etc. Their significant presence in these locations can be attributed to the favorable conditions they provide, including ample shade, abundant food sources, and a cooler environment, all of which contribute to the proliferation of their populations.

The highest Shannon-Wiener diversity index was recorded for *Blatella germanica*, with a value of 2.86, followed by *Periplaneta americana* at 2.51 (Table 2). The Pielou's evennsess index is derived from the ration of the observed Shannon index value to its maximum possible value, yielding results that range from 0 to 1. The evenness index for the present research comprises 0.07-0.51. *Periplaneta australasiae* exhibited a value of 0.51, which is closer to 1 compared to other species. This suggests that *Periplantea australasiae* is more evenly distributed across the study area (Fig. 1).

Cockroach species distribution was observed throughout the year, although environmental temperature may influence the distribution of certain outdoor species. Cockroaches are highly adaptable to diverse terrestrial environments, particularly dry and harsh conditions. In our research, 45% of cockroaches were collected and identified during the summer season, 39% during the monsoon season, and only 12% in the winter season (Table 3). During the colder months, cockroach activity was less noticeable. However, they likely possess physical and behavioral adaptations that enable them to survive in extremely low temperatures. These findings align with the study by Snoddy and Appel (2008), who conducted a survey in Southern Alabama and Georgia to assess the northward expansion of *Blattella asahinai* from Florida. The findings of Memona et al. (2016) observed that cockroaches were distributed throughout the year, although environmental temperature appeared to influence the occurrence of certain outdoor species. Cockroaches are highly adaptable insects, capable of surviving in a wide range of terrestrial environments, including dry and harsh conditions.

5 | Conclusions

The study revealed significant diversity and seasonal variations in cockroach populations across different habitats in Dhaka city. The Shannon-Wiener diversity index indicated moderate species richness, while Pielou's evenness index suggested varying species distribution across urban environments. Seasonal analysis showed peak abundance during warmer and humid months, emphasizing the role of climatic factors in population dynamics. These findings highlight the need for improved pest management strategies, particularly in high-risk seasons, to mitigate health risk associated with cockroach infestations. Future research should explore molecular identification methods and pathogen transmission risks to enhance our understanding of their ecological and epidemiological roles.

Acknowledgements

This work was supported by grants from Higher Education Quality Enhancement Project (HEQEP, CP-3424), a project of the University Grants Commission of Bangladesh and the Ministry of Education, Government of Bangladesh.

Ethical approval

Oral consent was obtained prior to collecting cockroach specimens from household and hospitals areas.

Authors' contributions

F.F.R designed the experiment, collected and analyzed data, and wrote the manuscript. A.F.M.A conceptualized the experiment and collected the field data. A.S. collected the field data.

Conflicts of interest

The authors declare no conflict of interest.

References

Abul-Hab, J.K. 1980. A list of Arthropoda of medical and veterinary importance recorded from Iraq. Bulletin of Biological and Allied Sciences Research, 12(1):9–40.

Abdullah, A.M., Merza, A.S. and Meer Khan, A.A. 2024. Cockroaches as carriers of human medically important parasites. Parasitology Research, 123:119. https://doi.org/10.1007/s00436-024-08146-9

Akter, T., Ahmed, S. and Biswas, R. 2017. Isolation and identification of some gram-negative bacteria from cockroaches collected from hospital, restaurant and slum areas of Dhaka city, Bangladesh. Journal of Biodiversity Conservation and Bioresources Management, 3 (2): 63–68. https://doi.org/10.3329/jbcbm.v3i2.36029

Auta, T., Yantaba, H.S. and Everest, A. 2019. Determination of Parasitic Agents Associated with Cockroaches in DutsinMa Town, Northwestern Nigeria. South Asian Journal of Parasitology, 2(2):1–6.

Bonnefoy, X., Kampen, H. and Sweeney, K. 2008. Cockroaches. In Public health significance of urban pests. World Health Organization. Regional office for Europe, Scherfigsvej 8. DK-2100 Copenhagon, Denmark, pp. 53–84.

Chamavit, P., Sahaisook, P. and Niamnuy, N. 2011. The majority of cockroaches from the Samutprakarn province of Thailand are carriers of parasitic organisms. EXCLI Journal, 10:218–222.

Choate, P.M. 2009. A Dichotomous Key for the Identification of the Cockroach Fauna (Insecta: Blattaria) of Florida. Department of Entomology and Nematology, University of Florida.

Debash, H., Alemu, M. and Ayehu, A. 2022. Species composition and parasite carriage rate of cockroaches among households of Sekota town, Northeast Ethiopia. International Journal of Tropical Insect Science, 42:3815–3820. https://doi.org/10.1007/s42690-022-00906-3

El Sherbini, G.T. and El Sherbini, E.T. 2011. The role of cockroaches and flies in mechanical transmission of medical important parasites. Journal of Entomology and Nematology, 3(7):98–104. https://doi.org/10.5897/JEN.9000039

Elijah, M.I. and Lamidi, B.T. 2023. Species Composition and Seasonal Distribution of Cockroaches in Bali Town, Taraba State, Nigeria. International Journal of Current Research in Sciences, Social Sciences and Languages, 4(1):1–7.

Hagenbuch, B.E., Koehler, P.G., Patterson, R.S. and Brenner, R.J. 1988. Peridomestic cockroaches (Orthoptera: Blattidae) of Florida: their species composition and suppression. Journal of Medical Entomology, 25:377–380. https://doi.org/10.1093/jmedent/25.5.377

Jalil, A. T., Abdulhadi, M.A., Al-Ameer, R.L., Naser, S. J., Merza, M., Alsandook, T, Alhili, A. and Zabibah, R.S. 2023. Bacterial contamination of cockroaches in different wards of hospital, restaurant and home, Heliyon, 9(11):e22103. https://doi.org/10.1016/j.heliyon.2023.e22103.

Lee, C.Y. and Lee L.C. 2000. Diversity of cockroach species and effect of sanitation

on level of cockroach infestation in residential premises. Tropical Biomedicine, 17:39–43. https://doi.full/10.5555/20033095066

Lee, D.K., Lee, W.J. and Sim, J.K. 2003. Population densities of cockroaches from human dwellings in urban areas in the republic of Korea. Journal of Vector Ecology, 28(1):90–96.

Lemos, A.A, Lemos, J.A., Prado, M.A., Pimenta, F.C., Gir, E. and Silva, H.M. 2006. Cockroaches as carriers of fungi of medical importance. Mycoses, 49(1):23–25. https://doi.org/10.1111/j.1439-0507.2005.01179

Liu, J., Yuan, Y., Feng, L., Lin, C., Ye, C., Liu, J, Li, H., Hao, L. and Liu, H. 2024. Intestinal pathogens detected in cockroach species within different food-related environment in Pudong, China. Scientific Reports, 14:1947. https://doi.org/10.1038/s41598-024-52306-x

Memona, H., Manzoor, F. and Riaz, S. 2017. Species Diversity and Distributional Pattern of Cockroaches in Lahore, Pakistan. Journal of Arthropod Borne Diseases, 11(2):249–259.

Nasirian, H. 2019. Recent cockroach bacterial contamination trend in the human dwelling environments: A systematic review and meta-analysis. Bangladesh Journal of Medical Science, 18(3):540–545. https://doi.org/10.3329/bjms.v18i3.41623

Nyarango, R.M., Aloo, P.A., Kabiru, E.W. and Nyanchongi, B.O. 2008. The risk of pathogenic intestinal parasite infections in Kisii municipality, Kenya. BMC Public Health, 8:237. https://doi.org/10.1186/1471-2458-8-237

Odum, E.P. 1975. Ecology. Holt Rinehart and Winston, London, UK.

Odibo, E.O., Egwunyenga, A.O. and Ojianwuna, C.C. 2019. Seasonal Distribution of Cockroaches' Species in Abraka, Delta State, Nigeria. FUW Trends in Science and Technology Journal, 4(1):163–168.

Pai, H.H., Ko, Y.C. and Chen, E.R. 2003. Cockroaches (*Periplaneta americana* and *Blattella germanica*) as potential mechanical disseminators of *Entamoeba histolytica*. Acta Tropical, 87:355–359. https://doi.org/10.1016/S0001-706X(03)00140-2

Pratt, H.D. and Littig, K.S. 1969. Cockroaches: Pictorial key to some common species. In: Chamberlain RW (Eds): Introduction to arthropods of public health importance. U.S. Department of Health, Education and Welfare, Atlanta, Georgia, pp. 55–62.

Rain, F.F. and Aslam, A.F.M. 2023. The first DNA barcode of medically important cockroaches in Bangladesh. Asia Pacific Journal of Molecular Biology and Biotechnology, 31(2):80–90. DOI: 10.35118/apjmbb.2023.031.2.07

Roth, L.M. 1995. New species of Blattella and Neuroptera from India and Burma (Dictyoptera: Blattaria: Blattellidae). Oriental Insects, 29:23–31.

Salehzadeh, A., Tavacol, P. and Mahjub, H. 2007. Bacterial, fungal and parasitic contamination of cockroaches in public hospital of Hamadan, Iran. Journal of Vector Borne Diseases, 44:105–110. PMID: 17722863

Sarangan, P. and Senraj, M. 2020. Checklist of cockroaches (Blattodea) of Kerala, India. Entomon, 45:273-284.

Shahraki, G.H., Parhizkar, S. and Nejad, A.R.S. 2013. Cockroach Infestation and Factors Affecting the Estimation of Cockroach Population in Urban Communities. International Journal of Zoology, 649089:1–6. https://doi.org/10.1155/2013/649089

Snoddy, E.T. and Appel, A.G. 2008. Distribution of *Blattella asahinai* (Dictyoptera: Blattellidae) in southern Alabama and Georgia. Annals of the Entomological Society of America, 101:397–401. https://doi.org/10.1603/0013-8746.

Spagna, J.C., Goldman, D.I., Lin, P.C., Koditschek, D.E. and Full, R.J. 2007. Distributed mechanical feedback in arthropods and robots simplifies control of rapid running on challenging terrain. Bioinspiration Biomimetics, 2:9. https://doi.org/10.1088/1748-3182/2/1/002

Tatfeng, Y.M., Usuanlele, M.U., Orukpe, A., Digban, A.K., Okodua, M. and Oviasogie, F. 2005. Mechanical transmission of pathogenic organisms: The role of cockroaches. Journal of Vector Borne Diseases, 42:129-134.

Thyssen, P.J., Moretti, T.D., Ueta, M.T. and Ribeiro, R.O. 2004. The role of insects (Blattodea, Diptera and Hymenoptera) as possible mechanical vectors of helminths in the domiciliary and peridomicile environment. Cadernos de Saude Publica, 20:1096–1102. https://doi.org/10.1590/s0102-311x2004000400025

Triplehorn, C.A. and Johnson, N.F. 2005. Cockroaches. In: Borror DG, DeLong DM (Eds): An introduction to the study of insects, 7th ed. Thompson-Brooks-Cole, Belmont, California.

Wannigama, D.L., Dwivedi, R. and Zahraei-Ramazani, A. 2014. Prevalence and antibiotic resistance of gram-negative pathogenic bacteria species isolated from *Periplaneta americana* and *Blattella germanica*in Varanasi, India. Journal of Arthropod Borne Diseases, 8(1):10–20.

Zarchi, A.A. and Vatani, H. 2009. A survey on species and prevalence rate of bacterial agents isolated from cockroaches in three hospitals. Vector Borne Zoonotic Diseases, 9(2). https://doi.org/10.1089/vbz.2007.0230