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# ECTO AND ENDOPARASITES OF BATS IN SELECTED AREAS OF LAFIA METROPOLIS, NASARAWA STATE, NIGERIA

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## ABSTRACT

Bats harbor parasites, increasing disease surveillance. Between November 2022 and January 2023, a survey in Lafia metropolis employed mist nets over 12 nights across six areas to assess bats ecto and endoparasites prevalence. Two hundred and nineteen bats were trapped, belonging to five species: Tadarida brasiliensis (139), Eidolon helvum (32), Afronycteris nanus (16), Scotophilus leucogaster (16), and Rhinolophus lander (16). Ectoparasites comprising four genera: Ixodes, Thaumapsylla, Nycteribia and Demodex; and endoparasites belonging to three groups: Nematodes, Protozoans and Cestodes) showed an overall prevalence (3.65%) and (10.04%) respectively. Locations based prevalence of ecto and endoparasites revealed Phase II recorded the highest prevalence (37.5%), with a significant difference ($X^2 = 0$, df = 5, $p < 0.001$) and Mararaba had the highest prevalence (31.18%), with a very high variation ($X^2 = 36.358$, df = 5, $p < 0.0001$). Prevalence of Ectoparasites, and endoparasites in relation to sex was higher in females (62.5%) than in males (37.5%) with significant difference ($X^2 = 6.25$, df = 1, p = 0.01242) and higher in males (63.64%) than in females (36.36%) varied significantly ($X^2 = 7.442$, df = 1, $p < 0.006372$). Ectoparasites of bats in relation to species revealed E. helvum recorded the highest prevalence (50%), with a significant difference ($X^2 = 103.12$, df = 4, $p < 0.0001$), for endoparasites, T. brasiliensis had the highest distribution (50%), with a significant difference ($X^2 = 71.503$, df = 4, $p < 0.0001$). Further research across the state is needed for a better understanding of bats parasites.

**Keywords**: Prevalence, Species, Sex, Locations

## INTRODUCTION

The only active-flying, genuine placental mammals in the animal kingdom are bats, which belong to the order Chiroptera. Chiroptera is a globally distributed mammalian order, ranking second in diversity after rodents. According to Álvarez-Castañeda (2024), bats are generally divided into two groups: Megachiroptera and Microchiroptera. Flying foxes and Old World fruit bats are examples of Megachiroptera, which are predominantly herbivorous, feeding on fruits, flowers, leaves, nectar, and pollen. They inhabit both tropical and temperate regions across the world (Schaer *et al.,* 2013; Heard, 2025).

Although most Microchiroptera species are insectivorous, a small number consume blood, fruits, nectar, pollen, and even vertebrates. Ectoparasites are organisms that live on the external surfaces of their hosts—such as the skin or skin-derived structures and can be harmful. They feed on the blood of their hosts while residing in the fur, wing membranes, or other body parts. Many ectoparasites possess specialized sucking mouthparts for blood-feeding and flattened bodies that facilitate movement through fur (Szentiványi *et al.*, 2024). Common external arthropod parasites found in bats include fleas, mites, ticks, and bugs (Tendu *et al.*, 2024).

Endoparasites are parasites that live within the internal organs or tissues of their hosts. Bats are known to harbor various protozoans, including nematodes such as *Rictularia chaeraphoni* and *Histostrongylus coronatus*, as well as flatworms like Cestoda and Trematoda, including *Posthodendrium pamuterus* and *Hymenolepis kerivonlar* (Okafor *et al.*, 2004). These parasites inhabit bat tissues during parts of their life cycle (Ghasemi and Miri, 2024).

In regions like Asia, Africa, and the Pacific, bats are utilized as a source of food and guano, often found in caves and roosts that may harbor parasites. They are also increasingly recognized as tourist attractions due to their ecological significance.

In Nigeria, bats are recognized as carriers of ecto- and endoparasites that can transmit zoonotic diseases dangerous to humans and other animals, including *Nipah virus, Ebola virus*, and *Hendra virus* (Chua *et al.*, 2002; Ghasemi and Miri, 2024). Despite harboring a range of pathogens, bats have developed defenses that typically prevent clinical illness, allowing them to carry bacteria, fungi, viruses, and protozoa asymptomatically (Xu *et al.*, 2024). They play vital ecological roles such as pollination, seed dispersal, and pest control, but during feeding, they may be exposed to infectious agents transmitted by ecto- and endoparasites (Oyewo *et al.*, 2021)

In Lafia, Nasarawa State, bats are observed roosting on trees, abandoned structures, caves, and rocky outcrops—habitats that may host parasitic organisms. However, limited information exists regarding the ecto- and endoparasites of bats in this region, as previous studies have primarily focused on zoonotic viral infections rather than parasitic infestations (Ombugadu *et al.*, 2021; Ameh *et al.*, 2022).

In order to ascertain the prevalence of both ectoparasites and endoparasites of bats in Lafia, this study focused on parasitic infestations using the saline wet mount technique. Bat species, sex, and locality were among the factors taken into account in the study. The findings are meant to be used as baseline information for further studies on bat parasites in the area.

## MATERIALS AND METHODS

### Study Area and Methodology

The study was conducted in selected communities within Lafia Local Government Area of Nasarawa State, Nigeria. Lafia LGA is situated at latitude 8°28'59.99" N and longitude 8°31'0.01" E. It is a bustling area characterized by settlements, schools, and various human activities such as trading, public transportation, and food vending. The predominant tree species in the area is the Neem tree (Azadirachta indica), which serves as a roosting site for bats. The region experiences an average annual rainfall of approximately 730 mm, primarily during two rainy seasons: the major rainy season from April to mid-July and the minor rainy season in October. The dry season spans December to January. Throughout the year, temperatures remain relatively stable, with mean monthly temperatures ranging from 24.7°C in August (the coolest month) to 28°C in March (the hottest month), averaging around 26.8°C annually. Rapid expansion of settlements has led to most animals being pushed inland, affecting local wildlife dynamics (Agidi et al., 2022).

**Sampling of Bats**
The study was carried out in six selected areas within Lafia LGA: Mararaba, Bukan Kwoto, Gimare, Gandu, Phase II, and Kwandare Road. These sites were chosen based on their accessibility and the notable presence of bats. The research was conducted over a period from November 2022 to January 2023, during which bats were captured and identified across these locations. Sampling was performed over 12 non-consecutive nights, with bats collected from the six designated areas: Mararaba, Gandu, Phase 2, Kwandare Road, Bukan Kwoto, and Gimare. A total of 219 bats were captured, with data recorded on their species, locations, and sex.

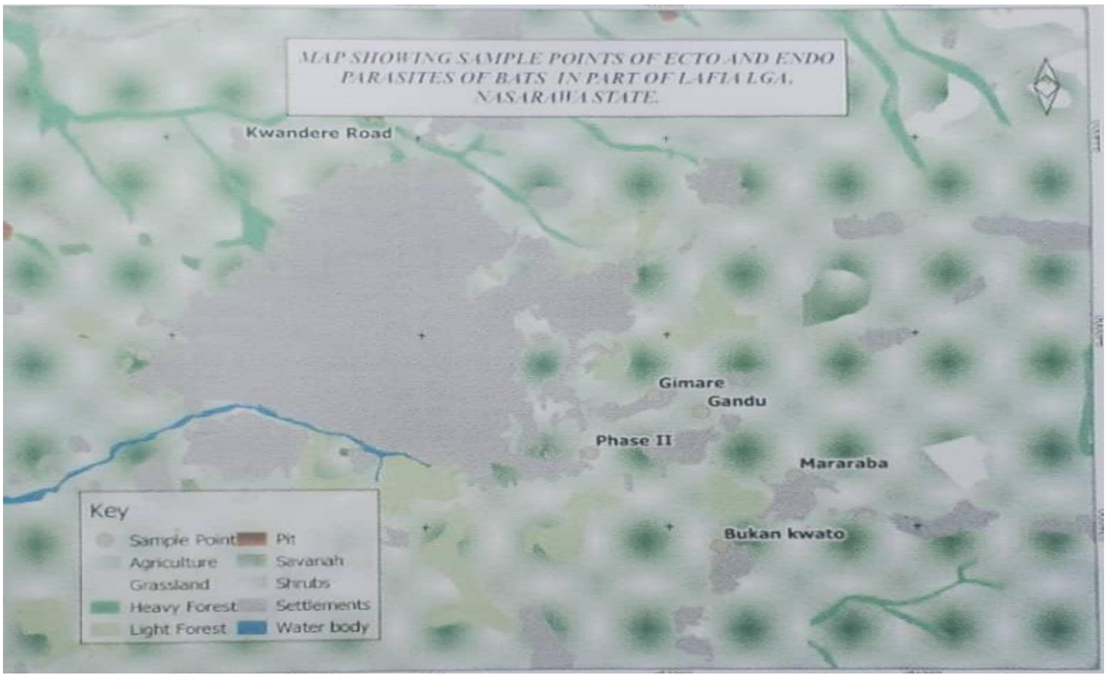


Figure 1: Map of study area

**Trapping of Bats**
Mist nets were installed in selected areas where the presence of bats was strong. The nets were opened at nightfall at 6:15 pm to 5:00am. The nets were installed at different sites around the selected areas. The nets were monitored at intervals to remove the captured bats so that they will not injure themselves by becoming entangled or struggling in the net or they will not attack by predators. The bats were released with care to the wing clearances, as they entered the nets with their wings outstretched and then folded them back. Each captured bat was placed in a bat bag and kept until it was identified. To avoid any direct contact with the bats, Personal Protective Equipment (PPE) with the "Code of ethics for the Practice of Catching Bats", designed as part of the National Plan of Chiroptera Actions 2009-2013 was used.

**Sampling Procedures for Ectoparasites and Endoparasites from Bats**
Individual bats were carefully handled and examined for ectoparasites. Each bat's fur, ear, face, wing membrane, and tail membranes were visually examined for the presence of ectoparasites, visible ectoparasites were extracted using blunt forceps and placed in a plastic Eppendorf tubes half filled with 70% ethanol. All the species, locations and sex were labelled. Apart from the visible ectoparasites that were picked, bats are known to harbor ectoparasites that are so small they are not visible to the human eye; such parasites were collected by cleaning the entire body surface of the bats with cotton wool soaked in 70% ethanol. The used cotton wool was then placed in a ziplock bag, sealed, and labeled until used.
Faecal samples of the bats were taken for helminth analysis. During the sampling process, stool passed out by the bats were collected and swap stick was also used to get samples from the anus region of bats and stored in collection tubes containing 70% ethanol. This is to preserve and maintain the integrity of any eggs or cysts that the faecal pellets may contain. Faecal pellets that fell on the ground or gloves were not collected to prevent cross contamination of samples (Kuk *et al*., 2012)

**Processing of Samples and Parasites Identification**
***Macroscopic and Microscopic Ectoparasites***
Ectoparasites that were preserved in ethanol were examined under a dissecting microscope and identified with a morphological identification key according to Klimpel *et al.,* (2016).
The ethanol-soaked cotton which was used to clean the bats was washed with distilled water and 70% ethanol in Petri dishes and observed under a light microscope for identification of parasites. Very small parasites were picked with forceps and placed onto a slide and a higher power of magnification (X100) was used to observe and identify them.

***Faecal Parasites Identification***

For faecal analysis, about 1g of each sample collected from the field was mixed with 2ml of normal saline solution, sieved and the supernatant was collected with a pipette. This was placed on a clean glass slide, covered with a cover slip and examined under a microscope at 400x and 1000x magnification to detect parasites (Adhikari *et al*., 2020).

**Data Analysis**

Descriptive statistics were presented in frequencies and percentages. Chi-square test was used to test for significant difference between categorical variables. $P < 0.05$ was considered statistically significant.

## RESULTS AND DISCUSSION

**Results**

A total of 219 individual bats, belonging to five species, were captured and examined, in six different locations in Lafia Metropolis, Nasarawa State, Nigeria. They species composition of ectoparasites are Demodex mite (25.0%), Nycteriba spp (25.0%), Flea (12.5%) and ticks (37.5%) while endoparasites belonging to Protozoans are Sarcocystis spp 2 (9.09%), Balantidium spp.1(4.55%), Entamoeba spp. 1(4.55%), Coccidia spp.7(31.8), Giardia 2(9.09%), Cryptosporidium Spp.1(4.55%); Cestodes: Taenia spp.3(13.6%), Hymenolepsi spp. 2(9.09%) and Nematodes: Ascaris spp. 2(9.09%), Toxocara spp.1(4.55%). An overall prevalence 8 (3.65%) for ectoparasites and (10.0%) for endoparasites (table 1).

**Table 1: Checklist of Ecto and Endoparasites from Bats in Lafia Metropolis, Nasarawa State, Nigeria**

| Genus | Ectoparasites | | Genus | Endoparasites | |
|---|---|---|---|---|---|
| | **Species** | **Frequency (%)** | | **Species** | **Frequency(%)** |
| Ixodes | Ixodes | 3 (37.5) | Giardia | Giardia | 2 (9.09) |
| Thaumapsylla | Thaumapsylla | 1 (12.5) | Balantidium | Balantidium | 1 (4.55) |
| Nycteribia | Nycteribia | 2 (25) | Coccidia | Coccidia | 7 (31.80) |
| Demodex | Demodex | 2 (25) | Hymenolepis | Hymenolepis | 2 (9.09) |
| | | | Entamoeba | Entamoeba | 1 (4.55) |
| | | | Ascaris | Ascaris | 2 (9.09) |
| | | | Taenia | Taenia | 3 (13.64) |
| | | | Toxocara | Toxocara | 1 (4.55) |
| | | | Sarcocystic | Sarcocystic | 2 (9.09) |
| | | | Crypto. | Cryptosporidium | 1 (4.55) |
| **Total** | | **8 (3.65)** | | | **22 (10.04)** |

**Distributions of Ectoparasites of Bats in Relation to Locations in Lafia Metropolis, Nasarawa State, Nigeria.**

The prevalence of ectoparasites in relation to locations showed Phase II recorded the highest percentage (37.5%), followed by Kwandare Road (25.0%) and the least was observed in Mararaba (12.5%), Gandu (12.5%) and Bukan Kwato (12.5%). No ectoparasite was collected from bats in Gimare (0.00%). However, there was a very high significant difference ( $\chi^2= 50$, df = 5, $P < 0.001$) in the percentage of ectoparasites of bats in relation to locations in Lafia metropolis (table 2).

**Table 2: Distributions of Ectoparasites of Bats in Relation to Locations in Lafia Metropolis, Nasarawa State, Nigeria**

| Locations | No of Bats examined | No of Parasite(s) | Percentages (%) |
|---|---|---|---|
| Mararaba | 25 | 1 | 12.5 |
| Gandu | 34 | 1 | 12.5 |
| Phase II | 11 | 3 | 37.5 |
| Kwandare Road | 64 | 2 | 25.0 |
| Bukan Kwato | 54 | 1 | 12.5 |
| Gimare | 31 | ____ | 0 |
| **Total** | **219** | **8** | **100** |

$\chi^2= 50$, df = 5, $P < 0.001$

**Distributions of Ectoparasites of Bats in Relation to Sex in Lafia Metropolis, Nasarawa State, Nigeria**

Analysis of the prevalence of ectoparasites of Bats in relation to sex indicated higher percentage in females (62.5%) than in male bats (37.5%). Nonetheless, the variation in the distributions of ectoparasites of bats in relation to sex showed some significance ( $\chi^2=6.25$, df =1, $P = 0.01242$) (table. 3).

**Table 3: Distributions of Ectoparasites of Bats in Relation to Sex in Lafia Metropolis, Nasarawa State, Nigeria**

| Sex | No.of Bats Examined | No. of Parasites | Percentages (%) |
|---|---|---|---|
| Male | 113 | 3 | 37.5 |
| Female | 106 | 5 | 62.5 |
| **Total** | **219** | **8** | **100** |

($\chi^2 = 6.25$, df =1, $P = 0.01242$)

**Distributions of Ectoparasites of Bats in Relation to Bat Species in Lafia Metropolis, Nasarawa State, Nigeria**

Results of the analysis of the prevalence of ectoparasites of bats in relation to bat species revealed that E. helvum recorded the highest percentage (50.0%) of ectoparasites. This is preceded by T. brasibensis (37.5%) and A. nanus (12.5%). Meanwhile, S. leucogaster and R. landeri reported percentage (0.00%) of endoparasites respectively. There is a very high significant difference in the prevalence of ectoparasites of bats in relation to bat species ($\chi^2 = 103.12$, df = 4, $P < 0.0001$) (table 4).

**Table 4: Distributions of Ectoparasites of Bats in Relation to Bat Species in Lafia Metropolis, Nasarawa State, Nigeria**

| Species of Bats | No. of Bats Examined | No. of Parasites | Percentages (%) |
|---|---|---|---|
| T. brasibensis | 139 | 3 | 37.5 |
| E. helvum | 32 | 4 | 50 |
| A. nanus | 16 | 1 | 12.5 |
| S. leucogaster | 16 | 0 | 0 |
| R. landeri | 16 | 0 | 0 |
| **Total** | **219** | **8** | **100** |

($\chi^2 = 103.12$, df = 4, $P < 0.0001$)

**Distributions of Endoparasites of Bats in Relation to Locations in Lafia Metropolis, Nasarawa State, Nigeria**

Results of the prevalence of endoparasites of bats in relation to location revealed that the highest percentage (31.8%) was recorded in Mararaba, then Kwandare (27.2%) and Gandu (18.18%). Phase II and Gimare both had the prevalence (9.09%) with the least percentage (4.55%) registered in Bukankwato. Therefore, the difference in the prevalence of endoparasites of bats in relation to location showed a very high variation ($\chi^2 = 36.358$, df = 5, $p<0.001$) (table 5).

**Table 5: Distributions of Endoparasites of Bats in Relation to Locations in Lafia Metropolis, Nasarawa State, Nigeria**

| Locations | No of Bats examined | No of Parasite(s) | Percentages (%) |
|---|---|---|---|
| Mararaba | 25 | 7 | 31.8 |
| Gandu | 34 | 4 | 18.2 |
| Phase II | 11 | 2 | 9.1 |
| Kwandare Road | 64 | 6 | 27.3 |
| Bukan Kwato | 54 | 1 | 4.54 |
| Gimare | 31 | 2 | 9.1 |
| **Total** | **219** | **22** | **100** |

$\chi^2 = 36.358$, df = 5, $p < 0.001$

**Distributions of Endoparasites of Bats in Relation to Sex in Lafia Metropolis, Nasarawa State, Nigeria**

The sex-based prevalence of endoparasites of Bats in Lafia showed highest distribution (63.64%) in the male bats than the female bats (36.36%). Nevertheless, the difference in the gender-based prevalence of endoparasites varied significantly ($\chi^2 = 7.442$, df = 1, P=0.006372) (table 6).

**Table 6: Distributions of Endoparasites of Bats in Relation to Sex in Lafia Metropolis, Nasarawa State, Nigeria**

| Gender | No. of Bats Examined | No. of Parasites | Percentages (%) |
|---|---|---|---|
| Male | 113 | 14 | 63.64 |
| Female | 106 | 8 | 36.36 |
| **Total** | **219** | **22** | **100** |

($\chi^2 = 7.442$, df = 1, P = 0.006372)

**Distributions of Endoparasites of Bats in Relation to Bats Species in Lafia Metropolis, Nasarawa State, Nigeria**

The prevalence of endoparasites of bats in relation to bat species revealed that T. brasibensis bears the highest (50%) prevalence of endoparasites. This is followed by E. helvum (27.27%), A. nanus (9.09%), and R. landeri (9.09%). The lowest prevalence (4.54%) of endoparasites was S. leucogaster. Thus, the variation in the prevalence of endoparasites in relation to bat species showed a very high significance ($\chi^2 = 71.50$, df = 4, $P < 0.0001$) (table 7).

**Table 7: Distributions of Endoparasites of Bats in Relation to Bats Species in Lafia Metropolis, Nasarawa State, Nigeria**

| Species of Bats | No. of Infected Bats | No. of Parasites | Percentages (%) |
|---|---|---|---|
| T. brasilensis | 139 | 11 | 50.0 |
| E. helvum | 32 | 6 | 27.27 |
| A. nanus | 16 | 2 | 9.09 |
| S. leucogaster | 16 | 1 | 4.54 |
| R. landeri | 16 | 2 | 9.09 |
| **Total** | **219** | **22** | **100** |

$\chi^2 = 71.50$, df = 4, $P < 0.0001$

**Discussion**

The public health implications of the known ectoparasites and endoparasites carried by bats are substantial. The potential for bats to serve as both reservoirs and vectors for a range of infectious illnesses is highlighted by the possibility that they may contain both ectoparasites and endoparasites. In the city of Lafia, Nasarawa State, an overall prevalence of 3.65% for ectoparasites on bats was found. The high prevalence of 95% in Ogbunike Caves, Anambra State, as reported by Okeke *et al.* (2020), 42.5% in Costa Rica by Carbonara *et al.* (2022), and 43.9% in South Africa by Szentivanyi (2022) is significantly higher than this.Variations in ecology, behavior, and methodology may be the cause of the low prevalence of ectoparasites in bats in the city of Lafia. Lafia's environment could not have the specialized habitats like deep woods or caverns, where bats and ectoparasites frequently flourish that sustain significant ectoparasite populations. Ectoparasite reproduction and survival can also be impacted by temperature, humidity, and rainfall patterns. For instance, the prevalence of ectoparasites may be decreased in Lafia by hot or dry weather. Furthermore, the exposure hazards for bats who roost in open areas near human structures may differ from those of bats that sleep in caves or areas with thick vegetation. Bats sampled in this study might have regular grooming which helps to eliminate ectoparasites more efficiently, which reduces infection levels. Furthermore, if ectoparasites are tiny, obscure, or found in difficult to reach body parts, they may be overlooked by the techniques employed to collect and inspect bats. However, if bats have fewer ectoparasites, there is a lower chance that these vectors may infect humans or other animals with disease, especially if human bat interactions are rare.

Additionally, this study discovered that the total endoparasites prevalence in bats in Lafia city was 10.0%, which is lower than the 14.0% prevalence that Carbonara *et al.* (2022) recorded in Costa Rica. Lafia's climate, habitat type, and environmental cleanliness may all have an impact on parasite transmission, which might explain the reduced prevalence. Some parasites and their infectious stages may be less likely to survive and proliferate in drier or less humid environments. Also, bat species found in Lafia may differ in their vulnerability to endoparasites or display exposure limiting behaviors. For instance, bats species that roosts in dense colonies or in an area with high environmental contaminations e.g. caves, abandoned buildings might have increased exposure to parasites transmitted via feces or contaminated surfaces.Conversely, species that roosts solitarily or in less contaminated environments may have reduced risk. Furthermore, differences in detection sensitivity, diagnostic techniques, and sampling durations can all have an impact on prevalence rates.

The six chosen locations have varying ectoparasite prevalence rates. Phase II showed a much greater incidence than Bukan Kwanto, Mararaba, Gandu, Gimare, and Kwandare. The reason for this might be that, in contrast to the smaller bat species observed in the other locations, more fruit bats were taken in Phase II. The bigger size of fruit bats probably contributes to their tendency to carry more ectoparasites. Andrianiaina *et al.*'s (2025) findings are consistent with the findings of this study. However, on endoparasite distributions, with Mararaba having the greatest frequency. Higher bat concentrations, ample food sources, and appropriate roosting locations are some of the favorable circumstances that the Mararaba ecological habitat may offer, increasing the risk of parasite exposure and transmission. Also, bats that eat fruit or insects are more likely to have endoparasites and these species are common in Mararaba. These observations align with the research conducted by Leal *et al.* (2019). The places with lesser incidence, such as Gandu, Phase II, Gimare, Bukan Kwanto, and Kwandare Road, may, on the other hand, have features that hinder the spread of parasites, such as fewer food supplies, lower bat numbers, or unfavorable environmental circumstances. This study has also revealed higher prevalence of endoparasites in females than their male's counterpart. This could be because females tend to stay in roosts longer than males do, which may raise the likelihood that they will become infected with ectoparasites. This result is consistent with studies by Kedang *et al.* (2023) and Bezerra and Bocchiglieri (2023). Furthermore, maternity colonies' increased density and social interactions make it simpler for ectoparasites like mites, ticks, and bat flies to spread and accumulate.

During pregnancy and lactation, reproductive hormones such as progesterone and estrogen might alter immunological responses. Immune suppression may take place to avoid fetal rejection, which unintentionally weakens the host's defenses against ectoparasite infestations. As a result, females may be less able to eradicate infestations and more vulnerable to parasite colonization because of this immunological suppression. Additionally, compared to males, a female's capacity to properly remove ectoparasites may be limited by the physical strain of childbearing and raising of young ones by spending more time in close proximity to their young, which facilitates the spread of ectoparasites. On the other hand, endoparasites were more common in male bats than in female bats. This could be because more male bats were apprehended. Additionally, male bats often exhibit distinct physiological traits and behaviors that may increase their susceptibility to parasite infections Males tend to be more active and have wider ranges, which may expose them to a wider range of contaminated environments and intermediary hosts that carry parasites. Male hormone such as the greater testosterone levels in bats, may weaken the immune system and make them more vulnerable to infections. This is also reported by the findings of Bocchiglieri (2023) and Schaeret *et al*. (2013).

Out of all the bat species in this study, *Eidolon helvum* had the greatest ectoparasite prevalence. Changes in their ecological and behavioral traits might be the cause of this. These variations are mostly caused by the behaviors of each species, particularly their eating and movement routines. Being a highly mobile bat and long distance flier, *E. helvum* regularly moves to new locations in pursuit of food, potentially exposing it to ectoparasites present in a variety of environments. The bats can more easily encounter hosts or parasite infested habitats as a result of this extensive movement. The other species, on the other hand, may have more restricted roosting or movement patterns that restrict their encounters with parasite or contaminated sources. When compared to other bat species, *T. brasilensis* had the greatest endoparasite prevalence. This could be related to its dietary habits of being insectivorous which are more exposed to parasites that are transmitted through insects such as certain helminths or protozoans especially if their prey is contaminated.Their foraging practices, like hunting in regions with a high concentration of parasite eggs or larvae, increases their exposure even more. It's possible that the diets and foraging habits of the other bat species differ. This concurs with Becker *et al.* (2025).

## CONCLUSION

This study established an overall prevalence of 3.64% for ectoparasites and 10.0% for endoparasites among bats in Lafia metropolis. The ectoparasites identified included ticks, flea, Nycteribia spp., and mites, while the endoparasites comprised Coccidia spp., Taenia spp., Sarcocystis spp., Balantidium spp., Ascaris spp., Toxocara spp., Giardia spp, Entamoeba spp., Cryptosporidium spp., and Hymenolepsi spp. Therefore, maintaining healthy habitats, and practicing good hygiene when handling bats are paramount. Future studies should utilize PCR techniques to differentiate between closely related species that cannot be distinguished morphologically. This approach will enhance our understanding of the species diversity of ecto- and endoparasites in bats within the region.

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