Scientific Research Publishing

**Open Journal of Animal Sciences, 2026, 16(1), 1-12**
https://www.scirp.org/journal/ojas
ISSN Online: 2161-7627
ISSN Print: 2161-7597

# Ectoparasites and Rodents in the Republic of Guinea: A Critical Interface for Disease Transmission

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**How to cite this paper:** Kolié, B., Diallo, S., Diallo, M.G., Diallo, A.O.S., Bah, B.S.S., Konate, D., Conde, Y., Mamadou, B.Y., Sacko, N., Tolno, F.R. and Boumbaly, S. (2026) Ectoparasites and Rodents in the Republic of Guinea: A Critical Interface for Disease Transmission. *Open Journal of Animal Sciences*, **16**, 1-12.
https://doi.org/10.4236/ojas.2026.161001

**Received:** September 25, 2025
**Accepted:** November 21, 2025
**Published:** November 24, 2025

## Abstract

Parasites affect their hosts by disrupting physiological functions or by reproducing excessively. This study aimed to assess the role of rodent ectoparasites in the transmission of zoonotic agents in the Republic of Guinea, in order to identify potential health risks and propose appropriate control strategies. Between April 2021 and August 2022, 200 Sherman traps were deployed across eight prefectures representing diverse ecosystems, leading to the capture of 1114 rodents belonging to 18 species, including *Rattus rattus* (n = 427), *Mus musculus* (n = 170), *Mus* spp. (n = 145), and *Cricetomys gambianus* (n = 72). A total of 356 ectoparasites were collected, comprising three mite species and four insect species. Molecular analyses (PCR and RT-PCR) revealed the presence of *Mammarenavirus Lassa* (3 cases), *Borrelia* spp. (36 cases), *Anaplasma* spp. (5 cases), *Ehrlichia* spp. (4 cases), *Leptospira* spp. (4 cases), and *Coxiella burnetii* (1 case). The prefectures of Nzérékoré and Kindia emerged as high-risk areas for zoonotic transmission. These findings highlight the importance of epidemiological surveillance of rodents and their ectoparasites to prevent infectious diseases in humans.

## Keywords

Ectoparasites, Rodents, Zoonoses, Public Health, Guinea

## 1. Introduction

Host-parasite dynamics examine the evolution of host and parasite populations over time and across different environments. These dynamics are influenced by a combination of biotic and abiotic factors, as well as by evolutionary processes. Co-evolution within host-parasite systems plays a central role, enabling parasites to adapt to their hosts while allowing hosts to develop effective defense mechanisms. According to evolutionary theory, models in disease ecology predict that pathogens involved in infectious diseases co-evolve with their hosts and typically disappear before the host populations become locally extinct [1] [2].

In the African context, several studies highlight that parasites and pathogens play a decisive role in shaping ecosystem dynamics. Long neglected by classical ecology, they can act as true population regulators by influencing host density, distribution, and behavior [3]. In West Africa, recent molecular and ecological surveys have revealed a wide diversity of infectious agents associated with rodents (bacteria, viruses, protozoa) and demonstrated that host community composition and infection prevalence vary greatly with seasonality, land use, and proximity to human settlements [4] [5].

In West Africa, rodents play a major role in the transmission of numerous pathogens of medical and veterinary importance. Among these, viruses, particularly Lassa virus, occupy a central position due to their epidemiological impact and wide geographic distribution. Recent studies indicate that transmission dynamics are strongly influenced by host species diversity and their proximity to human settlements [6]. Molecular and eco-epidemiological investigations reveal increased circulation of Lassa virus and other zoonotic agents among various Mastomys and Mus species, suggesting interspecies transmission events and ecological plasticity of the reservoirs. [7] highlights that changes in land use, agricultural expansion, and urbanization promote rodent population growth and increase the risk of human-reservoir contacts. These findings confirm that rodents constitute a critical link at ecological and health interfaces, underscoring the need for integrated surveillance within a One Health framework.

Recent field studies have also revealed major changes in reservoir and zoonotic pathogen dynamics. For example, surveys conducted in Senegal detected several bacterial and protozoan families in wild rodents, emphasizing the potential role of invasive species and landscape modifications in the emergence of new pathogens [4]. Similarly, studies in Nigeria and elsewhere in West Africa have reported an increased prevalence and greater diversity of rodent species carrying Lassa virus, suggesting interspecies transmission events and a broader distribution of viral lineages than previously recognized [8].

Moreover, intervention and applied ecology studies show that conventional rodent population control strategies (trapping, rodenticides) do not always result in sustainable reductions of viral transmission risk and may sometimes lead to unexpected outcomes such as rapid population recovery, compensatory reproduction, or the persistence of chronic carriers. These findings highlight the need for integrated approaches inspired by the "One Health" framework, combining ecological surveillance, environmental management, and community engagement [9].

Finally, global environmental changes, habitat fragmentation, agricultural intensification, and climate change, alter the geographic distribution and temporal dynamics of pathogens. Large-scale approaches integrating time series, epidemiological mapping, and reservoir surveys are therefore indispensable to understand the persistence and transmission of zoonotic pathogens in human and animal populations in West Africa. Integrating molecular, ecological, and socio-environmental data is essential for designing more targeted interventions to mitigate spillover risks [5] [9].

The loss of biodiversity and the degradation of ecosystems, exacerbated by deforestation and agricultural expansion, disrupt ecological balances and promote the emergence of new infectious diseases. Habitat fragmentation reduces the genetic diversity of animal populations, making them more vulnerable to diseases and disrupting natural regulatory mechanisms [10].

Within this context, the study of rodents and their ectoparasites in Guinea is particularly crucial. Rodents serve as reservoirs for numerous zoonotic pathogens, while their ectoparasites play a central role in transmitting infectious diseases to humans and domestic animals. Understanding the diversity, abundance, and distribution of these hosts and vectors across different ecosystems (bushlands, agricultural fields, villages, orchards, warehouses, and riverbanks) is essential for assessing health risks and designing effective prevention strategies.

**General Objective**

To assess the impact of rodents and their ectoparasites on the transmission of zoonoses in the Republic of Guinea.

**Specific Objectives**

- To record and identify rodent species present in the study areas;
- To collect and analyze ectoparasites associated with captured rodents;
- To identify and characterize the main zoonotic diseases circulating in the investigated regions.

## 2. Material

Rodents were handled using personal protective equipment (lab coat, gloves, face mask, goggles, visor, helmets) and captured with H.B. Sherman, Formizon, and traditional traps. Sampling and analyses were performed with standard laboratory instruments (scissors, forceps, scales, tubes, syringes, absorbent cotton), disinfection materials (70% alcohol, chlorine, NaCl solution), observation and documentation tools (lamps, magnifying glasses, camera, logbook), as well as molecular analysis equipment, including RNeasy Plus kits, Tissue Lyser LT, and Amplisens Ribo Prep reagents (Qiagen, Hilden, Germany).

### 2.1. Biomaterial and Sampling

The biomaterial studied included rodents, their ectoparasites (mites and insects), and biological samples. Capture campaigns were conducted between April 2021 and August 2022 in several prefectures of the Republic of Guinea. The snowball sampling approach was adopted to optimize collection by progressively expanding captures from the first identified specimens, thereby enabling the detection of other individuals or colonies associated with the same habitats or ecological networks. This method is particularly useful in contexts where species distribution is heterogeneous or poorly known, as it increases the likelihood of obtaining a representative sample despite logistical constraints. In total, 1114 rodents were trapped, from which 356 ectoparasites were collected for both morphological and molecular analyses.

## 2.2. Methodology

The study was conducted from April 2021 to August 2022, covering both dry and rainy seasons.

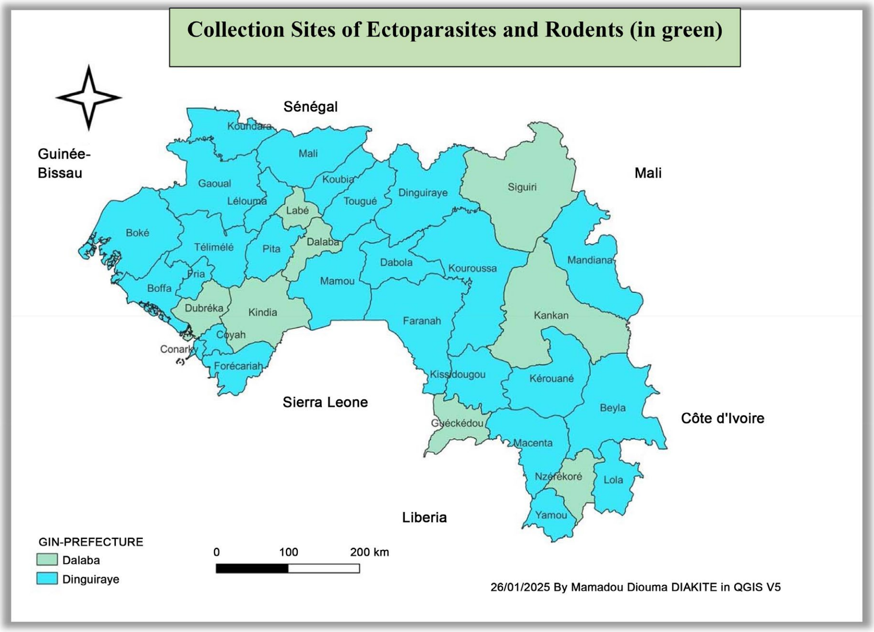

Figure 1. Map of the Republic of Guinea showing our study areas colored in green.

Sites were selected based on their biodiversity and characterized according to floristic composition and surface area (See Figure 1), using the transect method. Three types of rural plots were chosen: bushland, agricultural landscapes distant from villages, and villages with adjacent gardens. Each site measured 72 × 135 m, with 50 to 200 traps depending on site characteristics. The traps (Sherman, Russian, or traditional) were regularly spaced, numbered, and checked twice daily (morning and evening).

**Trapping effort** = Number of traps × Number of nights (trap-night)

- **Site A (bush, in agricultural landscape far from the village):** 80 traps × 4 nights = 320 trap-nights

- **Site B (near the village and its gardens):** 65 traps × 3 nights = 195 trap-nights
- **Site C (residential house and warehouses):** 55 traps × 2 nights = 110 trap-nights

**Total effort =** 625 trap-nights

- **Site A:** 320/625 × 100 ≈ 51.2%
- **Site B:** 195/625 × 100 ≈ 31.2%
- **Site C:** 110/625 × 100 ≈ 17.6%

Captured rodents were placed in moistened cotton bags to prevent dehydration and transported to the laboratory, where they were euthanized according to standard protocols. Each specimen was weighed, measured, and examined for sex and species determination. Capture information (date, location, animal ID, and trap number) was recorded in a logbook. Species identification followed classical methods described by [11] [12].

Ectoparasites were collected prior to dissection by visual inspection, careful brushing of the rodent body, and direct removal of ticks to preserve the rostrum necessary for identification. All specimens were stored in 70% ethanol and kept at −20˚C until further analysis (**Figure 2**).

In total, 1114 rodents were captured, yielding 356 ectoparasites. These samples formed the basis for morphological and molecular analyses aimed at evaluating the role of rodents and their ectoparasites in the transmission of zoonoses in Guinea.

**Figure 2.** Search and collection of ectoparasites from small mammals using visual inspection and careful brushing methods, including the identification of mites and hematophagous insects (Kolié, 2021).

## 2.3. Viral Detection

Detection of Arenaviridae RNA was performed using the commercial Amplisens Ribo Prep kit (Central Research Institute of Epidemiology, Moscow, Russia). Total RNA was extracted from skin homogenates, ectoparasites, oral swabs, blood plasma, urine, and non-pooled organ tissues (brain, liver, spleen, lungs, kidneys, lymph nodes, and salivary glands) of RT-PCR-positive animals, following the manufacturer's instructions and using the same extraction method.

## 3. Presentation of Results

Out of a total of 1114 rodents captured, five families were identified through morphometric analysis: Muridae, Soricidae, Nesomyidae, Sciuridae, and Gliridae. The distribution of the various species within these families is presented in Table 1 and Table 2.

Table 1. Species composition of captured rodent populations.

| Order | Families | Especies |
|---|---|---|
| Rodentia | *Muridae* | *Mus* spp. (Linné, 1758) |
| | | *Mus musculus* (Linnaeus, 1758) ou spp. |
| | | *Rattus rattus* (Linnaeus, 1758) |
| | | *Praomys daltoni* (Thomas, 1892) |
| | | *Lemniscomys zebra* (Heuglin, 1864) |
| | | *Mastomys natalensis* (Smith, 1834) |
| | | *Mus setulosus* (Peters, 1876) |
| | | *Praomys rostratus* (Miller, 1900) |
| | | *Lophuromys sikapusi* (Temminck, 1853) |
| | | *Lemniscomys striatus* (Linnaeus, 1758) |
| | | *Dasymys rufulus* (Meunier, 1900) |
| | *Soricidae* | *Crocidura* sp. (Walger, 1832) |
| | *Nesomyidae* | *Cricetomys gambianus* (Château d'eau, 1840) |
| | *Sciuridae* | *Epixerus ebii* (Temminck, 1853) |
| | | *Funisciurus pyrropus* (Cuvier, 1833) |
| | | *Heliosciurus gambianus* (Ogilby, 1835) |
| | | *Xerus erytropus* (Desmarest, 1817) |
| | *Gliridae* | *Graphiurus kelleni* (Reuvens, 1890) |

Table 2. List of ectoparasites identified in rodents by family and species.

| No. | Order | Families | Especies |
|---|---|---|---|
| 1 | Acariens | Ixodidae | *Ixodes* spp. (Linnaeus, 1758; Latreille, 1795) |
| 2 | | Dermanyssidae | *Ornithonyssus bacoti* (Hirst, 1913) |
| 3 | | Myobiidae | *Radfordia ensifera* (Poppe, 1896) |
| 4 | Insectes | Pulicidae | *Ctenophalides felis* (Bouché, 1835) |
| 5 | | | *Xenopsylla cheopis* (Rothschild, 1903) |
| 6 | | Ceratophyllidae | *Nosopsyllus fasciatus* (Bosc d'Antic, 1800) |
| 7 | | Haematopiridea | *Polyplax spinulosa* (Burmeister, 1839) |

The analysis of this table reveals a high taxonomic diversity among the rodents, with a predominance of Muridae, which is expected in inhabited or agricultural areas. The diversity of families and species highlights the presence of various microhabitats and ecological niches, providing a wide range of hosts for ectoparasites and zoonotic agents. The rodents listed in this table are therefore key indicators for the study of zoonoses, as their variety, abundance, and distribution directly influence parasite dynamics and the transmission of infectious diseases.

The analysis of this table highlights the diversity of identified ectoparasites (7 species, belonging to 2 orders and 7 families) and reflects the strong interactions between rodents, their parasites, and the environment.

Some ectoparasites, such as *Xenopsylla cheopis*, *Ixodes* spp., and *Ctenocephalides felis*, are major vectors of zoonotic diseases of medical importance (plague, rickettsioses, borrelioses). This parasitic composition suggests that the studied rodents constitute a significant epidemiological reservoir in Guinea, warranting enhanced surveillance to prevent emerging or re-emerging diseases.

Detailed results on rodent ectoparasite collection and pathogen detection are presented in **Table 3** and **Table 4**.

**Table 3.** Ectoparasites collected from rodents.

| Rodent species<br>Ectoparasite species | *Mus musculus* | *Ratus ratus* | *Cricetomys gambianus* | *Crocidura* spp. | *Mastomis natalensis* | *Praomys daltoni* | *Xerus erytropus* | *Mus* spp. | *Mus setulosus* | *Lophuromys sikapusi* | *Dasymys rufulus* | *Lemniscomys striatus* | *Praomys rostratus* | Totaux |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ixodes* spp. | 0 | 12 | 10 | 0 | 0 | 0 | 3 | 0 | 0 |  | 9 | 0 | 0 | **34** |
| *Ornithonyssus bacoti* | 0 | 10 | 8 | 0 | 0 | 0 | 0 | 7 | 5 | 6 | 0 | 2 | 0 | **38** |
| *Radfordia ensifera* | 4 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 7 | 1 | 0 | **32** |
| *Ctenophalides felis* | 10 | 95 | 6 | 0 | 0 | 0 | 5 | 0 | 0 | 7 | 4 | 8 | 0 | **135** |
| *Nosopsyllus fasciatus* | 2 | 18 | 12 | 0 | 3 | 0 | 5 | 2 | 7 | 0 | 0 | 0 | 0 | **49** |
| *Polyplax spinulosa* | 0 | 13 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **23** |
| *Xenopsylla cheopis* | 0 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **45** |
| Total | **16** | **204** | **46** | **0** | **3** | 0 | **13** | **9** | **12** | **22** | **20** | **11** | **0** | **356** |

A total of 356 ectoparasite infestations were recorded, The distribution of parasites is given as shown in **Table 3**. The diversity of collected parasites highlights strong interactions between rodents and hematophagous arthropods, playing a central role in zoonotic disease transmission.

Three parasite-host pairs dominate the dynamics:

- *Ctenocephalides felis-Rattus rattus*
- *Xenopsylla cheopis-Rattus rattus*

- *Hemimerus* spp.-*Cricetomys gambianus*

Broad-spectrum parasites include *Ixodes* spp., which was collected from *R. rattus*, *C. gambianus*, *X. erythropus*, and *D. rufulus*. Its multi-species distribution suggests a role in interspecific circulation of pathogens such as *Borrelia* and *Anaplasma*.

*Ornithonyssus bacoti* infests multiple rodent species (*R. rattus*, *C. gambianus*, *Mus* spp., *Mus setulosus*, *L. sikapusi*, *L. striatus*), highlighting its low host specificity and ability to transmit easily between hosts, including humans.

*Nosopsyllus fasciatus* affects both commensal species (*R. rattus*, *Mus musculus*, *Mus* spp.) and sylvatic species (*C. gambianus*, *X. erythropus*, *M. natalensis*), confirming its ecological plasticity.

Finally, *Rattus rattus* is by far the most heavily infested host, harboring over six parasite species with high rates of *C. felis*, *X. cheopis*, and *P. spinulosa*, making it the primary reservoir and vector of ectoparasites in urban and rural environments. *Cricetomys gambianus* is also highly parasitized, particularly by *Hemimerus* spp. (host-specific), as well as *Ixodes* spp. and *Nosopsyllus fasciatus*, serving as a secondary reservoir of strategic importance. Other rodents (*Mus* spp., *Lophuromys*, *Dasymys*, *Lemniscomys*, etc.) show lower but diverse infestations, contributing to the eco-epidemiological dispersal of ectoparasites across various habitats (fields, forests, human settlements).

**Table 4.** Pathogen frequency by rodent species (PCR/RT-PCR).

| No. | Species | Number of Samples | Pathogenic Agents | Number of Positive Cases | Percentage |
|---|---|---|---|---|---|
| 1 | *Mus* spp. | 145 | *Borrelia* spp. | 10 | 0.90 |
| 2 | *Mus musculus* | 170 | *Borrelia* spp. | 8 | 0.72 |
| 3 | *Rattus rattus* | 427 | *Borrelia* spp. | 15 | 1.35 |
| 4 | *Mastomys natalensis* | 70 | *Mamarenavirus lassa* | 3 | 0.27 |
| | | | *Borrelia* spp. | 1 | 0.09 |
| 5 | *Crocidura* spp. | 42 | *Anaplasma* spp. | 3 | 0.27 |
| 6 | *Lophuromys sikapusi* | 58 | - | 0 | 0 |
| 7 | *Dasymys rufulus* | 33 | *Borrelia* spp. | 2 | 0.18 |
| | | | *Leptospira* spp. | 3 | 0.27 |
| 8 | *Lemniscomys striatus* | 53 | *Anaplasma* spp. | 2 | 0.18 |
| 9 | | | *Leptospira* spp. | 1 | 0.09 |
| 10 | *Cricetomys gambianus* | 72 | *Ehrlichia* spp. | 4 | 0.36 |
| 11 | *Xérus erytropus* | 12 | *Coxiella burnettii* | 1 | 0.09 |
| 12 | *Lemniscomys zébra* | 16 | *Borrelia* spp. | 2 | 0.18 |
| 13 | *Praomys daltoni* | 4 | - | 0 | 0 |
| 14 | *Praomys rostratus* | 2 | - | 0 | 0 |
| 15 | *Funisciurus pyrropus* | 5 | - | 0 | 0 |

**Continued**

| | | | | | |
|---|---|---|---|---|---|
| 16 | *Heliosciurus gambianus* | 3 | - | 0 | 0 |
| 17 | *Epixerus ebii* | 1 | - | 0 | 0 |
| 18 | *Graphiurus kelleni* | 1 | - | 0 | 0 |
| | Total | **1114** | - | **55** | **4.98** |

Out of 1114 samples, 55 positive cases were detected, corresponding to a prevalence of 4.98% (See **Table 4**). This indicates that pathogen circulation remains relatively low but not negligible, suggesting the possibility of discreet endemicity.

*Rattus rattus* is the most affected species (15 positive cases; 1.35%), confirming its central role as a potential reservoir in urban and peri-urban environments.

*Cricetomys gambianus* shows a prevalence of 0.36%, but harbors a medically important pathogen (*Ehrlichia* spp.), representing a notable zoonotic risk.

*Mus* spp. and *Mus musculus* account for 18 positive cases (1.62%), indicating their active involvement in the dissemination of *Borrelia* spp.

*Borrelia* spp. was detected in multiple species (*Mus* spp., *Mus musculus*, *Rattus rattus*, *Dasymys rufulus*, *Lemniscomys zebra*), suggesting wide interspecific dispersion.

*Mammarenavirus Lassa* was detected only in *Mastomys natalensis* (3 cases, 0.27%), consistent with the recognized role of this rodent as the natural reservoir of Lassa virus.

*Leptospira* spp. and *Anaplasma* spp. were sporadically detected in *Dasymys rufulus* and *Lemniscomys striatus*, indicating localized eco-epidemiological foci.

*Coxiella burnetii* (1 case in *Xerus erythropus*), although rare, is the causative agent of Q fever, a zoonosis of veterinary and human importance.

These results confirm that synanthropic rodents (*Rattus*, *Mus*, *Mastomys*) are the main reservoirs of zoonotic agents. The low but significant detection of pathogens with high public health impact (*Lassa*, *Ehrlichia*, *Borrelia*, *Leptospira*) reflects a latent risk of transmission to humans, especially in areas with high human-rodent contact.

## 4. Discussion

Our results indicate that the study areas are particularly rich in ecosystems, as evidenced by the diversity of rodent fauna observed. Overall, rodents were closely associated with various vegetation formations, confirming their role as ecological indicators. The composition of the populations during this year of research revealed 18 species captured, a higher number than the 11 species reported by [13]. The Kindia region stands out for its greater species richness, with 16 species identified, surpassing the 12 species inventoried by [14] in the same area. These observations confirm the dynamic and complex nature of small mammal communities in the Republic of Guinea.

Regarding ectoparasites, all collected specimens consisted of mites belonging to the families Ixodidae, Dermanyssidae, and Myobiidae, as well as blood-feeding insects from the families Ceratophyllidae, Haematophiridae, and Pulicidae. In total, 356 ectoparasites were collected and distributed across seven species: *Ixodes* spp., *Ornithonyssus bacoti*, *Radfordia ensifera*, *Ctenocephalides felis*, *Nosopsyllus fasciatus*, *Polyplax spinulosa*, and *Xenopsylla cheopis*. This result differs from [15], who collected 539 ectoparasites in Benin but only identified four species. Furthermore, all ticks identified in our study belonged to the genus *Ixodes*, representing all three developmental stages (larvae, nymphs, and adults), consistent with the findings of [16] in Madagascar, who also reported the coexistence of all three tick stages on small mammals.

The ectoparasite abundances observed on *Rattus rattus* are comparable to those reported by [14], who considered this species the most heavily infested host, ahead of *Rattus norvegicus* and *Arvicanthis niloticus*. However, our observations differ from those of [17] in Egypt, where *Rattus norvegicus* was reported as the most abundant. These discrepancies highlight the geographic and ecological variability in the distribution and dynamics of hosts and their ectoparasites.

A key finding of our study is the detection, via PCR, of two positive cases of Lassa mammarenavirus, both from rodent blood and organ samples as well as from homogenates of mites and insects. This discovery is epidemiologically significant, given that confirmed cases of Lassa fever were reported by Guinean health authorities in Yomou in May 2021 and in Guéckédou in April 2022 [18]. These results confirm that rodents play a central role as pathogen reservoirs and, through their ectoparasites, serve as a source of infection for humans.

This situation more broadly illustrates the role of rodents in the transmission of infectious diseases, which is not limited to hemorrhagic fevers but extends to other zoonoses, including mosquito-borne arboviruses such as dengue and chikungunya. These diseases, strongly influenced by climatic and environmental conditions, reflect ecological disturbances caused by human activities that facilitate pathogen spread and accelerate biodiversity loss. A comprehensive analysis of our results highlights that the highest-risk areas are Nzérékoré and Kindia, due both to their richness in micromammals and the density of contacts among hosts, parasites, and human populations.

## 5. Conclusion

This study revealed the diversity of rodents and their ectoparasites across four natural regions of the Republic of Guinea, confirming their role as reservoirs for several zoonoses. Molecular and bacteriological analyses detected zoonotic pathogens, underscoring the potential for disease transmission between species and to humans. Although the overall health risk appears moderate, the presence of potentially dangerous zoonoses, particularly for exposed professionals, warrants strengthened surveillance. These findings highlight the importance of an integrated “One Health” approach to prevent disease spread, taking into account interactions between wildlife, vectors, and the environment.

## Authors' Contributions

**Conceptualization**: Kolié Bonaventure, Diallo Alpha Oumar Sily, Bah Boubacar Sidy Sily.

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## Acknowledgements

We express our sincere gratitude to the Guinean government through the Ministry of Higher Education, Scientific Research, and Innovation, the University of Kindia (UK), the Higher Institute of Veterinary Science and Medicine of Dalaba (ISSMV/Dalaba), the Institute of Applied Biology Research of Guinea (IRBAG/Kindia), the International Center for Research on Tropical Infections in Guinea (CIRIT-Guinea), the Central Research Institute of Epidemiology in Moscow, Russia, and the Laboratory of Applied Research in Natural Sciences (LARASCINA) for their support.

## Conflicts of Interest

The authors declare no competing financial interests relevant to the content of this article.

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