Blood parasites of the Black Rat (Rattus rattus) In El-Kala National Park in north-eastern Algeria

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Abstract. El-Kala National Park in north-eastern Algeria, a UNESCO Biosphere Reserve, is a protected yet inhabited area where diverse ecosystems and human activities coexist within the agriculturally oriented wilaya of El-Tarf. The cosmopolitan black rat (*Rattus rattus*) is widespread in the park and may act as a reservoir for ectoparasites, endoparasites, and blood parasites, potentially affecting wildlife, human health, and ecosystem stability. This study provides the first baseline assessment of blood parasite diversity in *R. rattus* within the Wildlife Park, the core zone of the Biosphere Reserve. A total of 115 rats were examined, and 200 thin blood smears were prepared and stained using May Grünwald–Giemsa for microscopic analysis. Five blood parasite taxa were observed, including forms morphologically compatible with *Plasmodium spp*. (notably *P. falciparum-like* organisms), *Plasmodium tomodoni*, *Fallisia simplex, Trypanosoma thecadactyli*, and a *Trypanosoma sp*. related to the *T. brucei* group. The overall infection prevalence reached 47.66% (55/115). These findings reveal a substantial infection burden in *R. rattus* and highlight its potential role as a reservoir facilitating parasite transmission within this inhabited protected area. This baseline study provides essential data to guide routine health surveillance and integrated parasite management as key components of sustainable wildlife conservation.

1 Introduction

El-Kala National Park in north-eastern Algeria, designated as a UNESCO Biosphere Reserve, is an inhabited protected area where diverse terrestrial, freshwater and coastal ecosystems coexist with human activities. Entirely located within the agriculturally oriented wilaya of El-Tarf, the park supports a rich assemblage of flora and fauna, including numerous avian species and mammals of conservation concern. Among its most widespread inhabitants, the cosmopolitan black rat thrives in both natural and human-influenced habitats and is known to carry a variety of blood parasites that may affect wildlife health and ecosystem balance [1].

Despite the recognised role of rodents as reservoirs for blood parasites, data on *R. rattus* in North African protected areas remain scarce. Assessing the diversity of these parasites is essential for evaluating their potential ecological impact and for guiding wildlife health monitoring.

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This study was undertaken to provide the first baseline assessment of blood parasite diversity in *R. rattus* captured within El-Kala Wildlife Park. Our aim is to document the diversity of blood parasites infecting this species and to discuss the implications of these findings for sustainable wildlife management and biodiversity conservation in this inhabited protected area.

2 Materials and Methods

The study was conducted over two consecutive years within El-Kala National Park (P.N.E.K.), north-eastern Algeria, a UNESCO Biosphere Reserve and an inhabited protected area entirely located in the agriculturally oriented wilaya of El-Tarf. Sampling was distributed across different seasons over two consecutive years to reduce temporal bias.
Sampling took place in the Wildlife Park, specifically in areas associated with semi-captivity enclosures of the Barbary deer (*Cervus elaphus barbarus*), in food storage reserves for captive animals, and in surrounding agricultural lands (including peanut, vine and watermelon crops). Additional captures were carried out within nearby agglomerations in close proximity to human dwellings. This diversity of sampling habitats reflects the coexistence of wildlife, agricultural activities and human settlements within the core zone of the Biosphere Reserve.

During two consecutive years, *Rattus rattus* was trapped within the park at several sites, including semi-captivity enclosures of Barbary deer, food storage areas for captive animals, surrounding agricultural lands (peanut, vine, watermelon and other crops) and nearby human settlements.

Sherman traps were used. These traps proved highly effective for capturing *R. rattus.* Multiple baits were tested to maximise capture success, including peanut butter paste, stale bread mixed with canned tuna in oil and, in some cases, pieces of castile soap.

Traps were checked regularly, and captured animals were transported to the laboratory. A total of one hundred fifteen *Rattus rattus* individuals were captured. For each individual, one to two thin blood smears were prepared, resulting in a total of 200 smearsin total, all of which were examined microscopically. Captured rats were humanely euthanized following institutional ethical guidelines and national regulations to minimise animal suffering.

Prepared smears were examined under a light microscope. Several fields per slide were observed to identify blood cells and blood parasites. Parasite identification was based on morphological characteristics, developmental stages and cellular localization following published parasitological keys [2].

3 Results

A total of one hundred fifteen *Rattus rattus* individuals were captured over two years from semi-captivity enclosures of Barbary deer, food storage areas, surrounding agricultural lands and nearby human settlements within the Wildlife Park. Approximately 200 thin blood smears were examined microscopically.

3.1 Blood Cell Morphology

May Grünwald Giemsa-stained smears showed that mature erythrocytes of *R. rattus* are anucleate, biconcave discs with a paler central area. The size and shape of erythrocytes were homogeneous and consistent with normal mammalian morphology. Platelets appeared as small cytoplasmic fragments scattered among erythrocytes.

Leukocytes were observed in peripheral blood with the following characteristics: monocytes were large round cells with indented (U shaped) nuclei and pale cytoplasm; lymphocytes were small round cells with dense spherical nuclei occupying most of the cell; neutrophils displayed multilobed nuclei with lightly stained cytoplasm; and basophils showed irregular or bilobed nuclei with coarse cytoplasmic granules.

3.2 Blood Parasites Identification

Microscopic examination revealed infection by five blood parasite taxa. Three parasites belonging to the family Plasmodiidae were observed, including forms morphologically compatible with *Plasmodium spp., particularly P. falciparum-like* organisms, as well as *Plasmodium tomodoni* and *Fallisia simplex*.

Two Trypanosome morphotypes were identified: *Trypanosoma thecadactyli* and a *Trypanosoma sp*. morphologically related to the *Trypanosoma brucei* group.

3.3 Epidemiology and Zoonotic Risk

To assess the epidemiological significance of our findings, we evaluated, for each blood parasite detected, its zoonotic potential, transmission route, and relevance to public health.

Fig 1 provides a One-Health perspective on the transmission of zoonotic and vector-borne diseases by illustrating the interconnected roles of animal reservoirs, vectors, and human populations. *Rattus rattus* is identified as a key reservoir, while vectors such as Anopheles and Glossina spp. act as critical bridges for pathogen transmission. The inclusion of wildlife and livestock highlights their importance in sustaining pathogen circulation across ecological interfaces. This integrative representation underscores the need for interdisciplinary approaches to better understand and control diseases such as malaria and human African trypanosomiasis.

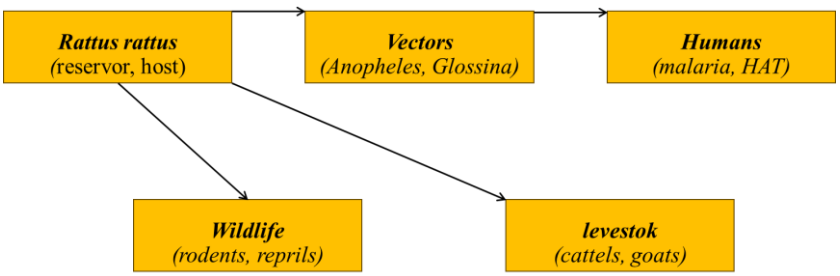

Fig. 1. Conceptual transmission cycle and One Health implications.

The detection of blood parasites in *Rattus rattus* prompted the development of a conceptual transmission scheme to assess potential zoonotic and ecological risks in El-Kala National Park. The model emphasizes the reservoir role of the black rat and its interactions with hematophagous vectors (mosquitoes, sand flies, ticks), which may enable parasite exchange among wildlife, domestic animals, and humans.

Although confirmed zoonotic transmission for some taxa remains limited, related species have been associated with human disease, suggesting a risk of spillover under favorable ecological conditions. Human exposure may occur through vector bites, direct contact with rodent tissues, or environmental contamination, particularly in peri-urban and agricultural interfaces.

These findings underscore the relevance of a One-Health perspective in protected natural areas, where rodent expansion, habitat overlap, and vector proliferation may facilitate parasite circulation. Continuous rodent-vector surveillance is therefore warranted to prevent potential emergence and safeguard both public health and biodiversity. The epidemiological and ecological characteristics of the detected parasites are summarized in Table 1.

Table. 1. Epidemiological and ecological risks associated with detected blood parasites [3-8].

Parasite species	Risk to humans	Environmental / ecosystem risk	Transmission route
Plasmodium falciparum (suspected)	High severe human malaria; detection in rats likely incidental	May compete with native rodent malaria parasites; possible indicator of anthropogenic pathogen spillover	*Anopheles* mosquitoes
Plasmodium tomodoni	No zoonotic risk (rodent-specific)	Can infect native rodent species → impacts wild murid populations	Rodent-feeding mosquitoes
Fallisia simplex	No known human infection	Spillover to small mammals may affect biodiversity and ecological dynamics	Suspected arthropod vectors (mosquitoes/sandflies)
Trypanosoma sp. (T. brucei-like morphotype)	Human African trypanosomiasis (associated with *T. brucei* complex)	Potential risk to livestock (trypanosomiasis), though vector absent in Algeria	Tsetse flies (*Glossina* spp.)

3.4 Infection prevalence and habitat distribution

A total of 115 *Rattus rattus* individuals were examined for blood parasites across three habitat types: agricultural fields (n = 42), food storage areas (n = 38), and peri-urban zones (n = 35). The overall prevalence of infection reached 47.66% (55/115) among the sampled population.

Habitat specific analysis revealed marked variation in infection rates. The highest prevalence was recorded in rats captured near food storage areas (61%), closely followed by peri-urban zones (58%), whereas individuals collected from agricultural fields exhibited a substantially lower infection rate (24%).

Although formal statistical comparisons were not performed in this preliminary survey, the observed differences suggest that anthropogenic environments characterized by food concentration, high rodent density, and increased contact interfaces may facilitate parasite transmission. In contrast, agricultural areas may present ecological conditions less favorable to sustained vector-host interactions.

These findings highlight the importance of habitat heterogeneity in shaping parasite circulation dynamics within inhabited protected areas.

4 Discussion

This study offers the first comprehensive overview of blood parasites in *Rattus rattus* from El-Kala National Park, an inhabited protected area of high ecological value. forms morphologically compatible with *Plasmodium falciparum. brucei,* reveals a substantial

parasitic burden in this common rodent. The predominance of *P. falciparum* with multiple developmental stages suggests active transmission cycles within the park, while the occurrence of *P. tomodoni and F. simplex*, typically described in reptiles, reflects the complexity of host-parasite interactions in a biodiverse environment where wild and domestic species coexist [9].

The overall infection prevalence of 47.66% observed in the examined population indicates a substantial circulation of blood parasites within *Rattus rattus* in El-Kala National Park. The marked variation across habitats, with higher prevalence in food storage areas and peri-urban zones compared to agricultural fields, suggests that anthropogenic environments may enhance transmission dynamics. Increased food availability, higher rodent density, and proximity to human activities likely create favorable conditions for sustained host vector interactions. These findings emphasize the role of habitat structure and ecological interfaces in shaping parasite distribution patterns in inhabited protected areas.

It should be noted that parasite identification in the present study was based exclusively on morphological criteria observed in stained blood smears. While several forms were morphologically compatible with *Plasmodium falciparum* and *Trypanosoma brucei*-like organisms, molecular confirmation was not performed. Therefore, species-level identification should be interpreted with caution. Future studies incorporating molecular tools (PCR-based assays) are necessary to confirm taxonomic status and better characterize parasite diversity in this rodent population.

Comparable studies in other human-influenced ecosystems have similarly reported elevated infection rates in synanthropic rodent populations, reinforcing the importance of ecological context in parasite maintenance.

The normal morphology of erythrocytes and the clear identification of major leukocyte types provide a reliable baseline for future haematological monitoring. Together, these findings establish reference data that can be used to detect possible haematological changes related to infection in future surveys.

When placed alongside previous investigations on the same *R. rattus* population documenting heavy infestations with ectoparasites (fleas and ticks) and multiple endoparasites (flatworms, small roundworms, stomach worms and cat worms), the present results highlight the truly multi-parasitic status of this species in the park. This cumulative evidence points to *R. rattus* as a key reservoir host at the interface between wildlife, agriculture and human settlements, capable of maintaining and disseminating diverse parasites across ecological compartments [10].

Although this study documents the presence of five distinct blood parasite species in *Rattus rattus*, the data collected do not yet allow assessment of coinfection patterns or potential competitive interactions among them. Individual level information on infection status and appropriate statistical analyses would be required to determine whether these parasites occur independently, exhibit positive associations, or exclude one another within hosts. Such investigations would provide valuable insights into parasite community dynamics and their implications for host health and disease transmission in this inhabited protected area.

From a public and animal health perspective, such a high diversity of parasites in *R. rattus* is of particular concern. Several of the blood parasites identified are known to cause disease or act as reservoirs for pathogenic agents in other vertebrates. Mixed parasitic infections may increase the likelihood of immunosuppression in host populations, facilitate spillover to endangered species and, in some cases, pose risks to humans living in close proximity to the park. These findings stress the need to implement routine health surveillance of rodent populations and integrated parasite management in protected areas. By combining new data

on blood parasites with existing knowledge of ecto and endoparasitic infections, this study provides a solid scientific basis for developing targeted prevention and monitoring strategies to support sustainable wildlife conservation, protect biodiversity and reduce health risks in an inhabited biosphere reserve [12].

The findings of the present study complement recent work conducted in Iringa District, Tanzania, where a low prevalence of haemoparasites and a high prevalence of ectoparasites were reported in rodents and shrews, with Anaplasma centrale and the mite Echinolaelaps echidninus identified as dominant species. In contrast, our investigation in El-Kala National Park revealed a higher diversity of blood parasites, including *Plasmodium falciparum, P. tomodoni, Fallisia simplex, Trypanosoma thecadacty* and *T. brucei*, in a population of *Rattus rattus* already known to host numerous ecto and endoparasites. Both studies converge in showing that small mammal communities in human influenced protected areas can sustain multi-parasitic burdens and may act as reservoirs or bridge hosts for a wide range of pathogens. This comparison underscores the need for integrated monitoring approaches that jointly address blood parasites, ectoparasites and endoparasites to better evaluate disease risks and guide conservation and public-health interventions [13].

Our findings echo the results of Babolin *et al.* (2016) in Brazil, who reported that *Rattus rattus* populations remained present despite public control measures and carried a wide range of zoonotic agents, including ectoparasites, *Calodium hepaticum* and antibodies to Leptospira and Vaccinia virus. Taken together with our data from El-Kala National Park, these observations underline the resilience of *R. rattus* in human-influenced environments and its role as a multi-parasite reservoir. They also highlight the limits of short-term control actions and the importance of sustained surveillance and integrated management to mitigate the risks of zoonotic transmission at the wildlife agriculture human interface [14].

The detection of *Plasmodium tomodoni* and *Fallisia simplex* in *Rattus rattus* is noteworthy because these genera are typically described in reptiles. According to Jacobson (2006), numerous Plasmodiidae and Trypanosoma are endemic in reptiles and are transmitted by a variety of arthropod vectors. The occurrence of these parasites in a mammalian host within El-Kala National Park may therefore reflect spillover events or shared vector exposure at sites where rodents and reptiles coexist. This observation reinforces the importance of understanding cross-species transmission pathways when evaluating parasite diversity and potential health risks in inhabited protected areas.

Our results also complement recent findings from Gabon, where Mbou-Boutambe *et al.* (2025) detected Plasmodium parasites in invasive *Rattus rattus*, albeit at very low prevalence. Together with our data showing multiple blood parasites in *R. rattus* within El-Kala National Park, this comparison highlights that invasive or synanthropic rodents can acquire local blood parasites and potentially participate in their transmission cycles. These observations reinforce the need to monitor not only native wildlife but also widespread commensal species when assessing the risks of parasite spread and the effectiveness of conservation and public health measures [15].

Although this study provides baseline qualitative data on parasite diversity, quantitative prevalence estimates and habitat-based statistical comparisons were beyond the scope of the present survey. Future investigations integrating individual infection data and multivariate statistical analyses will allow a more detailed assessment of coinfection patterns and habitat-related risk factors.

5 Conclusion

This study provides the first baseline data on blood parasites infecting *Rattus rattus* within El-Kala National Park, an inhabited UNESCO Biosphere Reserve. By documenting five blood parasite species in a rodent already known to host numerous ecto and endoparasites, our findings highlight the multi-parasitic status of this species and its potential role as a reservoir at the wildlife–agriculture–human interface.

In addition to potential human health implications, blood parasites associated with *R. rattus* may threaten native small mammals and, occasionally, domestic animals, reinorcing the importance of monitoring invasive rodents in biodiversity-rich regions such as El-Kala National Park. These results underscore the need for routine health surveillance of rodent populations and integrated parasite management to protect biodiversity, reduce disease risks and support sustainable wildlife conservation in inhabited protected areas.

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