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Ectoparasites and hemoparasites of the Emini Silvery Mole rats (Heliophobius Argentiocinereus Emini) in Morogoro region, Tanzania

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Abstract

Background: The silvery mole rat (Heliophobius Argentiocinereus Emini) is a subterranean rodent widely distributed across Sub-Saharan Africa and exploited as a protein source in some communities. Despite this, limited data exist on ectoparasite and hemoparasite infections in this species in Tanzania. This study aims to determine the prevalence of hemoparasites in silvery mole rats and to identify their potential arthropod vectors in the Morogoro region of Tanzania.

Methods: A cross-sectional study was conducted in Mvomero and Morogoro districts, Tanzania, between March and June 2023. A total of 137 silvery mole rats were captured through manual excavation. Ectoparasites were collected from animal fur and identified morphologically using taxonomic keys. Blood samples were obtained directly from the heart, and smears were prepared, stained with Giemsa, and microscopically examined for hemoparasites. Statistical analysis was performed to assess associations between host factors, ectoparasite infestation, and hemoparasite infection.

Results: Of the 137 captured mole rats, 65% (n=89) were females and 86.7% (n=120) were adults. The overall prevalence of ectoparasitism was 71.5% (98/137). A total of 1,503 ectoparasites were recovered, dominated by Androlaelaps spp. (93.15%, n=1400), followed by Echinolaelaps echidinus (6.19%, n=93), and Haemaphysalis spp. ticks (0.67%, n=10). Hemoparasites were detected in 29.2% (40/137) of hosts, including Anaplasma spp. (25.5%) and Babesia spp. (16.8%). Coinfections with both parasites occurred in 13.1% of individuals. Adult mole rats had significantly higher odds of hemoparasite infection (OR = 3.23, 95% CI: 1.15–9.11, p = 0.04). Tick infestation was strongly associated with Babesia spp. (χ^2 = 11.91, OR = 15.56, p < 0.001) and Anaplasma spp. (χ^2 = 5.82, OR = 8.3, p = 0.01).

Conclusion: This study demonstrates a high prevalence of ectoparasites and hemoparasites among silvery mole rats in the Morogoro region. The dominance of mite infestations and significant associations between ticks and blood parasites highlight the potential role of mole rats as reservoirs of zoonotic pathogens. Further molecular studies are warranted to characterize these parasites and evaluate their public health implications.

Keywords: Silvery Mole Rat, Heliophobius Argentiocinereus Emini, Ectoparasites, Hemoparasites, Anaplasma, Babesia, Prevalence; Zoonotic Diseases, Tanzania

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Background

The Emini Silvery Mole Rat (Heliophobius Argentiocinereus Emini) is a subterranean rodent with a wide distributional range throughout Sub-Saharan Africa [1,2]. These animal species are endemic to East and Central Africa, east of the Great Rift Valley, south of the Equator, and north of the Zambezi River, including Tanzania, Zambia, Malawi, Democratic Republic of Congo, South Africa, and Mozambique [2-4]. The Emin's silvery mole rat is endemic in the whole of Tanzania [1]. These small mammals live in the soil by burrowing in the ground, obtaining their food and water directly from the storage organs of underground root vegetation [4]. Rarely do they venture above the ground and include ground vegetation in their diet [5]. The season influences their burrow pattern, and they become more reticulated at the peak of the dry season when the soil is dry and hard [6]. The solitary living silvery mole-rat inhabits comparatively mesic habitats with subterranean food resources that are evenly distributed than their counterpart social genera that inhabit xeric regions with low and unpredictable rainfall [4, 7, 8]. Individuals show complex courtship lying down on their backs, characterized by breeding seasonally following the onset of long rainfall with one to six litters per adult female [1, 6, 9]. Due to their medium-sized body, they are utilized by local communities as an additional source of protein [10, 11]. Ectoparasites are organisms that infest the skin of a host [12].

Ectoparasites can induce several health issues in the host, including anemia, hypersensitivity, irritability, and skin lesions. Also, they play a paramount role as vectors of many pathogens of medical and veterinary importance [13]. There are reports of ectoparasites invading vertebrates, including rodents, some of which are blood-sucking arthropod vectors [14]. Fleas, ticks, mites, and lice are common examples of ectoparasites reported in rodents in Africa and elsewhere in the world, of which some are prominent vectors of plague, babesiosis, anaplasmosis, typhus, hemorrhagic fever, and spotted fever. Several studies have documented on presence of pathogens such as Anaplasma spp, Babesia spp, Borrelia spp, Bartonella spp, Coxiella burnetii, and Rickettsia spp, in arthropod vectors recovered in rodents [15, 16]. Hemoparasites are pathogens that invade the bloodstreams of the host, such as protozoa, filarial worms, and blood flukes, causing acute diseases with variable clinical symptoms including anemia, jaundice, anorexia, and weight loss [17]. Rodents have been reported to be among the major reservoir hosts of causative agents of plague, toxoplasmosis, leishmaniasis, babesiosis, and hemorrhagic fevers. Plague and hemorrhagic fevers are among the reported rodent-borne diseases in humans and animals associated with their hemoparasites and arthropod vectors harbored by them [18-20]. The silvery mole rat is one of the neglected species belonging to the order Rodentia. Globally, rodents constitute 42% of the world's mammalian population [21]. It has been reported to be one of the major reservoirs of pathogens that cause zoonoses and has played a central role in major epidemics [22]. Throughout Sub-Saharan Africa, including Kenya, Nigeria, South Africa, and Uganda, several studies have been conducted, focusing primarily on terrestrial rodents [23-26]. In Tanzania, hemoparasites, ectoparasite communities, and their associated pathogens in wild and house-dwelling rodents are well-studied issues [19, 27-31], whereas relatively little attention is paid to ectoparasites and hemoparasites in silvery mole rats. Since other families of the order Rodentia are serving as reservoirs host of several parasites, it's also possible for silvery mole rats to be serving the same function. Limited studies demonstrating parasitic infestation/infection in silvery mole rats lead to the lack of knowledge on their parasitic burden and their potential to transmit zoonotic diseases. This study will help to address the status of parasite infection/infestation in silvery mole rats. The baseline information on the burden of ectoparasites and endoparasites will generate knowledge that will be used in designing and implementing appropriate strategies to address zoonotic issues associated with silvery mole rats. Correct identification of parasites will help the responsible authorities to decide when and which measures to adopt before and during the control of zoonoses. Therefore, this study aims to investigate the prevalence of hemoparasites and the associated blood-sucking arthropod vectors in silvery mole rats in Morogoro region, Tanzania.

Methods

Study design Study area

We captured Silvery mole rats in Morogoro municipality (latitude 06049'20" S, longitude 037039'55" E and 509 meter above sea level) and Mvomero district (Latitude 060 57'16.45-48" S, longitude 0370 32'05.40-47" E, and 1266-1330 meters above sea level. The area is classified as an agri-ecological zone where Silvery mole rats are considered as agricultural pests. The study area experiences bi-modal type of rainfall with a mean annual of 600mm having short wet (November to January) and long wet (March to May) seasons. The remained months are dry season with temperature ranging from 18°C to 30°C whereby July, August, and September being the hottest months [32].

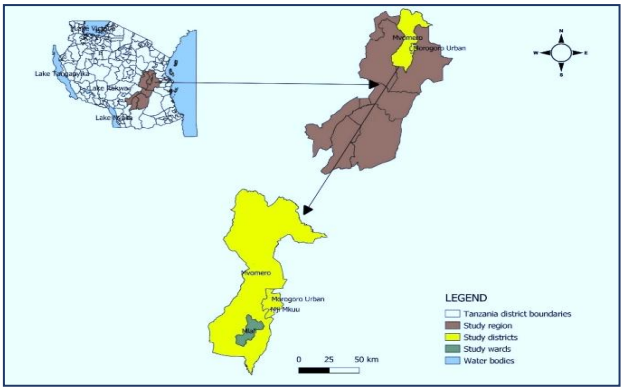

Figure 1. Map of Morogoro region highlighting the study area (Source: Shija DE, et al., 2024)

Study design, sampling strategies, and selection of the study area

A cross-sectional study design was carried out from March to June of 2023 at five different sites in the north-eastern area of the Morogoro Region (Mvomero and Morogoro districts) Animals were collected from Mji Mkuu division of the Morogoro District and in four villages (Mlali, Kipera, Mkuyuni, and Mongwe) of Mvomero District. Sampling sites were selected purposively based on vegetation characterized by underground storage organs (geophytes, bulb, and agricultural root production) and with evident fresh mole mounds as an indicator of burrowing activity by mole rats. Burrows were selected randomly by opening a distinct burrow within the farm fields following the positive responses of farm owners. We selected farms based on the presence of geophytes that form the staple diet of silvery mole rats [4] Mvomero and Morogoro urban districts are characterized by mesic climatic habitats, with a wide range of altitudes, rainfall patterns, and different vegetation with geophytes that make high chances of their availability. In addition, silvery mole rats have been deemed as agricultural pests in Mvomero district [33].

Capturing, handling, and transportation of silvery mole rats

Silvery mole rats were captured manually using hand hoes by digging out the burrow and the animals found in the burrow were picked using hands. Trapping was done in the early morning, following the help of new, fresh mole hills on the surface made every last night [6] and was conducted for 3 weeks with at least 20 animals in each study site. Captured animals were kept in 20-litre plastic buckets half filled with fresh soil, and tightened with lids containing aeration pores [9]. Captured animals were transported to the parasitology laboratory at Sokoine University of Agriculture Morogoro, where ectoparasites and blood samples were collected under the animals' maintenance guidelines of the American Society of Mammalogists [34].

Collection of ectoparasites and blood sample

Before sample collection, each animal was placed inside a killing bottle soaked with cotton wool containing Diethyl Ether (1 mL

diethyl ether/ 3 mL chamber volume) for euthanization. Once individuals were induced (after 3-4 min), ectoparasites were collected using a fine brush, fine-tooth comb, blunt forceps, and hand lens. The fur of each animal was combed with a fine-tooth comb to dislodge any ectoparasites onto an enamel tray. Forceps were used to remove mites from the skin when it was difficult to dislodge them by combing. The obtained contents were examined carefully with a hand lens and preserved in 70 % ethanol. Animals' body parameters were recorded (sex, age, and reproductive status) using body morphological features, whereby age based on their body size, reproductive and non-reproductive females were characterized based on the perforated vagina and non-perforated vagina, respectively, reproductive and non-reproductive males based on well-developed testes with large size and poorly developed testes with small size respectively. Animal boy weight (gm) was measured by using a digital weighing balance. Animals were dissected by opening the thoracic cavity, and blood was drawn directly from the heart using a 2ml syringe and kept on heparinized vacutainer tubes for hemoparasite identification. Viscera (liver, lungs, and kidneys) was also collected for preparation of impression smears.

Laboratory sample processing and identification of parasites

Ectoparasites were prepared for further identification, whereby mites were isolated first from each other by observing their dorsal surface (dorsal plate size), and grouped based on the size of their dorsal plate, for each group the ventral view was observed and individuals were classified to genus and species level where possible based on morphological features, the anal plate and genital pore were the basic key identification features. Ticks were placed on petri dishes, and wrapped with tissue paper to remove fixative that could block the passage of light during observation, starting with the dorsal view, the scutum and core scutum were observed to identify the sex of the specimen, the shape of the mouth, punctuation and festoon enameling, and presence or absence of eyes was used as key identification features categorize tick to their genus level. On ventral view, the anal plate and genital pore were observed. All identification procedures were done under a Stereo microscope (OPTA-TECH) under a magnification power of 45x, by following the taxonomic keys of the Pictorial keys for arthropod identification [35] and principles of veterinary parasitology [36] by following protocols according to Veterinary clinical parasitology [37]. Blood samples were used to prepare smears for hemoparasites identification, thick blood smears were prepared by spreading two drops of blood onto the center of a microscopic slide, and the unfixed slide was air-dried for 5 minutes. Thin blood smears were prepared by placing one drop of blood near one end of a microscopic slide, the spreader was placed with its edge touching the drop and inclined to enable a drop run along less than 900, and the spreader was squeezed forward on the slide to make a smear, the obtained smear was allowed to air dry, and fixed with methanol for about 3-5 minutes [30], a fresh cut of viscera (liver, kidney, and lungs) was made and lightened by applying a fresh cut surface of a piece of organ in several times, the slides made were waved in air. The prepared blood smears and impression smears were stained by 10% Giemsa stain (1:10 dilution) for 30 and 20 minutes respectively [38,39], and washed with running tape water for 10 seconds following protocols explained in Veterinary Clinical Parasitology [40] and standard operating procedures for Giemsa stain by the World Health Organization [41]. Stained slides were examined under the light microscope (OPTA-TECH) at 100x magnification with oil immersion, and approximately 200 fields of vision were inspected for the identification of blood parasites [42]. The hemoparasites were identified based on the morphology of different stages of the parasites by using the information and structures of parasitized red blood cells [42,43]..

Statistical analysis

The data collected were employed to compute the prevalence of ectoparasites and hemoparasites, which indicates the proportion of hosts within populations that were infested or infected with parasites. Prevalence was calculated by dividing the total number of silvery mole rats that tested positive for parasites (represented as 'n') by the total number of animals that were sampled (represented as 'N'). The results were then expressed as a percentage. In addition, the chi-square test was applied to assess the relationship between parasites and various body parameters of the animals. It was also used to examine the association between hemoparasites infections and ectoparasite infestations. In both cases, a p-value of < 0.05 was considered statistically significant. These associations were determined using the Epi-info version 7.2.4.0.

Results

Ectoparasite infestation

In this study, we examined 137 Emin's silvery mole rats for ectoparasites infestation and hemoparasites infection. Females comprised 65% (n=89) of the samples with 86.7% being adults (n=120) and 12.4% being sub-adults (n=17), as shown in (Table 1). A total of 1503 ectoparasites were recovered from 98 infested silvery mole rats (Figures 1, and 2). The overall prevalence of ectoparasites was 71.5% (98/137), single infestation was observed in 53.3% (73/137) of the hosts, and multiple infestations by two or three ectoparasites were found in 18.2% (25/137) of the hosts. Three species of ectoparasites that include Echinolaelap echidinus (Mite), Androlaelaps spp (Mite), and Haemaphysalis spp (tick) were identified (Figures 2 and 3). Among the collected ectoparasites Androlaelaps spp were recorded most frequently at 70.1%, followed by E. echidinus at 16.06% and Haemaphysalis spp at 5.1% with an average of 15 mites, 4 mites, and one tick per infested rat respectively (Table 2). The results of this study show that host age, sex, reproductive categories, and body weight had no significant association with the prevalence of ectoparasites infestation, with p-values > 0.05 (Table 1). However, adult and female silvery mole rats showed a slightly higher risk of either encountering or getting exposure to ectoparasites in comparison to their counterpart's sub-adult and males with an odds ratio (OD) of 1.05 (95% Confidence Interval (CI) 0.35-3.21) and 1.13 (95% CI 0.52-2.42) respectively. Furthermore, our findings suggest that breeding rats are at a slightly lower risk of encountering ectoparasites compared to non-breeding rats, with an odds ratio of 0.8 (95% CI 0.29-2.22).

Hemoparasites infection

The overall prevalence of hemoparasites infection was 29.19% (40/137). Anaplasma spp and Babesia spp were blood parasites detected from blood smear, kidney impression smear, liver impression smear, and lung impression smear (Figure 4). Of these, Anaplasma spp was found in 12.4% (17/137), Babesia spp

in 3.6% (5/137), and 13.1% (18/137) harbored both pathogens (Table 3). The prevalence of Anaplasma spp among tested rodents was 25.5% (35/137). Of these, 82.86% (n=29) were adults, 17.14% (n=6) were sub-adults, with a sex distribution of 77.14% (n=27) and 22.86% (n=8) for female and male respectively. Babesia spp had a prevalence of 16.8% (23/137), of these 73.9% (n=17) were adult, and 26.09% (n=6) were sub-adult, of which 78.26% (n=18) were female.

The age of silvery mole rats had a significant association with hemoparasites infection with a p-value < 0.04, a higher risk of acquiring blood parasite infection was observed in adult silvery mole rats than in their counterpart sub-adult silvery-mole rats with an odds ratio of 3.23 (95% CI 1.15-9.11) (Table 4). Other body parameters including sex and reproductive status had no association with hemoparasites infection with p-value > 0.05 (Table 4).

Table 1. The overall prevalence of ectoparasites of silvery mole rats collected in Morogoro region.

Variable	Category	Infested (n)	Prevalence (n/N ×100)	OD	95% CI	X2	P-value
Age	Adult (N=120)	86	71.67%	1.05	0.35-3.21	0.008	0.92
	Sub-adult (N=17)	12	70.59%				
Sex	Female (N= 89)	63	70.79%	1.13	0.52-2.42	0.09	0.76
	Male (N=48)	35	72.92%				
Reproductive category	Breeder (N=113)	80	70.80%	0.8	0.29-2.22	0.17	0.68
	Non-breeder (N=24)	18	75.00%				

Figure 2. Dorsal and ventral (A) Echinolaelap echidnus, (B) Androlaelaps spp (These pictures were taken in SUA's Parasitology lab by the author).

Table 2. Prevalence of specific species of ectoparasites collected from silvery mole rats in Morogoro region

Ectoparasite species	**Positive rats ectoparasites (prevalence)**	**The total number of ectoparasites collected**	**The average number of ectoparasites per rat**
Androlaelaps spp	96 (70.1%)	1400	15
Echinolaelap echidinus	22 (16.06%)	93	4
Haemophysalis spp	7 (5.11%)	10	1

Table 3. Prevalence of hemoparasites in silvery mole rats in Morogoro region

Hemoparasites	**No. host**	**Number of infected (n)**	**Prevalence**
Anaplasma spp	137	17	12.4%
Babesia spp	137	5	3.6%
Anaplasma spp & Babesia spp	137	18	13.1%
Total	137	40	29.19%

Table 4. Association of body parameters and prevalence of hemoparasites in silvery mole-rats in Morogoro region

Variable	**Categories (N=individuals collected)**	**Infected (n)**	**Prevalence (n/N*100)**	**Odds Ratio**	**95% Confidences Interval**	**X^2**	**p-value**
Age	Adult (N= 120)	31	0.26%	3.23	1.15-9.11	4.06	0.04
	Sub-adult (N= 17)	9	0.53%				
Sex	Female (N=89)	27	0.30%	0.85	0.39-1.86	0.04	0.83
	Male (N= 48)	13	0.27%				
Reproductive categories	Breeder (N= 113)	32	0.28%	1.27	0.49-3.325	0.06	0.81
	Non-breeder (N=24)	8	0.33%				

Figure 3. Haemaphysalis spp (This picture was taken in SUA's Parasitology lab by the author)

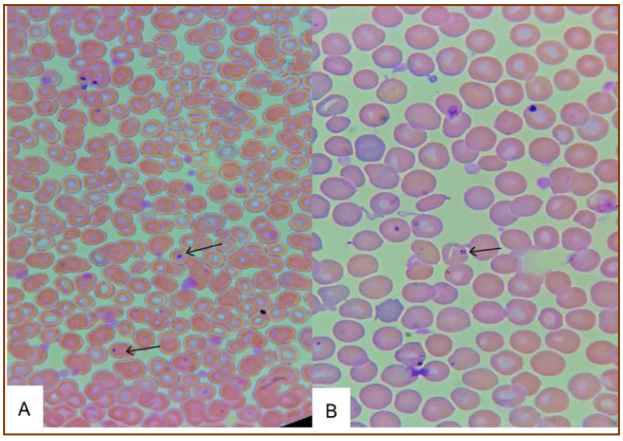

Figure 4. (A) Anaplasma centrale, and Anaplasma marginale (B) Babesia spp (These pictures were taken in SUA's Parasitology lab by the author).

Discussion

The study has established ectoparasites and hemoparasites in Emini silvery mole rats in Morogoro regions at the rate of 71.5% for ectoparasites and 29.19% for hemoparasites. The ectoparasites found in the present study belonged to Haemaphysalis spp (tick) and mites species of Echinolaelap echidinus and Androlaelaps spp which are all known to be parasitic on vertebrates. This is rather low compared to other African rodents [42, 44, 45] and this is probably attributed to the subterranean lifestyle of the studied silvery mole rats that could limit exposure to parasites [46-49]. Although, rarely venture above the ground and include above-ground vegetation in their diet [5] making a way for them to encounter parasites. The occurrence of only 3 species collected from Heliophobius Argentiocinereus Emini is slightly lower when compared with other closely related species of silvery mole rats elsewhere such as Fukomys Damarensis, Cryptomys hottentotus and Cryptomys hottentotus mahali from Zambia and South Africa with nine (9), six (6), five (5) and four (4) species of ectoparasites respectively this is probably attributed to solitary nature of silvery mole rats than the other reported African mole rats which live social life [46, 48, 49]. Among all these closely related species F. Damarensis has shown greater ectoparasites species richness among reported bathyergids to date [5]. The dominance of Androlaelaps spp on silvery mole rats in this study was also previously reported on closely related species in the family Bathyergidae [46-49], indicating host specificity of Androlaelaps spp at the family level. Moreover, E. echidinus was recorded at low prevalence and is commonly reported in house-dwelling and wild rodents, its occurrence in subterranean rodents implies that this mite is a generalist species [50] capable of parasitizing a wide range of rodent species, an aspect that favors its survival and perpetuates its spread. Similarly, a one-host tick Haemaphysalis was obtained at low prevalence in comparison to mite species, its presence had been also documented in previous studies conducted in other species of African mole rats. For instance, studies from DRC [51], South Africa, Zambia, and Zimbabwe [52] documented Haemaphysalis leachi of Bathyergus suillus in the family Bathyergidae. Moreover, Haemaphysalis spp has been documented on wild rodents (Crocidura viara, Mus minutoides, and Mus triton) at a prevalence of 43%, 14%, and 100% respectively, from southern eastern Kenya [23].

Haemaphysalis spp has been reported to be a prominent transmitter of the protozoan Babesia spp, a causative agent of babesiosis, Theileria spp, Anaplasma spp, Rickettsia spp, and Bartonella spp [53]. Despite the fact that ectoparasites infestation was high in silvery mole rats (71.5%), there were no variations in infestation related to animal body parameters (sex, age, body weight, and reproduction status), this could be linked to the sedentary lifestyle of the study species favoring all animals to have an equal chance to be infested [5]. Similar findings have been previously reported in a closely related species, C. h. pretoriae, and C. h. mahali [32,54]. Given the importance of ectoparasites in the transmission of disease etiological agents in humans and animals, Echinolaelap echidinus and some species of the genera Haemaphysalis have been reported to have medicinal and veterinary importance. The Haemaphysalis spp has been reported as a prominent transmitter of babesiosis and anaplasmosis, a good example is Haemaphysalis longicornis has been reported to transmit Babesia microti a causative agent of human babesiosis in East Asia and Australia, and Haemaphysalis punctata has been reported to be a prominent transmitter of Babesia major, Babesia Motas and Borrelia miyamoti in human being in Europe [23,53}. E. echidinus is of medical and veterinary significance as a parasite of disease agents that carry pathogens of zoonotic diseases such as Rickettsia, Pseudotuberculosis, and Leptospira [50]. Additionally, this present study has established that hemoparasites mainly Babesia and Anaplasma spp were prevalent among studied silvery mole rats in Tanzania. This could be among the very few studies that report the hemoparasites infecting silvery mole rats of the family Bathyergidae in Africa. However, blood parasites have been reported previously in other rodents in Tanzania and elsewhere, in Africa [30, 31, 38]. In this present study, Anaplasma spp (Figure 4 (A)) was the most prevalent, and adult silvery mole rats were more infected, this could be associated with their diverse foraging habits, making them more prone to parasitic infections [55]. Furthermore, females were highly infected with Anaplasma compared to males, contrasting other studies where males are more infected due to testosterone immune suppressive effect and naturally males are more vagility than females hence increasing exposure to parasites [56–58]. The reason for this contradiction could be associated with the fact that 65% of captured animals in this study were females. Babesia spp is an intraerythrocytic protozoan parasite usually transmitted by ticks (Figure 4 (B)),

leading to babesiosis in humans and animals [59]. In the present study Babesia species were recorded at a prevalence of 16.8 %, the majority of infected silvery mole rats were adult females this might be attributed to the task-specific division of labor, as the majority of the adult females are breeders, and based on observation, reproductive investment in females tends to be more associated with increased susceptibility to parasites [60], increasing their chances of exposure to infection. Previous studies in Turkey, Lithuania, and Tanzania have also reported infection of Babesia spp in other types of wild rodents [30,31,61,62]. Moreover, the relationship study between the prevalence of ectoparasites species and infection of blood parasites, showed Haemaphysalis spp was significantly associated with Babesia spp and Anaplasma spp with a p-value of 0.001 and 0.01 respectively. This association may be attributed to the fact that vector-transmitted theme is common within the genus Haemaphysalis [63]. Haemaphysalis spp has been reported as the prominent transmitter of babesiosis and anaplasmosis [53] perhaps being a cause of Anaplasma and Babesia parasites in this study. Babesia and Anaplasma parasites are present in the world affecting several mammals including humans, pets, rodents, and livestock [59]. This study has some limitations that should be acknowledged. First, the cross-sectional design restricts causal inference between ectoparasite infestation and hemoparasite infection. Second, the study relied solely on morphological and microscopic identification, which may underestimate parasite diversity; molecular techniques could provide more precise characterization. Additionally, sampling was limited to two districts and a single season (March–June), which may not capture temporal and spatial variations in parasite prevalence. Lastly, manual excavation might have biased sample representativeness, favoring more active burrows. Despite these limitations, the findings provide valuable baseline data on parasite ecology in silvery mole rats from Morogoro.

Conclusion

Our findings provide the first baseline information on the prevalence of ectoparasites and hemoparasites in Emini silvery mole rats in Tanzania. These findings suggest that the silvery mole rat may act as the source for the ectoparasites (E. echidinus and Haemaphysalis) and hemoparasites (Anaplasma Centrale, Anaplasma Marginale, and Babesia spp) transmission to livestock and human given the increased interaction. The presence of Haemaphysalis spp, Babesia spp and Anaplasma spp highlights potential public health concerns associated with silvery mole rats. We conclude by highlighting the future research to assess the potential of recovered parasites in zoonoses, inclusion of silvery mole rats from different geographical location will provide more information and clarification in epidemiological surveillance.

Abbreviation

N: Total number of Silvery mole rat captured; n: Total number of Silvery mole rat tested positive; mL: Milliliter; gm: Gram; OD: Odds ratio; CI: Confidence interval

Declaration

All figures presented in this study are original works created by the authors and have not been reproduced or adapted from any previously published source. (Except figure 1: Source acknowledged).

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Availability of data and materials

Data will be available by emailing deboraeliphace@gmail.com

Authors' contributions

Debora E. Shija (DES) and Mungo K. Ngalameno (MKN) participated in conceptualization, while Jahashi Sid Nzalawahe (JSN), (DES) and (MKN) participated in methodology, writing review, and editing. DES participated in data curation and writing of the original draft. DES and JSN both participated in formal analysis. All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

We conducted the research following the declaration of Helsinki. The study was conducted according to the guidelines of the Research Committee of the Sokoine University of Agriculture. All procedures in this study have been permitted and approved by the Institutional Ethics Committee of the Sokoine University of Agriculture (SUA/ DPRTC/ R/ 186/ Vol IV- 68 issued on 9/10/2023). Data Availability Statement: The data presented in this study are available upon request from the corresponding author for use other than commercial use.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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References

1. Ngalameno MK, Bastos AD, Mgode GF, Bennett NC. The Pattern of Reproduction in the Mole-Rat Heliophobius from Tanzania: Do Not Refrain during the Long Rains! Can. J. Zool. 2017;95 (2):107–114. https://doi.org/10.1139/cjz-2016-0153.

2. Faulkes CG, Bennett NC, Cotterill FP, Stanley W, Mgode GF, Verheyen, E. Phylogeography and Cryptic Diversity of the Solitary-Dwelling Silvery Mole-Rat, Genus Heliophobius (Family: Bathyergidae). J. Zool. 2011;285 (4):324–338. https://doi.org/10.1111/j.1469-7998.2011.00863.x.
3. Shabani R, Assey RJ, Kimaro W, Kisinza N. Histomorphology of the stomach of Emini's mole rat (Heliophobius Emini). Tanz. Vet. J. 2018;33(1):51-61.
4. Katandukila JV, Ngalameno MK, MgodeGF,BastosADS,Bennett NC (2017), The pattern of ovulation in an ancient, solitary mole rat lineage: Heliophobius argenteocinereus emini from Tanzania. Can. J. of Zool.2017;95(10): 705-712. DOI: 10.1139/CJZ-2016-0292
5. Lutermann H. Socializing in an Infectious World: The Role of Parasites in Social Evolution of a Unique Rodent Family. Front. Ecol. Evol. 2022;10:1–22. https://doi.org/10.3389/fevo.2022.879031.
6. Montoya-Sanhueza G, Bennett NC, Chinsamy A, Šumbera R. Functional anatomy and disparity of the postcranial skeleton of African mole-rats (Bathyergidae). Front. Ecol. Evol. 2022;10:857474. doi: 10.3389/fevo.2022.857474
7. Dalga S, Asln K, Yildiz B. Morphometric studies on skulls of male mole rats [(Nannospalaxnehringi)] Satunin (1898)(Rodentia: Splacidae) collected from Kars Province. Acta morphologica et anthropologica. 2020;27:84-91
8. Montoya-Sanhueza G, Bennett NC, Šumbera R Functional and morphological divergence in the forelimb musculoskeletal system of scratch-diggingsubterranean mammals (Rodentia: Bathyergidae). J.Anat. 2024.00:1-31. doi: 10.1111/joa.14058
9. Hart L, O'Riain MJ, Jarvis JUM, Bennett NC. Is the Cape Dune Mole-Rat, Bathyergus Suillus (Rodentia: Bathyergidae), a Seasonal or Aseasonal Breeder? J. Mammal. 2006;87 (6): 1078–1085. https://doi.org/10.1644/05-MAMM-A-411R2.1.
10. De Graaff G. The Rodents of Southern Africa : Notes on Their Identification, Distribution, Ecology and Taxonomy". Butterworths;1981.
11. Skinner J, Chimimba C. The Mammals of the Southern Africa Subregion., 3rd ed.; Cambridge University Press, 2005.
12. Pollack RJ, Engelman D, Steer AC, Norton SA. Ectoparasite. International Encyclopedia of Public Health. 2017; 2: 417–428. https://doi.org/10.1016/B978-0-12-803678-5.00123-5.
13. Hopla C, Durde L, Keirans J. Ectoparasites and Classification. Rev Sci Tech.1994;13 (4):985–1017. https://doi.org/10.20506/rst.13.4.815.
14. Mawanda P, Rwego I, Kisakye JJ, Sheil D. Rodents as Potential Hosts and Reservoirs of Parasites along the Edge of a Central African Forest : Bwindi Impenetrable National Park , South Western Uganda. Afri. Heal. Sci. 2020;20 (3):1168–1178. https://doi.org/10.4314/ahs.v20i3.20.
15. Mhamphi G, Katakweba AS, Massawe AW, Makundi RH, Machang'u, RH, Komba EV, Mnyone LL. Prevalence of Bartonella spp. in rodent and shrew species trapped in Kigoma and Morogoro Regions, Tanzania: A public health concern. Afri. J. microb.2023;17(7):156-163. https://doi.org/10.5897/AJMR2023.969
16. Divari S, Pregel P, Zanet S, Ferroglio E, Giannini F, Eleonora F, Scaglione EF, Grinberg A, Biolatti B, Bollo E. Molecular Evidence of Bartonella spp. in Rodents: A Study in Pianosa Island, Italy. Anim.2020;10(11):2070. https://doi.org/10.3390/ani10112070
17. Stuen S. Haemoparasites — Challenging and Wasting Infections in Small Ruminants : A Review. Anim. 2020;10:1–12.
18. Kilonzo B, Mhina J, Sabuni C, Mgode G. The Role of Rodents and Small Carnivores in Plague endemicity in Tanzania. Belgian J. Zool. 2005;135(SUPPL.1):119–125.
19. Waya P, Mwega E, Sabuni C, Martin M. Prevalence and molecular characterization of Bartonella species from rodents and their associated ectoparasites in Kilwa District, Lindi region, Tanzania. J Ideas Health. 2025 Apr. 30 ;8(2):1273-80. doi: 10.47108/jidhealth.vol8.iss2.407
20. Laudisoit A. Diversity, Ecology and Status of Potential Hosts and Vectors of the Plague Bacillus, Yersinia Pestis. Contribution to Plague Epidemiology in an Endemic Plague Focus: The Lushoto District (Tanzania). PhD Thesis, Universiteit Antwerpen, 2009.
21. Wilson DE, Reeder DM. Mammal Species of the World:A Taxonomic and Geographic Reference.; Johns Hopkins University Press: Baltimore, Maryland, 2005.
22. Jittapalapong S, Sarataphan N. Maruyama S, Hugot JP, Morand S, Herbreteau V. Toxoplasmosis in Rodents: Ecological Survey and First Evidences in Thailand. Vector-Borne Zoon Dis. 2011;11 (3):231–237. https://doi.org/10.1089/vbz.2009.0238.
23. Oguge NO, Durden LA, Keirans JE, Balami HD, Schwan TG. Ectoparasites (Sucking Lice, Fleas and Ticks) of Small Mammals in Southeastern Kenya. Med. Vet. Entomol.2009;23 (4):387–392. https://doi.org/10.1111/j.1365-2915.2009.00820.x.
24. Archer AEK, Bennett NC, Junker K, Faulkes CG, Lutermann H. The Distribution of Gastrointestinal Parasites in Two Populations of Common Mole-Rats.J. Parasitol. 2017;103 (6):786–790. https://doi.org/10.1645/17-62.
25. Mawanda P, Rwego I, Kisakye JJ, Sheil D. Rodents as Potential Hosts and Reservoirs of Parasites along the Edge of a Central African Forest: Bwindi Impenetrable National Park, South Western Uganda. 2020;20 (3):1168–1178.
26. Abdullahi AM, Mamman SG. Prevalence of Endo and Ecto Parasitic Infection of African Giant Rat (Cricetomys Gambianus) in North Eastern Nigeria. Int. J. Res. Rev. 2021;8 (7):25–29.
27. Gebrezgiher GB, Makundi RH, Katakweba AAS, Belmain SR, Lyimo CM, Meheretu Y. Arthropod Ectoparasites of Two Rodent Species Occurring in Varied Elevations on Tanzania's Second Highest Mountain. Biol. (Basel). 2023;12(3):https://doi.org/10.3390/biology12030394.
28. Samiji AM, Katakweba AS, Phiri EC. Trypanosomes Infection in Rodents and Their Zoonotic Potential from Ruaha Ward in Kilosa District, Tanzania. In Proceedings of the 2nd SUA Sci Conf. 2021;126–133.
29. Shija D, Nzalawahe J, Ngalameno M, Mafie E. Cestodes fauna of silvery mole rats (Heliophobius Argentiocinereus Emini) in Morogoro Region, Tanzania. J Ideas Health. 2024 Oct. 31;7(5):1167-73. doi: 10.47108/jidhealth.vol7.iss5.372
30. Katakweba AS. The Prevalence of Haemoparasites in Rodents and Shrews Trapped from Domestic and Peridomestic Houses in Morogoro Municipality, Tanzania. A Hidden Public Health. Tanz Vet. Assoc. Proc. 2018;36: 75–82.
31. Katakweba AS, Kipanyula MJ, Durnez L, Mhamphi G, Luziga C, Mgode GF, Machang'u, RH. Rodents and Shrews as Vectors of Zoonotic Spirochetes and Trypanosomes in Tanzania. Tanz Vet. J. 2013;28 (1):14–19.
32. MRP. Morogoro Region Social-Economic Profile.2020; 2022.
33. Katandukila JV, Chimimba CT, Bennett NC, Makundi RH, Le Comber SC, Faulkes CG. Sweeping the House Clean: Burrow Architecture and Seasonal Digging Activity in the East African Root Rat from Tanzania. J. Zool. 2014;293 (4):271–280. https://doi.org/10.1111/jzo.12143.
34. Animal Care and Use Committe. Guidelines for the Capture, Handling, and Care of Mammals as Approved by the American Society of Mammalogists. J. Mammal. 1998;79 (4):1416–1431. https://doi.org/10.2307/1383033.
35. Center for Diseases Control and Prevention (CDC). Pictorial Keys to Arthropods, Reptiles, Birds and Mammals of Public Health Significance. Dep. Heal. Educ. Welf. 2003;196.
36. Jacobs D, Fox M, Gibbons L Hermosilla C. Principles of Veterinary Parasitology by December 2015; 2015.
37. Zajac AM, Conboy GA, GreinerEC, Smith SA, Snowden KF. Vet. Clinic Parasitol. 8th ed.; USA: Wiley Blackwell, 2012.
38. Dada EO. Study on the Ectoparasites and Haemoparasites of Domestic Rats in Parts of Akure South Local Government Area of Ondo State. Int. J. Clin. Chem. Lab. Med. 2016;2 (1):1–5. https://doi.org/10.20431/2455-7153.0201001.
39. Katakweba AS, Mulungu LS, Eiseb S, Mahlaba TA, Makundi R, Massawe A, Belmain SR. Prevalence of Haemoparasite, Leptospires and Cocobacilli with Potential for Human Infection in the Blood of Rodents and Shrews from Selected Localities in Tanzania, Namibia and Swaziland. Afri. Zool. 2012;47 (1):119–27.
40. Zajac AM, Conboy GA, Greiner EC, Smith SA, Snowden KF. Vet. Clinical Parasitol.2012.
41. WHO. Giemsa Staining of Malaria Blood Films. Malaria Microscopy Standard Operating Procedure—MM-SOP-07A. World Heal. Organ. Geneva, Switz. 2016;1–6.

42. Thanee N, Kupittayanant S, Pinmongkholgul S. Prevalence of Ectoparasites and Blood Parasites in Small Mammals at Sakaerat Environmental Research Station, Thailand. Thail. J. Agric. Sci.2009;42 (3):149–158.
43. WHO. Basic Laboratory Methods in Medical Parasitology; Geneva, 1991.
44. Amin OM. Intestinal and Ectoparasites of Black Rats (RattusRattus) in Garmian , Kurdistan Region of Iraq. J. Univ. Garmian. 2019;6 (1).
45. Yesica R, Bagus I, Rama G, Hermanto J, Nurholizah Y, Trinastuti MW. Preliminary Study: Detection of Ecto and Endoparasites Among Wild Rats from Urban Area in Blimbing, Malang, East Java. 2021, No. May, 95–101.
46. Lutermann H, Carpenter-Kling T, Ueckermann EA, Gutjahr G, Bennett NC. Ectoparasites Burdens of the Damaraland Mole-Rat (Fukomys Damarensis) from Southern Africa. J. Parasitol. 2015;101(6):666-70. doi:10.1645/15-775
47. Archer EK, Bennett NC, Faulkes CG, Luterman H. Digging for Answers: Contributions of Density- and Frequency-Dependent Factors on Ectoparasite Burden in a Social Mammal. Oecologia.2016;180 (2):429–438. https://doi.org/10.1007/s00442-015-3494-0.
48. Archer EK, Bennett NC, Ueckermann EA, Lutermann H. Ectoparasites Burdens of the Common Mole-Rat (Cryptomys Hottentotus Hottentotus) from the Cape Provinces of South Afri. J. Parasitol. 2014;100 (1):79–84. https://doi.org/10.1645/13-270.1.
49. Fagir DM, Bennett NC, Ueckermann EA, Howard A, Hart DW. Ectoparasitic Community of the Mahali Mole-Rat, Cryptomys Hottentotus Mahali: Potential Host for Vectors of Medical Importance in South Africa. Parasites and Vectors. 2021;14 (24).
50. Changbunjong T, Jirapattharasate C, Buddhirongawatr R, Chewajon K, Charoenyongyoo P, Suwanapakdee S, et al. Ectoparasitic Fauna of Birds, and Volant and Non-Volant Small Mammals Captured at Srinakarin Dam, Kanchanaburi, Thailand. Southeast Asian J. Trop. Med. 2010;41 (3):526–535.
51. De Graaff G. A Systematic Revision of the Bathyergidae (Rodentia) of Southern Africa. Un- Publ. Ph.D. Dissert., Univ. Pretoria, Pretoria, South Africa, 1964, 340.
52. Hoogstraal H, Kammah K, Camicas JL. Notes on African Haemaphysalis Ticks: XI. H. (Rhipistoma) Paraleachi (Ixodoidea: Ixodidae) Distribution and Hosts of Adults. Int. J. Acarol. 1992;18 (3):205–212. https://doi.org/10.1080/01647959208683953.
53. Walker A, Bouattour A, Camicas JL, Estrada-Peña A, Horak I, Latif A, Pegram RG, Preston PM. Ticks of Domestic Animals in Africa: A Guide to Identification of Species.; 2003.
54. Scharff A, Burda H, Tenora F, Kawalika M, Barus V. Parasites in Social Subterranean Zambian Mole-Rats (Cryptomys Spp., Bathyergidae, Rodentia). J. Zool. 1997;241 (3):571–577. https://doi.org/10.1111/j.1469-7998.1997.tb04848.x.
55. Lutermann H, Butler KB, Bennett NC. Parasite-Mediated Mate Preferences in a Cooperatively Breeding Rodent. Front. Ecol. Evol. 2022;10:1–10. https://doi.org/10.3389/fevo.2022.838076.
56. Ben-Batalla I, Vargas-Delgado ME, von AmsbergG, Janning M, Loges S. Influence of Androgens on Immunity to Self and Foreign: Effects on Immunity and Cancer. Front. Immunol. 2020; 11:1–20. https://doi.org/10.3389/fimmu.2020.01184.
57. Greives TJ, McGlothlin JW, Jawor JM, Demas GE, Ketterson ED. Testosterone and Innate Immune Function Inversely Covary in a Wild Population of Breeding Dark-Eyed Juncos (Junco Hyemalis). Funct. Ecol. 2006;20 (5):812–818. https://doi.org/10.1111/j.1365-2435.2006.01167.x.
58. Klein SL. The Effects of Hormones on Sex Differences in Infection: From Genes to Behavior. Neurosci. Biobehav. Rev. 2000;24 (6):627–638. https://doi.org/10.1016/S0149-7634(00)00027-0.
59. Karbowiak G, Demiaszkiewicz AW, Pyziel AM, Wita I, Moskwa B, Werszko J, Bień J, Goździk K, Lachowicz J, Cabaj W. The Parasitic Fauna of the European Bison (Bison Bonasus) (Linnaeus, 1758) and Their Impact on the Conservation. Part 2 The Structure and Changes over Time. Acta Parasitol. 2014;59 (3):372–379. https://doi.org/10.2478/s11686-014-0253-z.
60. Ezenwa VO, Stefan-Ekernas L, Creel S. Unravelling Complex Associations between Testosterone and Parasite Infection in the Wild. Funct. Ecol. 2012;26 (1):123–133. https://doi.org/10.1111/j.1365-2435.2011.01919.x.
61. Usluca S, Celebi B, Karasartova D, Gureser AS, Matur F, Oktem MA, Sozen M, Karatas, A, Babur C, Mumcuoglu KY, Ozkan AT. Molecular Biology / Genomics Molecular Survey of Babesia Microti (Aconoidasida : Piroplasmida) in Wild Rodents in Turkey. 2019;56:1605–1609. https://doi.org/10.1093/jme/tjz084.
62. Mardosaitė-busaitienė D, Radzijevskaja J, Balčiauskas L, Paulauskas A. Babesia Microti in Rodents from Different Habitats of Lithuania. Anim. 2021;11 (6):1707.https://doi.org/10.3390/ani11061707.
63. Beard CB, Occi J, Bonilla DL, Egizi AM, Fonseca DM, Mertins JW, et al. Multistate Infestation with the Exotic Disease–Vector Tick Haemaphysalis Longicornis — United States.2018;67(47):1310-1313.https://doi.org/10.15585/mmwr.mm6747a3.