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Prevalence of Gastrointestinal Nematodes in Silvery Mole-Rats in Morogoro Region, Tanzania

Prevalensi Nematoda Gastrointestinal pada Tikus Tanah Perak di Wilayah Morogoro, Tanzania

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ABSTRACT

Background: Exploring the nematode diversity in silvery mole rats opens up a fascinating avenue for understanding the intricate relationships between underground-dwelling mammals and their parasites. It is intriguing to consider the potential transmission of parasitic zoonotic between humans, livestock, and silvery mole rats due to the notable interactions of these animals. **Purpose:** This study aims to acquire crucial information about the nematode fauna in silvery mole rats in the Morogoro region, Tanzania. **Method:** A survey of nematode parasites in silvery mole rats was conducted in the Morogoro region, from March to June 2023. Collected rats were euthanized using Diethyl Ether, and dissected to remove the gastrointestinal tract (GIT). Adult worms were collected and preserved in 70% ethanol. A flotation method and lactophenol mounting techniques were employed to process gastrointestinal contents and adult roundworms. The prevalence of nematodes was computed, and a chi-square test was applied to assess the relationship, a p-value< 0.05 was considered significant. **Results:** The examination of the gastrointestinal tract contents revealed two nematode taxa; *Physaloptera spp.* and *Strongyloides spp.* The overall prevalence of nematode infection was 38.69% (53/137), with Physaloptera species being the most prevalent (37.22%). Adult rats had a lower infection risk than sub-adult rats. Female silvery mole rats were at higher risk of being infected compared to males. **Conclusion:** The study established two nematodes in silvery mole rats of Morogoro region, Tanzania, which are *Physaloptera spp.* and *Strongyloides spp.*

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ABSTRAK

Latar Belakang: Menjelajahi keragaman nematoda pada tikus tanah perak membuka jalan yang menarik untuk memahami hubungan rumit antara mamalia bawah tanah dan parasitnya. Sangat menarik untuk mempertimbangkan potensi penularan parasit zoonosis antara manusia, ternak, dan tikus tanah perak karena interaksi penting antara hewan-hewan ini. **Tujuan:** Penelitian ini bertujuan untuk memperoleh informasi penting tentang fauna nematoda pada tikus mol keperakan di wilayah Morogoro, Tanzania. **Metode:** Survei parasit nematoda pada tikus mol keperakan dilakukan di wilayah Morogoro, dari Maret hingga Juni 2023. Tikus tanah perak yang dikumpulkan dieutanasi menggunakan Dietil Eter, dan dibedah untuk membuang saluran gastrointestinal (GIT). Cacing dewasa dikumpulkan dan diawetkan dalam etanol 70%. Metode flotasi dan teknik pemasangan laktofenol digunakan untuk memproses isi gastrointestinal dan cacing gelang dewasa. Prevalensi nematoda dihitung, dan uji chi-square diterapkan untuk menilai hubungan, nilai-p< 0,05 dianggap signifikan. **Hasil:** Pemeriksaan isi saluran pencernaan menunjukkan dua taksa nematoda; *Physaloptera spp.* dan *Strongyloides spp.* Prevalensi keseluruhan infeksi nematoda adalah 38,69% (53/137), dengan spesies Physaloptera sebagai yang paling umum (37,22%). Tikus dewasa memiliki risiko infeksi yang lebih rendah daripada tikus sub-dewasa. Tikus mol perak betina memiliki risiko lebih tinggi terinfeksi dibandingkan dengan tikus jantan. **Kesimpulan:** Penelitian ini menemukan dua jenis nematoda pada tikus tanah perak di wilayah Morogoro, Tanzania, yaitu *Physaloptera spp* and *Strongyloides spp.*

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Kata kunci: Gastrointestinal; Nematoda; Prevalensi; Tikus Tanah Perak

INTRODUCTION

Silvery mole rat *(Heliophobius argenteocinereus)* is a subterranean rodent found in the Sub-Saharan regions of Africa such as in southern Kenya, Tanzania, southeast Democratic Republic of Congo, eastern Zambia, Malawi, and northern Mozambique (Bennett and Faulkes, 2000; Burda, 2001; Faulkes *et al.,* 2011). They have unique physical characteristics including cylindrical body shape, short legs, very short tails, grayish or silver dense fur coat, and large, protruding teeth (Horáková, *et al.,* 2019). These teeth are specialized for digging tunnels and burrows in the ground, which is where these rodents spend most of their time. The silvery mole rat is an excellent digger and can create complex tunnel systems that extend for several meters underground (Modrý, *et al.,* 2005). One interesting adaptation of the silvery mole rat is its ability to survive in low-oxygen environments. It can tolerate high levels of carbon dioxide and low levels of oxygen, which allows it to thrive in underground burrows (Šumbera, *et al.,* 2007). This adaptation is particularly useful during periods of drought when food and water sources may be scarce. In terms of diet, silvery mole rats are primarily herbivorous, feeding on roots, tubers, and other underground plant parts (Bennett and Faulkes, 2000). Accidentally, they may also eat insects and other small invertebrates (Jarvis, *et al.,* 1994; Bennett and Faulkes, 2000). They are solitary and rarely venture on the ground, because of that certain phases of their life history and ecology are poorly studied, especially their endoparasites fauna (Rossin and Malizia, 2002; Lutermann, *et al.,* 2022).

Worldwide, endoparasite diversity occurring in subterranean rodents has been reported since 1857, among these endoparasites nematodes were mostly found, followed by protozoa, cestodes, acanthocephalan, and trematodes (Dursahinhan, *et al.,* 2023). Several studies have been conducted on African mole rats, including a study by Ortlepp in 1937 whichreported three nematode species of *Libyostrongylus bathyergid, Longistriata bathyergid* and *Mammalakis macrospiculum* in Cape dune mole rats from Cape Town, South Africa. A study by Viljoen *et al.,* (2011) on *Cryptomys honttentotus* in the Tshwane region reported two nematode species including *Heligmonina spp.* and *Protospirura spp.* Lutermann and Bennett, (2012) discovered three species of nematodes - *Mammalakis macrospiculum, Paralibyostrongylus bathyergid* and *Trichuris spp.* in *Bathyergus suilus* from Cape Town (South Africa). A study was carried out in South African along the western coast, where three helminth species *(Hexametra spp, Protospirura mumidica,* and *Protospirura muricola)* were found in common mole rats with an overall prevalence of 54.15% (Archer, *et al.,* 2017). Ascarid nematode *(Mammalakis zambiensis)* was reported in Fukomys ansell collected from West Lusaka, Zambia (Junker, *et al.,* 2017). Four nematode species including *Protospirura mumidica, Protospirura muricola, Mammalakis zambiensi,* and *Rodentolepis microstoma* were reported in Ansell mole rats (Zambia) with an overall prevalence of 14.7% (Lutermann, *et al.,* 2018). In silvery mole rat, gastro-intestinal nematodes have been reported by Baruš, *et al.,* (2003) and Tenora, *et al.,* (2003) who both found one species of nematode *Protospirura muricola* collected from the Blantyre-Limbe region of Malawi, south-eastern. Advances in faunal surveys and reserves of nematode parasites in Tanzania are still modest. They have focused only on some host species mainly humans and livestock, and also they are geographically limited to most pastoralist regions (Esrony, *et al.,* 1997; Keyyu, *et al.,* 2006; Nzalawahe, *et al.,* 2015; Manz, *et al.,* 2017). As a result, there are undoubtedly many species waiting to be discovered, described, and identified for this group of invertebrates especially those found in silvery mole rats. Exploring the nematode species diversity in silvery mole rats opens up a fascinating avenue for understanding the intricate relationships between these underground dwelling mammals and their parasites. It is intriguing to consider the potential threat for transmission of parasitic zoonotic between humans, livestock, and silvery mole rats due to the notable interactions of these animals. Therefore, the present study aimed to collect informative data on the nematode fauna in silvery mole rats in Morogoro region, Tanzania.

MATERIAL and METHOD

Study Area

The study was conducted in two districts in the Morogoro region of Tanzania, namely Mvomero and Morogoro (Figure 1), from March to June 2023. Mvomero is positioned at latitude 060 57'16.45-48" S, longitude 0370 32'05.40-47" E, with an elevation ranging from 1266 to 1330 meters above sea level. Morogoro is situated at latitude 06049'20" S, longitude 037039'55" E, and at 509 meters above sea level. The terrain in these areas is predominantly flat, with an average annual rainfall of 600mm following a bi-modal pattern. The shorter rainy season spans from November to January, with an average of 130mm, while the longer rainy season occurs from March to May, averaging 470mm. June, July, August, and September are typically dry months. The climate is characterized by hot temperatures, with an average annual temperature of 25ºC ranging from 18ºC to 30ºC. July, August, and September are considered the warm season. The region is an agri-ecological zone with river valleys and basins that support the cultivation of food and cash crops, as well as grazing activities (MRP, 2022).

Study Design and Sampling Strategies

A cross-sectional study was conducted in five locations in Mvomero and Morogoro districts. The study animals were gathered from the Mji Mkuu division of Morogoro District and four villages (Mlali, Kipera, Mkuyuni, and Mongwe) in Mvomero District. Farm fields were chosen purposefully for sampling based on the presence of geophytes, which are the main food source for silvery mole rats, and visible fresh mole hills indicating burrowing activity by underground animals (Bennett and Faulkes, 2000). Burrows for capturing animals were randomly selected by opening a specific burrow within the farm fields, with the consent of farm owners. Trapping areas with compact soil were preferred, as the georychinae sub-family is more prevalent in compact soil compared to the bathyergidae sub-family (Bennett and Faulkes, 2000). Mvomero and Morogoro districts have mesic climatic habitats with diverse altitudes, rainfall patterns, and vegeta-

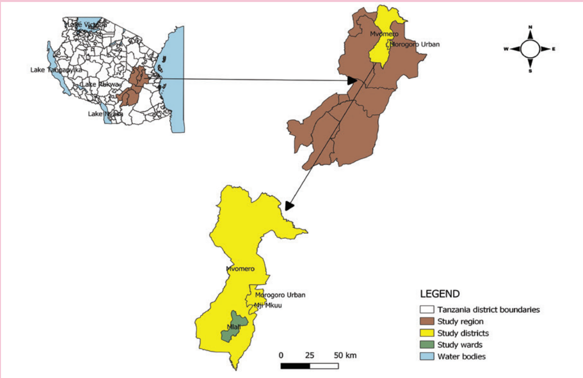

Figure 1. Map of Morogoro region highlighting the study districts and wards. The map was created using QGIS software version 3.2.6.1 and shape files from DIVA-GIS (retrieved on 5 July 2023).

tion containing geophytes, increasing the likelihood of their presence. Additionally, silvery mole rats have been identified as agricultural pests in the Mvomero District (Katandukila, *et al.,* 2014).

Capturing, Handling, and Transportation of Silvery Mole Rats

Silvery mole rats were manually captured using hand hoes to excavate the burrow, and animals found within were retrieved using hands assisted by half-cut plastic bottles. The capturing process took place early in the morning, guided by the presence of new fresh mole hills on the surface created by subterranean animals during the night (Sumbera, *et al.,* 2003). Animal capturing was carried out at each site for three weeks, with a minimum of 20 animals collected. The captured animals were housed in 20-liter plastic buckets filled halfway with fresh soil and equipped with a lid containing aeration pores (Hart, *et al.,* 2006). Subsequently, they were transported to the parasitology laboratory at SUA, where gastrointestinal contents were extracted following the animal maintenance guidelines set by the American Society of Mammalogists (Animal Care and Use Committe, 1998).

Collection of GIT Contents

Before collecting the gastrointestinal contents, rats were humanely euthanized using Diethyl Ether by placing them in a killing bottle containing cotton wool soaked with diethyl ether for approximately four minutes. The rats' body parameters, including sex, age, and reproductive status, were documented by observing their physical characteristics, and their body weight was measured using a digital weighing balance. The rats were then dissected by opening their body cavity to extract the gastrointestinal tract following standard procedures outlined by Rusli (1988). The stomach, small intestines, and large intestines were separated and flushed with physiological saline (50 ml) to remove their contents, which were then mixed thoroughly with a wood applicator, sieved with a fine tea strainer, and preserved for egg assessment. During the postmortem examination, adult worms were retrieved from the gastrointestinal tract and various body cavities (thoracic, abdominal, and pelvic). The internal organs (lung, liver, kidney, and heart) were individually removed, dissected, and visually inspected with a hand lens for the presence of adult worms. Any visible parasites were rinsed with physiological saline and preserved in 70% ethanol for further identification.

Laboratory Sample Processing

A coprological and post-mortem examination was conducted at the veterinary parasitology laboratory at Sokoine University of Agriculture to detect nematode parasites. The flotation technique was used to analyze nematode eggs in the gastrointestinal contents collected (Dryden, *et al.,* 2005). A mixture of 3 ml of gastrointestinal contents and 42ml of saturated sodium chloride solution (prepared by mixing 400 g of analytical sodium chloride with 1 liter of distilled water to achieve a specific gravity of 1.2) was sieved through a tea strainer. The resulting suspension was transferred to a clean container after pouring off the supernatant. The suspension was then divided into two compartments of a Mc Master Chamber (0.15 ml each) and allowed to settle for one minute. The flotation fluid helped separate debris from eggs, making the eggs more visible. Nematode eggs were identified based on their general morphological features using morphological keys provided by Soulsby (1982) and Zajac, *et al.* (2012) under a compound microscope with magnifications of 10x, 40x, and 100x (Taylor, *et al.,* 2016). The different types of eggs within the grid were counted using an electronic tally counter in each positive sample, and the fecal eggs per gram (EPG) for each parasite were calculated following the method by Catalano, *et al.,* (2019). Adult worms were identified based on their body morphology using guidelines from Soulsby (1982). Before identification, adult worms were cleared, temporarily mounted in lactophenol, and examined under a compound microscope at 4x, 10x, and 40x magnifications, with measurements taken using micrometry.

Data Analysis

The prevalence was determined by dividing the number of silvery mole rats testing positive for nematodes ('n') by the total number of animals sampled ('N'). Additionally, a chi-square test was used to examine the relationship between nematode infection prevalence and host body parameters, with a p-value < 0.05 indicating statistical significance. These analyses were conducted using Epi-info version 7.2.4.0. Parasite intensity was calculated by counting the total adult worms and eggs per gram (EPG) in positive samples (Wells, *et al.,* 2007; Hodder and Chapman, 2012; Barelli, *et al.,* 2020). The mean intensity (MI) for eggs and adult worms was calculated by dividing the sum of EPG for each nematode species by the number of hosts infected with that specific parasite, and by dividing the sum of adult worms for each specific species by the number of hosts infected with that specific nematode species. The intensity range (RI) represented the minimum and maximum values for nematode EPG and adult worms. The mean abundance (MA) was determined by dividing the total number of isolated parasite eggs or adults by the total number of sampled animals.

RESULTS

Population Dynamics

We captured and examined 137 silvery mole rats in the Morogoro and Mvomero districts, of which 89 (65%) were female. Proportionally, more adult rats were captured than sub-adult rats 120 (86.7%), and 17 (12.4%) respectively (Table 1). The macro and microscopic examination of the gastrointestinal tract contents yielded 870 adult nematodes and 83,100 nematode eggs. The nematodes inventory of sampled hosts revealed the presence of two taxa, from the spiruridae family *Physaloptera spp.* (adult and eggs were recovered) and strongyloididae family *Strongyloides spp.* (only eggs were recovered).

Prevalence of Gastrointestinal Nematodes

The overall prevalence of nematodes infection in silvery mole-rats was 39.42% (54/137), of which 57.41% (31/54) had both adult helminths and eggs, 27.78% (15/54) had adult helminths only and 14.81% (8/54) had helminth eggs only. *Physaloptera spp.* was the most prevalent (37.22%), followed by *Strongyloides spp.* (2.19%). The mean abundance, mean intensity, and intensity range are given in Table 2.

Predilection Sites of the Recovered Nematodes

Physaloptera spp. adult stage was found in all parts of the gastrointestinal tract of the host; the most predilection site was the stomach which had a total of 562 (64.59%) adult worms collected from 33 infected hosts. In small intestine, adult worms were 258 (29.66%) collected from 26 infected hosts, and in large intestine adult worms were 10 (1.15%) collected from four infected hosts. Furthermore, 40 (4.60%) adult stage of *Physaloptera spp.* were collected from eight infected hosts outside the gastrointestinal tract, specifically, in the thoracic cavity three worms, abdominal cavity 31 worms, especially on the mesentery, and pelvic cavity six worms. The average number of adult worms per host was 19 worms. A conspicuously visible adult *Physaloptera spp.* (Figure 4.2) exhibited the following characteristics: a pinkish to whitish coloration, slightly tight coiled, measuring 1-4 cm long, 0.3-0.7cm in width, the anterior region with triangular lips bearing small teeth, and a reflective cuticular sheath which protruded forward as an anterior-end prepuce-like collar.

A total of 83,100 nematode eggs were collected from 38 infected host, of which 82300 were *Physaloptera spp.* eggs (55x 29 µm- 59x 1 µm) ranged from 150-18000 EPG, and 800 were Strongyloides eggs ranged from 150-500 EPG collected from 35 and three infected hosts respectively. Strongyloides eggs had the following characteristics; tiny size egg with an ellipsoid shape, 47–50 mm in length and 32.5 mm in width (Figure 3). Additionally, none of the infected silvery mole rats exhibited multiple nematode parasite infections in this study period.

Prevalence Relationship between Nematode Species and Host Body Parameters

A significant correlation was observed between the prevalence of nematode infection and the age of the host ($p<0.04$). Adult silvery mole rats had a lower risk of being infected with nematodes compared to sub-adults with an odds ratio of 0.3 (95% confidence interval (CI) 0.11-0.88). The prevalence of nematode infection was significantly associated with reproductive status, non-breeder's silvery mole rats were more infected with nematodes while breeders showed a reduced

Table 1. Prevalence, Mean Abundance, Mean intensity, Mean range and Site of Infection of each Nematodes Species of Silvery Mole Rats

Helminths Species	No. of Host Infected	Prevalence (%)	No. of Collected Parasites	Mean Abundance	Mean Intensity	Intensity Range	Predilection site			
							Stomach	Small Intestines	Large Intestine	Outside GIT
Physaloptera spp. adult	46	33.58	870	6.35	18.91	1-144	32[a] (562)[b]	26[a] (258)[b]	4[a] (10)[b]	8[a] (40)[b]
Physaloptera spp. eggs	35	25.55	82,300	600.73	2351.43	150-18000	15[a] (13750)[c]	22[a] (25650)[c]	33[a] (42900)[c]	
Strongyloides spp. eggs	3	2.19	800	5.84	266.67	150-500	1[a] (250)[c]	2[a] (400)[c]	1[a] (150)[c]	

Note: a-number of infected silvery mole rats, b-number of adult parasites, c-number of eggs collected.

Table 2. Association of Body Parameters and Prevalence of Nematode Fauna in Silvery Mole-Rats

Variable	Category	Number of examined hosts	Number of infected hosts	Prevalence (n/N ×100)	Odds Ratio	95% CI	X^2	P-value
Age	Adult	120	43	35.83%	0.30	0.11-0.87	4.06	0.04
	Sub-adult	17	11	64.71%				
Sex	Female	89	40	44.94%	1.98	0.90-4.20	12.62	0.1
	Male	48	14	29.17%				
Reproductive Category	Breeder	113	39	34.50%	0.32	0.13-0.79	5.37	0.02
	Non-breeder	24	15	62.50%				

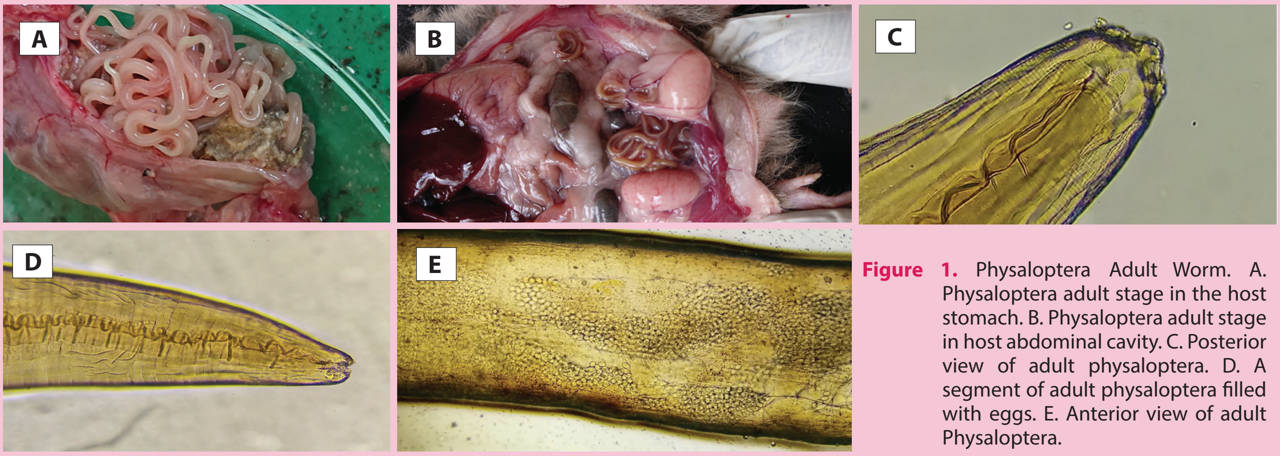

Figure 1. Physaloptera Adult Worm. A. Physaloptera adult stage in the host stomach. B. Physaloptera adult stage in host abdominal cavity. C. Posterior view of adult physaloptera. D. A segment of adult physaloptera filled with eggs. E. Anterior view of adult Physaloptera.

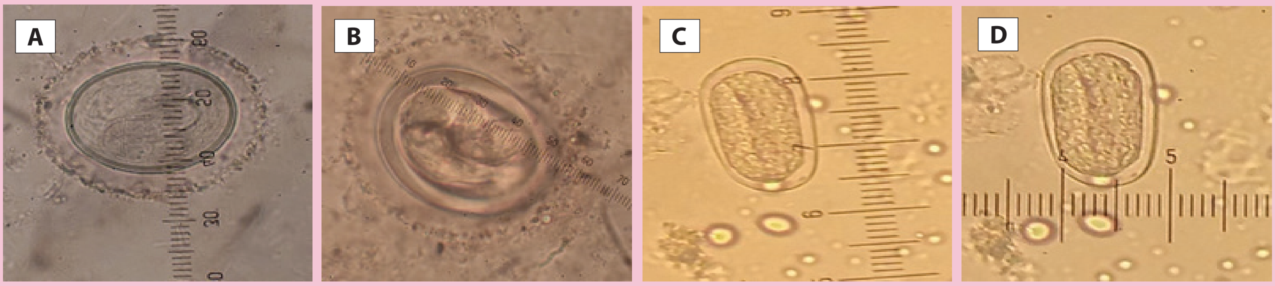

Figure 2. Eggs of nematodes . A. Embryonated physaloptera spp egg measured in width. B. Embryonated physaloptera spp egg measured in width. C. Strongyloides spp egg measured in length. D. Strongyloides spp egg measured in width

infection risk, with an odds ratio of 0.32 (95% CI =0.13-0.79). Interestingly, there was no association between the prevalence of nematode infection and the host's sex. However, females had a higher risk of nematode infection compared to males (Table 2), with an odds ratio of 1.98 (95% CI 0.90-4.20).

DISCUSSION

Determining the nematodes infecting silvery mole rats in the country is important, as it serves as a baseline for understanding the diverse parasitic nematodes and the potential for zoonotic nematode transmission to humans and livestock in these regions. Two nematode species *(Physaloptera spp.* and *Strongyloides spp.)* were found in this study, species richness was low and consistent with most studies carried out in other subterranean rodents in other parts of the world. Indeed, Rossin and Malizia (2002), reported two nematode species in *Ctenomys talarum* (Argentina), while Lutermann and Bennett, (2012) and Lutermann, *et al.,* (2018) each identified four nematode species in the Cape dune mole-rat (South Africa) and Ansell's mole-rat (Zambia), respectively. Generally, subterranean rodents have low species richness compared to other members of order Rodentia. These findings support the hypothesis that the subterranean niche limits their exposure to parasites (Rossin, *et al.,* 2010; Lutermann & Bennett, 2012). Furthermore, due to their strictly herbivorous diet, coupled with brief surface excursions to collect plant material, they experience reduced exposure to parasites. In this study, the overall prevalence of nematode infection was 38.7% dominated by *Physaloptera spp.* This finding contradicts most studies conducted on African mole rats in various areas across Sub-Sahara Africa. These studies have reported a low prevalence of nematode parasitic infection (Scharff, *et al.,* 1997; Tenora, *et al.,* 2003; Viljoen, *et al.,* 2011; Lutermann & Bennett, 2012; Lutermann, *et al.,* 2013, 2018; except for Archer, *et al.,* 2017). This is primarily because the sample sizes were relatively small except for Lutermann, *et al.,* (2018). Another reason could be their sedentary lifestyle, subterranean niche, and herbivorous diet.

Physaloptera spp., ubiquitous parasitic nematodes, belong to the order spiruridae and family physalopteridae. These nematodes are prevalent in mammals (90 species), reptiles (45 species), birds (24 species), and amphibians (Mohamedain and Ammar, 2012). This nematode has an indirect life cycle that includes intermediate hosts i.e. orthopterans and coleopterans. The life cycle also includes paratenic hosts, which harbour larval forms in their intestinal walls (Castillo, *et al.,* 2020). The definitive host becomes infected upon ingesting intermediate or paratenic hosts contaminated with the parasite. The predilection site of this nematode is the stomach; it was evident in our study since a large number of *Physaloptera spp.* adult stage were observed in the stomach of infected silvery mole rats, these nematodes are also present in the esophagus, small intestine, and body cavity. The presence of these adult stages in large numbers suggests that silvery mole rat *(Heliophobius argenteocinereus emini)* predominantly plays the role of a definitive host for this parasite. This marks the first report of *Physaloptera spp.* infection in a subterranean rodent from Africa. Bartel and Gardner, (2000) reported *Physaloptera limbata* from the Plains pocket gopher *(Geomys bursarius)* in the northern boundary range, Minnesota.

The prevalence of *Strongyloides spp.* in this study was 2.19; this is the first report of *Strongyloides spp.* infection in subterranean rodents in Africa. Worldwide Rossin (2009) and Rossin, *et al.,* (2010) reported *Strongyloides myopotami* found in the small intestines of the *Ctenomys talarum*, collected from Mar de Cobo (Argentina). The genus Strongyloides is a diverse group of nematodes, consisting of both parasitic and free-living species. With over 60 species, they are capable of infecting a wide range of animals from phylum Chordata, namely mammals, birds, reptiles, and amphibians (Fisher and Viney, 1998; Rossin, *et al.,* 2009) It has a complex direct life cycle that alternates between free-living and parasitic cycles and also has the potential for autoinfection and multiplication within the host. Adult female Strongyloides lay eggs in the intestines of the host, then it's passed out of the host's body through feces. In favorable environmental conditions, the eggs hatch and release rhabditiform larvae, which can either develop into infective filariform larvae or undergo a direct development cycle. Infective filariform larvae penetrate the skin or enter the host's body through ingestion of contaminated food or water.

Sub-adult silvery mole rats were found to have more nematode infections than their adult counterparts; this may be due to an innate immune response that targets foreign molecules in young animals, making them more susceptible to parasitic infections (Adelman, 2010; Lutermann, 2022). This finding aligns with previous research in highveld mole rats (Viljoen, *et al.,* 2011). The prevalence of nematode infections varied based on reproductive status. Breeders experienced less infection than non-breeders, regardless of their sex. This difference may be because reproductive individuals tend to be older, and the lower parasite abundance in these individuals could indicate adaptive immunity, the body's primary defense against parasitic re-infections (Adelman, 2010; Fagir, *et al.,* 2021), and non-breeders due the age tend to spend time on energetical costly foraging and locomotion activities than breeders, increases their exposure to parasites (Lutermann, 2022). This study found that sex didn't determine the prevalence of nematode infection with a p-value greater than 0.05. However, females were at risk of infection than their male counterparts, with an odds ratio of 1.98. This is contrary to most of the studies in which males are at higher risk due to testosterone immune suppressive effect and naturally males are more vagility than females hence increasing exposure to parasites (Klein, 2000; Greives, *et al.,* 2006; Ben-Batalla, *et al.,* 2020). The reason for this discrepancy could be due to many animals captured were females than males.

CONCLUSION

The study established nematode infections of *Physaloptera spp.* and *Strongyloides spp.* in silvery mole rats of Morogoro region, Tanzania. Despite heavy infection with adult worms of Physaloptera spp on some animals, silvery mole rats still appeared healthy and active, reflective of a well-established and presumably successful rat host-parasite interrelationship. However, their underground lifestyle, which minimizes their contact with various sources of infection, helps protect the silvery mole rats from parasites. Further studies on parasite epidemiology would be useful in determining the zoonotic parasite risk ongoing habitat disturbance poses to other vertebrates other than silvery mole rats.

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CONFLICT of INTEREST

The authors declare no conflicts of interest. The funding sources had no input into the study's planning, data collection, analysis, interpretation, manuscript writing, or the choice to publish the findings.

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ETHICAL APPROVAL

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). The Ministry of Regional Administration and local government authority and the Morogoro Regional Administrative Committee provided the permit to conduct research in Mvomero and Morogoro urban districts on 22nd February2023 with reference number AB.175/245/01/218.

AUTHORS' CONTRIBUTIONS

Conceptualization, D.E.S. and M.K.N.; Methodology, D.E.S., M.K.N., E.M.M. and J.S.N.; Data curation, D.E S.; Formal analysis, D. E. S. and J. S. N.; Writing-preparation of origin draft, D. E. S.; Writing- review and editing, D. E. S., M. K. N., E.M.M. and J. S. N.; Supervision, M. K. N., E. M. M. and J. S. N. All authors have read and agreed to the published version of the manuscript.

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