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RESEARCH

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Gastrointestinal parasites of three peri-domestic animals in selected areas in Accra, Ghana

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Abstract

Background: The rapidly increasing rodent and lizard populations in human dwellings and markets could be attributed to the destruction of their natural habitats due to rapid urbanization and poor management of urban wastes that attracts these animals. The public health concern is the potential for these animals to influence the transmission of zoonotic diseases, including helminths. In this study, the occurrence of helminth parasites in the gastrointestinal tract of rodents and lizards was determined.

Results: Of the 34 rodents, 61.8% (21/34) were observed to be infected with one (1) or more of *Toxascaris sp., Isospora sp., Hymenolepis sp., Trichuris sp., Ascaris sp.*, or *Taenia sp.* Out of these, 17.6% (6/34) had single parasite infections, while 44.1% (15/34) had multiple infections of *Enterobius sp., Ascaris sp., and hookworm* in various combinations. Of all the *Agama* lizards, 54.2% (26/48) had single parasite infections compared to 18.8%, which had multiple infections. The most common parasite infection in the *Agama* lizards was *Enterobius* sp. with a mean of 7.0 ova per lizard, followed by *Ascaris* sp., (mean ova = 2.7) and hookworm (mean ova = 0.3) at the Legon Campus. Similarly, for Adumanya, mean ova counts were 3.9, 0.4, and 0.8, respectively, for the three helminths detected. The common parasite found in both rodents and the *Agama* lizards was *Ascaris* sp. with adults having higher burdens compared to the juveniles.

Conclusions: This study identified helminth parasites, which share the same genus as those observed to infect humans. Since these animals are ubiquitous in human dwellings and markets in Ghana, there could be a potential risk of transmission of these helminths and other disease-causing agents. We are, however, uncertain whether these agents can survive in the human digestive system to cause disease.

Background

Common household rodents (*Rattus rattus* and *Mus Musculus*) and the *Agama agama* have been documented as important reservoirs of various zoonotic diseases of public health importance, especially in least developing countries (Himsworth et al., 2013; Wekhe & Olayinka, 1999). These animals are ubiquitous and adapt to varying environmental conditions. *Rattus rattus* and *Mus Musculus*, for instance, are described as very successful in terms of survival both in the wild and in human dwellings. They are also known to cause a lot of damage to agricultural products and are responsible for pre- and post-harvest losses (Tripathi, 2014).

Exposure to these animals' pathogens could be direct or indirect, through exposure to their urine fecal droppings, fur, directly through their bites and indirectly through bites from ectoparasitic vectors (Singla et al., 2008). There is the possibility that people may become infected through contact with contaminated soil, water, food, or surfaces they inhabit (Bharti et al., 2003; Meerburg et al., 2009). Availability of food leftovers (Donaldson, 1925)

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and insanitary conditions (Taylor et al., 2008) have been identified as factors responsible for attracting rodents to human dwellings, as they feed on almost everything (Archer et al., 2017; Taylor et al., 2008).

Parasites of rodents have been described worldwide, but few studies have investigated those in proximity to humans, such as those found in homes or close to buildings and markets. With regard to rodents, Mafiana et al. (1997) reported in a study in Abeokuta three cestodes, three nematodes, and one acanthocephalan in *Rattus rattus*. Endoparasites recovered from three rodents, *Rattus norvegicus, Rattus rattus, and Mus natalensis* in the Durban Metropolitan area, South Africa, including three Protista and Cestoda, one Acanthocephala, and five Nematoda (Archer et al., 2017). A similar study in the *Agama* lizard by Adeoye and Ogunbanwo (2007) in Lagos identified four species of Nematodes and one parasite, each of Cestoda, Trematoda, and Pentastomida.

Regardless of the relative public health significance and the likely diseases they can transmit, there is a paucity of published literature in Ghana on the gastrointestinal parasites found in rodents and lizards. Therefore, this study addressed that gap by establishing the presence of gastrointestinal parasites in two rodents (*Rattus rattus* and *Mus Musculus*) and *Agama agama* in the study areas.

Methods

Study site

The study was conducted on the University of Ghana botanical gardens, campus (5° 39′ 3″ N, 0° 11′ 13″ W), the Dome market (5° 39′ 18″ N, 0° 14′ 6″ W) both in the Greater Accra Region, and Adumanya (5° 55′ 0″ N 0° 40′ 0″ W) in the Eastern Region, 42 km north of Accra. The University of Ghana, Legon Campus, lies approximately 12 km NE of the center of Accra, an altitude between 300 and 400 feet. The University has about ten (10) halls and four (4) hostels on the Legon Campus. Trapping was done at four traditional Halls of Residence, Commonwealth, Akuafo, Mensah Sarbah and Legon, and the Dome market. Areas around the Balme Library, University Bookshop, and lecture theaters were also included.

Trapping methods

Galvanized aluminum heavy-duty Shearman collapsible traps (3 × 3.5 × 9″) and locally made kill traps were employed to capture the rodents and lizards from some traditional hall canteens on the Legon Campus. Some other *Rattus rattus* and *Mus musculus* were trapped from the Dome market. Baits consisting of either bread, fish, or peanut butter mixed with corn dough were placed in the traps to lure the rodents and lizards into the trap. The trapping was done between January and March 2019. In total, 34 rodents (*Rattus rattus* and *Mus musculus*) and 18 lizards (*Agama agama*) were trapped. The traps were distributed in cubicles, behind dustbins, under tables, in dark places, and holes close to signs of activity or places that are potential sources of food and/or harborage. The traps were set late in the afternoon, around 4 pm each day, and were checked early the next morning. Both live and dead trapped animals were transported to the laboratory and anesthetized with chloroform.

Examination of gut contents

Briefly, live *Rattus rattus, Mus musculus* and *Agama agama* were chloroformed and dissected to remove their intestines (both large and small) and their stomachs for pathogen (parasite) determination. The main method that was used to detect the egg of the parasites was the modified zinc flotation method (Dryden, 2017). About 1 g of the fecal matter (pellet from the intestine) was taken and crushed with a spatula and mixed well with 15 ml of saline in a glass test tube. This was filtered with the help of surgical gauze. The suspension was centrifuged at a speed of 1500 rpm (rate per minute) for about two (2) minutes. The supernatant was decanted, and about 12 ml of zinc sulfate is added to top it up to the 15-ml mark. The solution is centrifuged again at a speed of 1500 rpm for two (2) minutes. A sample from the solution's surface is removed with the help of a dropper and placed on a microscope slide. A drop of iodine solution is later added to stain the cysts or ova, and a coverslip is placed on the slide. All intestinal samples were treated similarly and examined using × 10 and × 40 under a light microscope.

Data analysis

Examination results were entered into Microsoft Excel and used to generate frequencies and percentages of helminths detected. The intensity of helminths per animal, as well as total helminth intensity, was also estimated.

Results

Thirty-four rodents belonging to two species, *Rattus rattus* and *Mus musculus*, were trapped and their intestinal contents examined for parasites. All rodents were trapped from the Dome market and the Legon Campus. The highest number of rodents trapped were from the Dome market ($N = 22$, 64.7%), while the remaining (12, 35.3%) were from the Legon Campus. Parasites identified included *Toxascaris* sp., *Hymenolepis* sp., *Trichuris* sp., *Ascaris* sp., and *Taenia* sp. Combining the parasite ova counted for the two sites, 17.6% (6/34) had single parasite infection, 44.1% (15/34) has multiple infections (two or more parasite ova detected), while 38.2% (13/34) of the rodents were uninfected.

Also, forty-eight *Agama* lizards were trapped from both the Legon Campus and Adumanya and examined for parasite ova. Eighteen (18) of the *Agama* lizards were trapped from the Legon Campus and made up of four adult females, six adult males, five juvenile females, and three juvenile males (Fig. 1). Single parasite infection in *Agama* lizards (54.2%, 26/48) was higher than multiple infections (18.8%, 9/48).

The highest number of rodents (*Rattus rattus* and *Mus musculus*) trapped was from the Dome market (N = 22, 64.7%), while the remaining (12, 35.3%) were from the Legon Campus. Parasites identified from the gut contents of these animals included *Toxascaris* sp., *Isospora* sp. oocyst, *Hymenolepis* sp., *Trichuris* sp., *Ascaris* sp., and *Taenia* sp. (Figs. 2, 3, 4, 5, 6, 7). In all, 17.6% (6/34) of the animals had single parasite infections, whilst 44.1% (15/34) were observed to have multiple infections (two or more parasite ova detected), with only 38.2% (13/34) of them having no parasite infestations.

Three parasite ova, *Ascaris* sp. (Fig. 8), *Enterobius* sp. (Fig. 9), *Hookworm* sp. (Fig. 10), and an adult *Enterobius* sp. (Fig. 11), were detected in the *Agama agama* (Table 1). *Enterobius* sp. had the highest total ova count of 73 (mean = 7.0), followed by *Ascaris* sp., 23 ova count

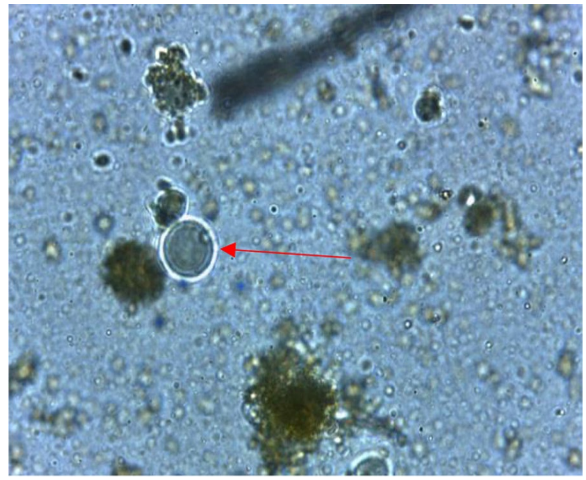

Fig. 2 Egg of *Ascaris sp.*

(mean = 2.7). Hookworm ova had the least count and were detected only in adult male lizards.

In total, 30 *Agama* lizards from Adumanya (consisting of nine adult females, 17 adult males, and four juvenile males) were trapped, killed, and examined for parasite

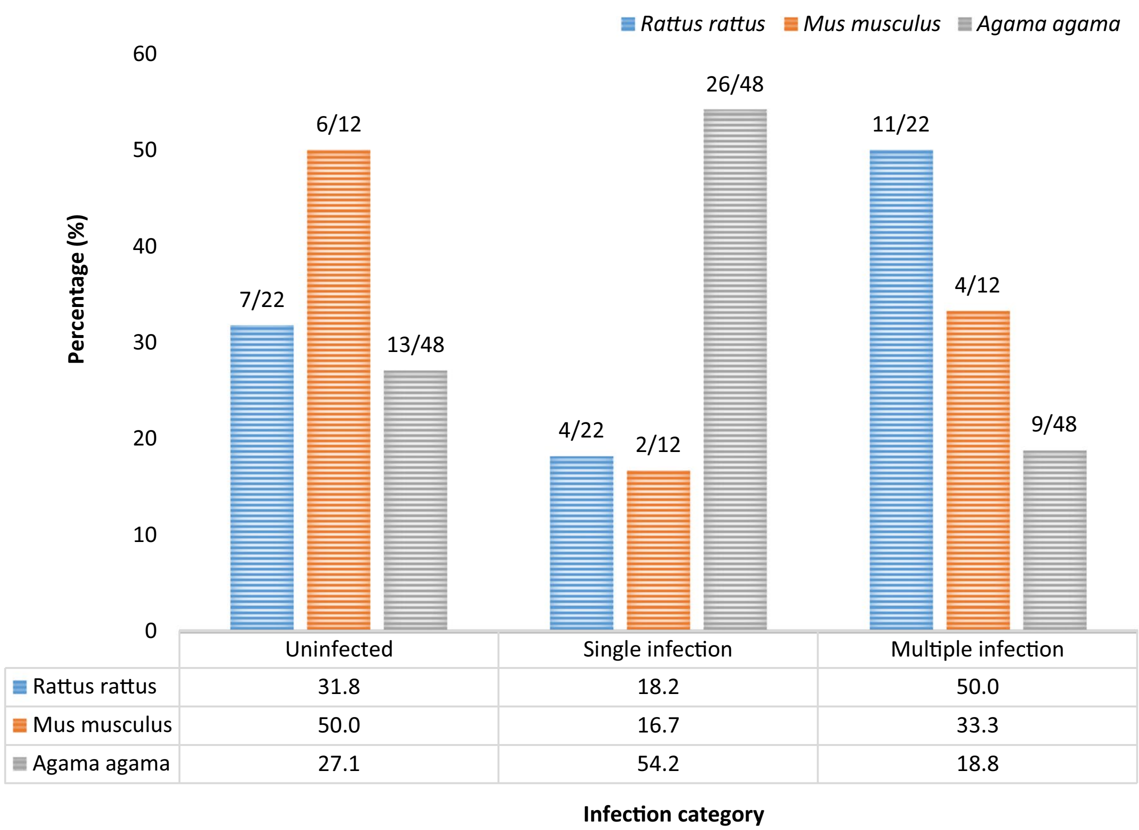

Fig. 1 Level of parasite infection among rodents and lizards

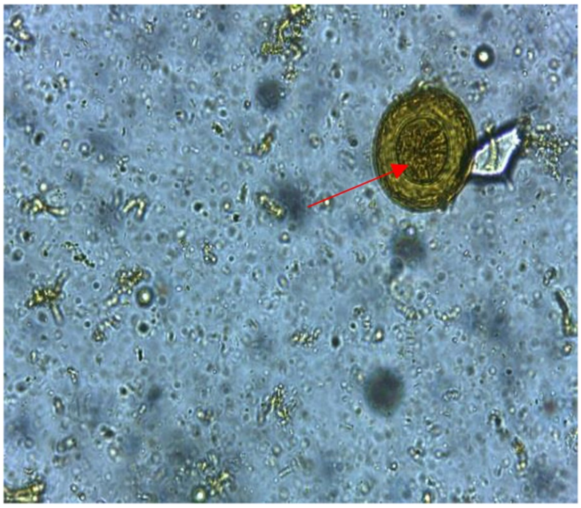

Fig. 3 Egg of *Hymenolepis sp.*

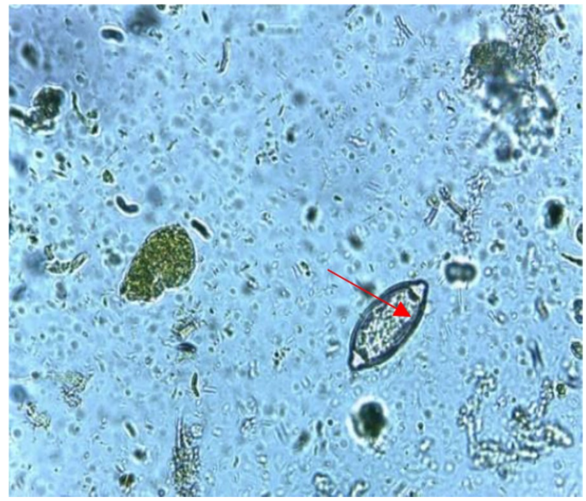

Fig. 5 Egg of *Trichuris sp.*

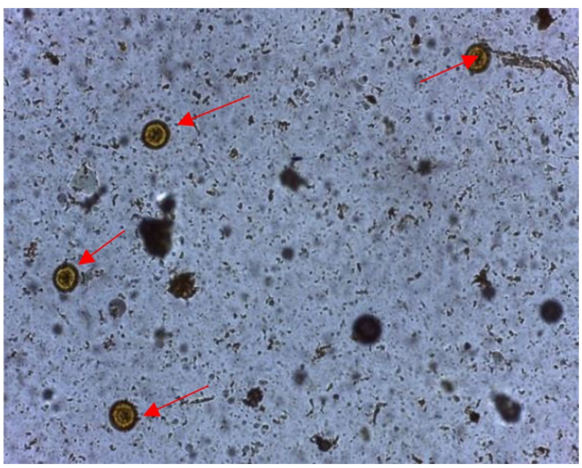

Fig. 4 Eggs of *Taenia sp.*

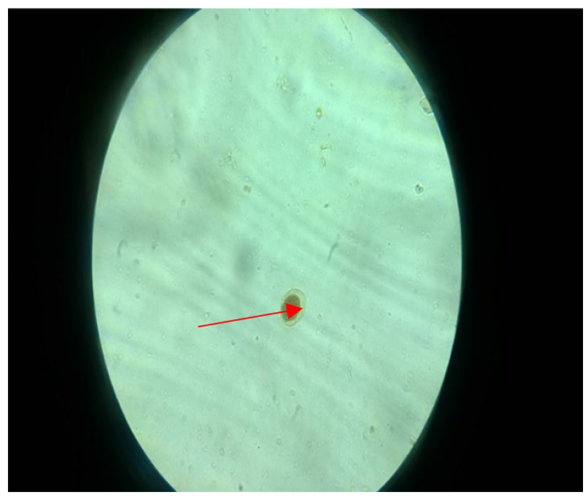

Fig. 6 *Isospora* oocyst

ova. *Enterobius* sp. was the most common parasite ova detected (104 ova among 30 *Agama* lizards, mean ova count per *Agama* lizard = 3.9), followed by *Ascaris* (13 ova among 30 *Agama* lizards, mean ova count per *Agama* lizard = 0.4) (Table 2). Adult *Agama* lizards harbored most parasites as compared to the juveniles.

Discussion

The proximity of peri-domestic animals, including rodents and lizards, to human dwellings in Ghana and cross-infection dynamics of parasites, justifies the need to investigate the gastrointestinal parasites associated with them. This increasing synanthropic phenomenon could be largely explained by increasing urbanization, coupled with climate change, and increasing habitat loss and pollution (Costantini et al., 2014; French et al., 2008; Prange et al., 2003). Regardless of the increasing populations and the associated nuisance they pose, they offer some remarkable economic and environmental importance that cannot be overlooked. Their health and survival could serve as key environmental health indicators for humans and their domesticated animals. Of utmost relevance in this study is the potential zoonotic cross-infection between these animals and humans.

Five species of helminths (*Toxascaris* sp., *Hymenolepis* sp., *Trichuris* sp., *Ascaris* sp., and *Taenia* sp.) and the coccidian parasite, *Isospora* sp. oocyst, were detected in rodents, representing 61.8% overall

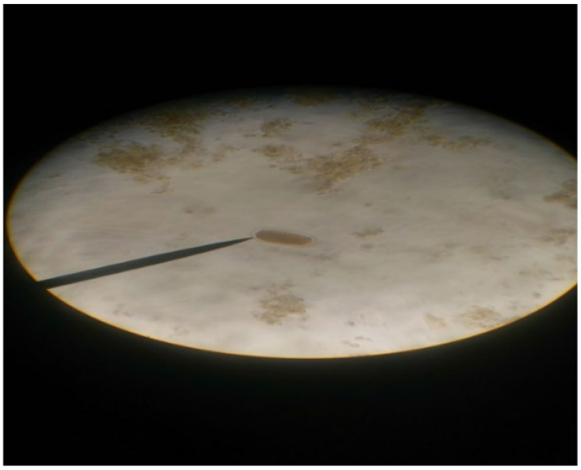

Fig. 7 Egg of *Toxascaris* sp.

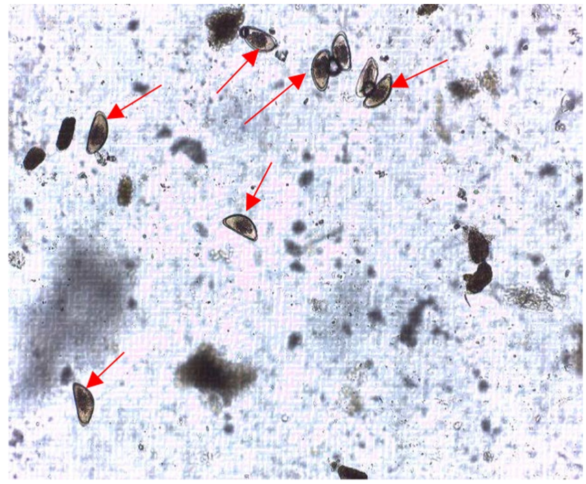

Fig. 9 Eggs of *Enterobius* sp.

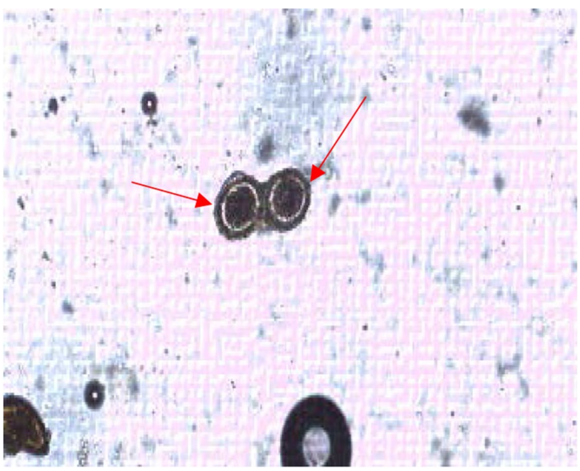

Fig. 8 Eggs of *Ascaris* sp.

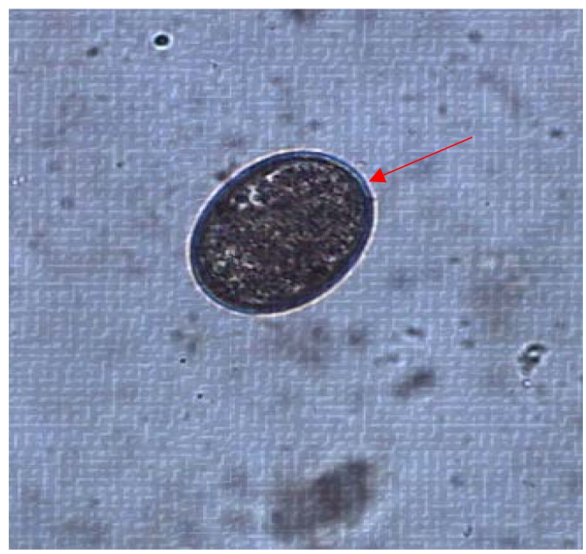

Fig. 10 Hookworm ova

infectivity. Among the rodents examined, 68.2% and 50.0% of rats and mice were observed to be infected with parasites, respectively. A study by Mafiana et al., (1997) reported seven gastrointestinal helminth parasites in the black rat in Abeokuta, Nigeria, with an overall prevalence of 64.7%. Similarly, two recent studies, one in South Africa (Archer et al., 2017), detected eight parasites of public health importance, while another in Iran (Ranjbar et al., 2017) detected 12 parasites. A previous survey in Iran (Pakdel et al., 2013) also reported nine different parasites in two rodents. It is becoming increasingly evident that rodents harbor relatively large numbers of parasites. However, the probable transmission dynamics to humans and vice versa has not yet been established.

Multiple parasitemias were described as the detection of two or more helminths in a rodent. Of the 22 *Rattus rattus,* 50.0% had multiple parasites, compared with 33.3% of *Mus musculus*. In a systematic review of urban rats' helminths in developed countries, species richness per host ranged from one to six (Gliga et al., 2020). The variation in parasite intensity per host of the same species is not clear. Still, it has been hypothesized by Bordes et al. (2007) that foraging in a greater diversity of habitats could expose rodents to a greater variety of infections, hence increasing the richness. There is also the likelihood habitat diversity that could increase the number of contacts between rodent species, increasing the chances

Fig. 11 Adult *Enterobius* sp.

Table 1 Parasite ova detected in *Agama* lizards trapped on the Legon Campus

Stage (sex)	Parasite ova *n* ($\bar{x}$)*			
	No. trapped	*Ascaris* sp.	*Enterobius* sp.	Hookworm
Adult (female)	4	–	18 (4.5)	–
Adult (male)	6	18 (3.0)	24 (4.0)	2 (0.3)
Juvenile (female)	5	5 (2.3)	20 (9.7)	–
Juvenile (male)	3	–	29 (9.7)	–
Total	18	23	73	2

*$\bar{x}$ mean parasite ova per lizard

Table 2 Parasite ova detected in *Agama* lizards trapped at Adumanya

Stage (sex)	Parasite ova *n* ($\bar{x}$)*			
	No. trapped	*Ascaris* sp.	*Enterobius* sp.	Hookworm
Adult (female)	9	2 (0.2)	35 (3.9)	7 (0.8)
Adult (male)	17	11 (0.6)	49 (2.9)	–
Juvenile (female)	–	–	–	–
Juvenile (male)	4	–	20 (5.0)	–
Total	30	13	104	7

*$\bar{x}$ = mean parasite ova per lizard

of sharing a greater number of more generalist parasite species. In our view, the increasing rodent population, coupled with their adaptation to food previously eaten exclusively by humans, may contribute immensely to the survival of zoonotic parasite species in man.

At least one parasite ova of either *Ascaris* sp., *Enterobius* sp., or hookworm was detected in 35 of the 48 *Agama* lizards examined from both sites. Of this total, 54.2% had single parasite ova, while 18.8% had two or more detected. Mean ova count for *Enterobius* sp. was 7.0 per lizard compared to Ascaris sp., 2.7, and hookworm, 0.3, at the Legon Campus. Similarly, for Adumanya, mean ova counts were 3.9, 0.4, and 0.8, respectively. The most common parasite ova detected was that of *Enterobius* sp. A recent related survey in 133 *Agama* lizards in Ibadan, Southwest Nigeria, all had at least one of five species of helminths documented. These consisted of three nematodes, one cestode, and one trematode, where multiple infections with at least two parasites (81.2%) were the most common (Sowemimo & Oluwafemi, 2017). In this current study, we observed that adult *Agama* lizards had the highest intensity burden than the juveniles. Adeoye and Ogunbanwo (2007) also suggested in their study where they found adult lizards harbored high parasite intensity that older lizards have increased contact with parasites due to their predatory mode of life. Similarly, Sowemimo and Oluwafemi (2017), through their analysis, showed that the size of the lizards used in their study was associated with worm burden. In their study, juvenile lizards had the lowest intensity, while the highest intensities were recorded in adults. Regarding sex, our study found a higher intensity burden in males than females, but sex did not appear to influence the burden in the Ibadan study.

Conclusions

The prevalence of helminths in the two rodents and *Agama* lizard is high and shares the same genus with those typically found to infect humans. In this study, rodents were found to harbor more helminth parasites than lizards. We are currently uncertain of the exact species found in these animals, so we cannot conclude whether they can survive to cause disease in man. However, considering the nuisance and destructive activities of these animals, efforts must be directed at controlling their populations to minimize potential contact with the animals, surfaces they come into contact with, or their excreta.

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Authors' contributions

This research was done by the collaborative involvement of all the authors and have all read and approved the manuscript. LB performed conceptualization, design, and methodology of the study. Also he contributed in the project administration, resources, supervision, laboratory and data analysis, manuscript drafting and reviewing as well as editing. JAY and LAA were involved in field and laboratory investigations, data analysis, and manuscript drafting and reviewing. BYO contributed to study design, methodology of the study, contribution of resources, field capture of the animals, supervision, and reviewing. DO done supervision, data analysis, and manuscript drafting and reviewing. AKT performed data analysis and manuscript drafting, review and editing. EHO did project administration, resources, supervision, and manuscript reviewing and editing. All authors read and approved the manuscript.

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Availability of data and materials

All relevant data are within the manuscript.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors have declared that no competing interests exist.

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