

Original papers

Helminth parasites of the Nile Rat, *Arvicanthis niloticus*, from Shendi area, Sudan

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ABSTRACT. Eighty nine rats, *Arvicanthis niloticus*, were collected from the horticultural fields of Shendi area in Sudan, between January and June 2018, and examined for the first time for helminth parasites. Thirty seven (41.6%) of the collected rats were infected, with an overall mean intensity of 4.4 helminths per a rat. A total of 6 helminth species were identified including three nematodes (*Nippostrongylus brasiliensis*, *Monanema nilotica* and *Capillaria hepatica*) and three cestodes (*Hymenolepis diminuta*, *H. nana* and *Taenia taeniaeformis*). The most prevalent helminth was found to be the nematode, *N. brasiliensis* (21.3%), followed by the cestode, *H. diminuta* (10.1%), while the least was the nematode, *C. hepatica* (1.1%). Higher prevalence and intensity of infection were observed among older rats. Likewise, male rats were found to harbor a higher prevalence and intensity of infection. In conclusion, the rat, *A. niloticus* in Shendi area has found to be parasitized by various species of helminths, which some are of zoonotic importance, thus, any possible contact between this rat and humans or their pets may pose potential risk to public health.

Keywords: *Arvicanthis niloticus*, helminth parasites, prevalence, intensity, Sudan

Introduction

The Nile Rat, *Arvicanthis niloticus*, is a species of rodent in the family Muridae [1]; it has been classified as the Least Concern (LC) according to the International Union for the Conservation of Nature (IUCN) Red List criteria [2]. This species is primarily diurnal and known to occur along the Nile Valley and across most of sub-Saharan Africa, however, rarely found in the southern and south-western regions of the continent; this rat resides in burrows under bushes. It is primarily herbivorous, feeding on grasses and seeds, however, arthropods are also eaten by this species [1,3].

Economically, *A. niloticus* is considered as an important pest in agricultural habitats; besides, it has also been used in various research fields such as physiology, behavior and medicine [4,5]. *A. niloticus* also serves as the host and/or vector for a

variety of pathogenic organisms, such as helminths, protozoans, viruses, ticks, mites and fleas [6,7].

Because of the limited information concerning parasites of rat species in Sudan, this study was carried out for the first time to investigate the followings: the helminth species which parasitize the Nile Rat, *A. niloticus* in Shendi area, and the prevalence and intensity of infection according to age and gender of this rat.

Materials and Methods

The rat, *A. niloticus* was captured alive using a collapsible wire trap measuring 24L×10W×10H cm and baited with pieces of bread or onion, at the horticultural fields of the eastern bank of the River Nile, approximately 2 km opposite to Shendi city (16°40'N, 33°25'E), Sudan, over span of five days from January to June 2018. This area has a semiarid

Table 1. Infection parameters and site of infection of helminths in the Nile Rat, *A. niloticus* (n = 89) collected between January and June 2018, from Shendi area, Sudan

Helminth species	Prevalence %	Mean intensity (range)	Site of infection
Nematodes			
<i>Nippostrongylus brasiliensis</i>	21.3	7.2 (2–12)	Small intestine
<i>Monanema nilotica</i>	2.2	2.5 (2–3)	Pulmonary arteries
<i>Capillaria hepatica</i>	1.1	3 (3)	Liver
Cestodes			
<i>Hymenolepis diminuta</i>	10.1	1.3 (1–2)	Small intestine
<i>H. nana</i>	4.5	1.3 (1–2)	Small intestine
<i>Taenia taeniaeformis</i> (larvae)	2.2	1 (1)	Liver
Overall	41.6	4.4 (1–12)	

climate with annual mean precipitation of 29.3 mm between August and September, and annual temperature ranges from 28–41°C. The specimens were immediately transferred in separate cages to the Laboratory of Zoology at the University of Shendi and euthanized using chloroform. Thereafter, they were measured, weighted and sexed. A rat was considered as an adult if it weighed > 40 g according to our observation. In the necropsy, the internal organs: esophagus, stomach, small intestine, large intestine, urinary bladder, liver, lungs, heart and peritoneum were removed, dissected and placed in separate Petri-dishes containing a normal saline solution (0.9%). Thereafter, parasites were carefully collected, counted under a dissection microscope, then preserved in 70% alcohol before further identification. For clearing and identification of nematodes, 5% glycerin in 70% ethanol was used as a temporary mount. Cestodes were stained in Paracarmine staining, dehydrated in alcohol series, cleared in methyl salicylate oil and mounted. Under

a microscope, helminths were identified to the genus level and species level using available literature and systematic keys [8,9]. The prevalence and mean intensity of infection were calculated [10] as prevalence ($P = n/Z \times 100$); mean intensity ($MI = N/n$), where: n = number of rats parasitized, N = total number of parasites, and Z = total number of rats examined. Data analyses were performed using the statistical software, SPSS 16.0 for Windows (SPSS Inc., Chicago, IL, USA). The difference in the prevalence of infection was analyzed using the Chi-square test, whereas the difference in the intensity of infection was analyzed using the Mann–Whitney test. Values were considered significant when $P < 0.05$.

Results

Eighty nine Nile Rats were collected, with a mean body length of 96.8 mm and mean body weight of 70.3 g, respectively, (including 30 adult males, 19 juvenile males, 27 adult females and 13

Table 2. Prevalence of infection and comparative analysis of helminth parasites, according to sex and age of the Nile Rat *A. niloticus* (n = 89) collected between January and June 2018, from Shendi area, Sudan. ND = no data.

Helminth species	Prevalence %							
	Male rat (n = 49)	Female rat (n = 40)	χ^2	P value	Adult rat (n = 57)	Juvenile rat (n = 32)	χ^2	P value
Nematodes								
<i>Nippostrongylus brasiliensis</i>	22.4	20	30.4	0.99	21.1	21.9	65.6	0.04
<i>Monanema nilotica</i>	4.1	ND	ND	ND	3.5	ND	ND	ND
<i>Capillaria hepatica</i>	2	ND	ND	ND	1.7	ND	ND	ND
Cestodes								
<i>Hymenolepis diminuta</i>	10.2	5	0.4	0.8	12.3	6.3	7.03	0.03
<i>H. nana</i>	4.1	5	19.5	0.000	5.3	3.1	0.07	0.96
<i>Taenia taeniaeformis</i> (larvae)	4.1	ND	ND	ND	3.5	ND	ND	ND
Overall	46.9	30	1.04e	0.01	47.4	31.3	58.8	0.40

Table 3. Mean intensity of infection and comparative analysis of helminth parasites, according to sex and age of the Nile Rat *A. niloticus* (n = 89) collected between January and June 2018, from Shendi area, Sudan. ND = no data.

Helminth species	Mean intensity							
	Male rat (n = 49)	Female rat (n = 40)	U	P value	Adult rat (n = 57)	Juvenile rat (n = 32)	U	P value
Nematodes								
<i>Nippostrongylus brasiliensis</i>	6.8	7.8	39	0.72	7.2	7.3	41	0.9
<i>Monanema nilotica</i>	2.5	ND	ND	ND	2.5	ND	ND	ND
<i>Capillaria hepatica</i>	3	ND	ND	ND	3	ND	ND	ND
Cestodes								
<i>Hymenolepis diminuta</i>	1.3	1	5	0.7	1.3	1	5	0.7
<i>H. nana</i>	1.5	1	1	0.7	1.3	1	1	1
<i>Taenia taeniaeformis</i> (larvae)	1	ND	ND	ND	1	ND	ND	ND
Overall	4.1	5.6	848.5	0.21	4.1	5.4	824	0.40

juvenile females). Out of the 89 collected rats, 41.6% was found to be infected, with an overall mean intensity of 4.4 helminths per a parasitized rat. A total of 6 helminth species were identified including three nematodes: *Nippostrongylus brasiliensis*, *Monanema nilotica* and *Capillaria hepatica*; three cestodes: *Hymenolepis diminuta*, *H. nana* and *Taenia taeniaeformis*.

The predominant helminth species was the nematode *N. brasiliensis*, followed by the cestode *H. diminuta*, while the least was the nematode *C. hepatica* (Table 1).

The small intestine was the most organ parasitized, while the stomach, urinary bladder and peritoneum were found to be free from infection (Table 1).

A higher prevalence of infection was observed among adult rats compared to juveniles; however, this difference was not statistically significant. Similarly, a higher intensity of infection was observed among adult rats compared to younger ones, nevertheless, the difference was also not statistically significant (Tables 2 and 3).

On the other hand, significantly higher prevalence of infection ($\chi^2 = 1.038e$, $df = 72$, $P = 0.01$) was observed among male rats compared to females. Likewise, male rats harbored higher intensity of infection than females, although this difference was not statistically significant (Tables 2 and 3).

Discussion

In the present study, a total of six helminth species were found to parasitize the Nile Rat, *A. niloticus*, which some are of zoonotic importance.

Nematode species identified were: *Monanema nilotica*, which was found to inhabit pulmonary arteries of the lungs. Previous reports from Khartoum area in Sudan revealed that this nematode species infection was quite specific to the Nile Rat [6,11]. Species of *Monanema* are primarily lymphatic that requiring rodents as the final host while ticks as the intermediate host [12]. Herein, further studies covering the life cycle of this nematode are needed. *Capillaria hepatica* is a parasitic nematode found primarily in rodents, however, is known to parasitize numerous other mammal species, including humans in temperate and tropical zones, with a direct life cycle [13,14]. Surprisingly, *C. hepatica* has been found in the liver of only one rat in this study; this is likely due to its limited occurrence within the study area. *Nippostrongylus brasiliensis* is a common intestinal nematode among rodents and has been reported from different parts of the world [15,16], and it was the most prevalent helminth parasitizing the Nile Rat in this study. This species characterized by its simple life cycle, whereas its infective larva penetrates the host skin when coming in contact with infested moist soil.

Cestode species identified in the present study were: *Hymenolepis nana*; this species is a cosmopolitan zoonotic cestode, though most common in temperate zones [17] and rodents are the principal animal reservoir for it. Previously, it has been reported to parasitize the Nile Rat in Sudan [6]. Furthermore, some other rats, such as *Mus musculus* and *Rattus norvegicus* were also reported to be parasitized with this cestode species [18,19]. Likewise, *H. diminuta* is a typical cestode of rats with a cosmopolitan distribution and previously has

been reported from *Rattus* spp. [18]. Life cycle of this cestode begins when rats that feed on infected arthropods such as beetles and fleas. Although this species is zoonotic, however, it is rarely considered as a public health issue, because of few infection cases regarding humans [20]. *Taenia taeniaeformis* is a tapeworm, which commonly parasitizes cats and primarily uses rodents as its intermediate host [21]. Livers of two adult rats in this study were found to be parasitized with the larva of this species. This case of infection may be due to the presence of cats or dogs nearby the investigated area, which they likely serve as the final host for this cestode species.

In the present study, the small intestine was found to be the most parasitized organ with the parasites; the richness of small intestine with helminth parasites is likely due to the richness of this part of the alimentary canal with digested nutrients.

In the present study, a relatively higher prevalence and intensity of infection were observed among adult rats. This finding is consistent with previous reports on rodents that were infected with helminth parasites were significantly correlated with age, whereas adults harbored heavier infection than juveniles [22,23]. However, there are some conclusions that the host age or sex did not influence the parasites community structure [24,25]. Parasitic burdens differently between the host ages could be attributed to longer exposure time to infective stages in older rats. In addition, the large number of rats occupy a similar niche, besides, a prey-predator relationship will also facilitate higher transmission [26,27].

On the other hand, relatively higher prevalence and intensity of helminth infection were observed among male rats compared to females. This finding is in line with several previous reports that males are more parasitized than females [28,29]. However, there are some reports of female-biased parasitism [30] and others of no sex-biased parasitism among rodents [25]. This finding can be explained that males are more active and have a wide home range leading in acquiring an infection. Furthermore, the inhibitory effect of the male hormone on immunity may increase parasites infection susceptibility [31]. Specific for helminth infection, in which eosinophils that are responsible for immunity are suppressed by male testosterone [32].

In conclusion, it is worthy of note that the horticultural field area where samples were collected in this study is about 2 km to Shendi city

is occupied by parasitized rodents. Since the samples examined were found to harbor various helminth parasites and some are of zoonotic importance, any possible contact of this rat, *A. niloticus* with humans or their pets may facilitate the transmission of these parasites and this will pose risks to public health.

Acknowledgements

The authors are grateful to Jibriel Tia and Hassan Hamid, University of Shendi for their kind assistance in collecting the samples of this study.

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Received 06 March 2019

Accepted 05 July 2019