

## Original papers

# Ectoparasites of the Nile Rat, *Arvicanthis niloticus* from Shendi area, Sudan

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**ABSTRACT.** This study investigated the ectoparasites of the Nile Rat, *Arvicanthis niloticus* in Shendi area, River Nile State, Sudan. Eighty nine *A. niloticus* were collected for the first time from the horticultural fields of Shendi, between January to June 2018, and their entire fur was combed thoroughly, using a fine-tooth comb. Any removed ectoparasites were relaxed, mounted and examined under a microscope for morphological identification. Forty two (47.2%) of the collected rats was found infested, with an overall mean intensity of 13.4 (range 2–67) ectoparasites per an infested rat; 10 different species of ectoparasites were identified, including: 2 species of flea – *Xenopsylla cheopis*, *Leptopsylla segnis*; 3 species of louse – *Polyplax spinulosa*, *P. abyssinica*, *P. serrata*; a species of tick – *Rhipicephalus* sp.; 4 species of mite – *Laelaps agilis*, *L. nuttalli*, *Ornityssus bacoti*, *Dermanyssus gallinae*. The most prevalent ectoparasite found was the flea *Xenopsylla cheopis*, 23.6%, followed by the mite *Laelaps nuttalli*, 10.1%, while the least was the mite *Ornityssus bacoti*, 1.1%. Significantly higher prevalence and intensity of infestation was found among male rats. Likewise, older rats significantly harbored a higher prevalence and intensity of infestation.

**Keywords:** *Arvicanthis niloticus*, ectoparasites, prevalence, intensity, Sudan

## Introduction

Rodents are the largest order of mammals with wide species diversity; they present in almost every terrestrial environment that supports life [1]. In urban environments, rodent species are prevalent and pose a threat to public health, by serving as a vector or reservoir host together with their ectoparasites for various pathogens that can be transmitted to humans and their livestock [2,3]. Ectoparasites that infest rodents include various species of fleas and lice (Insecta) and ticks, mites (Acari); they serve as vectors of several diseases important to human health including bubonic plague, murine typhus, and tularaemia [4].

The Nile Rat, *Arvicanthis niloticus* is a rodent in the family Muridae [5]; it is primarily diurnal and known to occur along the Nile Valley and across most of sub-Saharan Africa. This species resides in

burrows under small bushes, trees, rocks and trash piles. It is primarily herbivorous, feeding on grasses and seeds; it is also a commensal species that is very common close to human dwellings [6]. Economically, *A. niloticus* is considered as an important pest in agricultural habitats; beside it has been widely used for laboratory research in the fields of medicine, physiology, behavior, and other related subjects [7,8]. *A. niloticus* serves as host and/or carrying vectors of various pathogenic organisms, such as acarines, insects, helminths, protozoans and viruses [9,10].

Because of the limited information concerning parasites of rat species in Sudan, this study was carried out and for the first time to investigate the following: (i) the ectoparasite species infest the Nile Rat, *A. niloticus* in Shendi area; (ii) the prevalence and intensity of ectoparasite infestations in relative to age and gender of this host.

## Materials and Methods

From January to June 2018, the Nile Rat, *A. niloticus* was captured using a collapsible trap measuring 24L×10W×10H cm baited with pieces of bread or onion, at the horticultural fields of the eastern bank of the River Nile, approximately 2 km to Shendi city (16°40'N, 33°25'E), Sudan. This area has a semiarid 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, University of Shendi and euthanized using chloroform. Thereafter, their body length in millimeters from nose to anus, weight in grams and sex were recorded. A rat was considered an adult when it weighed > 40 g according to our observation. The entire fur of each specimen was combed thoroughly, using a fine-tooth comb to remove any of ectoparasites into a clean white tray. Then, fine forceps were gently used to remove any remain attached parasites to the skin. The contents of the white tray were carefully examined using hand lenses and any parasites were picked and placed into a labeled vial containing 70% alcohol. Thereafter, they were relaxed and mounted on glass slides [11] and examined under a microscope for morphological identification according to available literature and taxonomic keys [11–13].

The prevalence and mean intensity of infestation were calculated as follows: Prevalence ( $P = n/Z \times 100$ ), mean intensity ( $MI = N/n$ ) where: n = number

of rats infested, N = total number of parasites, and Z = total number of rats examined [14]. Data analysis was performed using Chi-square (for the prevalence of infestation) and Mann–Whitney (for the intensity of infestation) tests, SPSS software and values were considered significant when  $P < 0.05$ .

## Results

Eighty nine *A. niloticus* were collected (30 adult males, 19 juvenile males, 27 adult females and 13 juvenile females) with a body length of 33–150 mm (average 96.8 mm) and body weight of 23–122 g (average 70.3 g). Out of the 89 collected rats, 42 (47.2%) were found infested, with an overall mean intensity of 13.4 (range 2–67) ectoparasites per an infested rat. A total of 10 ectoparasite species were identified include: 2 species of flea – *Xenopsylla cheopis* and *Leptopsylla segnis*; 3 species of louse – *Polyplax spinulosa*, *P. abyssinica* and *P. serrata*; a species of tick – *Rhipicephalus* sp.; 4 species of mite – *Laelaps agilis*, *L. nuttalli*, *Ornitoonyssus bacoti* and *Dermanyssus gallinae*.

The dominant species identified was the flea, *Xenopsylla cheopis*, followed by the mite, *Laelaps nuttalli*, while the lowest was the mite, *Ornitoonyssus bacoti*. Likewise, *X. cheopis* recorded a higher range of intensity of infestation (Table 1). Significantly higher prevalence of infestation was found in male rats compared to females, ( $\chi^2 = 1.96$ ,  $P = 0.03$ ). Likewise, a higher prevalence of infestation was found in adult rats compared to the juveniles, ( $\chi^2 = 1.6$ ,  $P = 0.04$ ). (Table 2).

Table 1. Infestation parameters of ectoparasites on the Nile Rat, *A. niloticus* (n=89), collected from Shendi area, Sudan between January and June 2018

Ectoparasite species	Prevalence %	Mean intensity (range)
<b>Insecta</b>		
<i>Xenopsylla cheopis</i> (flea)	23.6	11.7 (2–44)
<i>Leptopsylla segnis</i> (flea)	3.4	5.3 (3–8)
<i>Polyplax spinulosa</i> (lice)	6.7	7.8 (3–12)
<i>P. abyssinica</i> (lice)	5.6	4.4 (2–7)
<i>P. serrata</i> (lice)	2.2	8.5 (5–12)
<b>Arachnida</b>		
<i>Rhipicephalus</i> sp. (tick)	2.2	8.5 (1–10)
<i>Laelaps nuttalli</i> (mite)	10.1	10.2 (3–22)
<i>Ornitoonyssus bacoti</i> (mite)	1.1	14 (14)
<i>Dermanyssus gallinae</i> (mite)	2.2	9.5 (7–12)
<i>Laelaps agilis</i> (mite)	5.6	15 (3–34)
<b>Overall</b>	<b>47.2</b>	<b>13.4 (2–67)</b>

Table 2. Prevalence of infestation and comparative analysis of ectoparasite according to sex and age of the Nile Rat *A. niloticus* (n=89) collected from Shendi area, Sudan between January and June 2018

Ectoparasite species	Prevalence %							
	Male (n=49)	Female (n=40)	$\chi^2$	P value	Adult (n=57)	Juvenile (n=32)	$\chi^2$	P value
<b>Insecta</b>								
<i>Xenopsylla cheopis</i>	24.5	22.5	85.4	0.007	22.8	25	81.0	0.02
<i>Leptopsylla segnis</i>	6.1	ND	ND	ND	5.3	ND	ND	ND
<i>Polyplax spinulosa</i>	8.2	25	0.23	1	8.8	3.1	0.1	0.9
<i>P. abyssinica</i>	ND	12.5	ND	ND	5.3	6.3	ND	ND
<i>P. serrata</i>	4.1	ND	ND	ND	3.5	ND	ND	ND
<b>Arachnida</b>								
<i>Rhipicephalus</i> sp.	2.04	2.5	ND	0.9	3.5	ND	ND	ND
<i>Laelaps nuttalli</i>	12.2	7.5	0.5	1	8.8	12.5	0.7	1
<i>Ornityssus bacoti</i>	2.04	ND	ND	ND	1.8	ND	ND	ND
<i>Dermanyssus gallinae</i>	4.1	ND	ND	ND	3.5	ND	ND	ND
<i>Laelaps agilis</i>	6.1	2	0.2	1	8.8	ND	ND	ND
<b>Overall</b>	51	42.5	1.96	0.03	54.4	34.4	1.6	0.04

ND = no data

On the other hand, male rats significantly harbored a higher intensity of infestation than the females, ( $U = 750.5$ ,  $P = 0.04$ ). Likewise, significantly higher intensity of infestation was observed in adult rats compared to juveniles, ( $U = 667.5$ ,  $P = 0.02$ ), (Table 3).

## Discussion

In the present study and for the first time, the Nile Rat, *A. niloticus* in Shendi area has found to be infested by various ectoparasites, comprising ten different species of fleas, lice, mites and ticks. The Oriental or Tropical Rat Flea, *Xenopsylla cheopis* was found infesting most of the examined rats. Previous studies from Egypt [15] and Sudan [10] have shown the infestation of the Nile Rat with this flea species. Moreover, this flea species have also found to parasitize many other rat species such as *Rattus rattus* and *R. norvegicus* [16]. Importantly, *X. cheopis* has considered as the most efficient vector for the agents that cause plague disease and murine typhus [17], besides, the Nile Rat serves as a natural reservoir of plague throughout the Nile Valley and into East Africa [18]. The other flea species observed here, was the Mouse Flea, *Leptopsylla segnis* with an overall prevalence of infestation of 3.4%. This flea primarily infests rat species such as *R. rattus* and *R. norvegicus* and is

known to be somewhat more effective in transmitting murine typhus infection in rats [19].

Three lice species were identified in the present study; the Spined Rat Louse, *Polyplax spinulosa* with a relatively higher prevalence of infestation compared to other lice identified, this finding is consistent with a previous report from Sudan [10]. *P. spinulosa* is a cosmopolitan louse parasitizing obligatory on rat species such as *R. rattus* and *R. norvegicus*, causing anemia when feeding on host blood [20]. It acts as a biological vector for viruses and bacteria [21]. *P. serrata* louse was also found with a considerable load of infestation, this louse is almost cosmopolitan and is typically found on species of *Apodemus*. However, it was also recorded from the shrew, *Crocidura leucodon*, the voles *Clethrionomys glareolus* and *Microtus arvalis* [22]. Likewise, *P. abyssinica* louse was found to be of a moderate load of infestation. This louse species, mainly distributed in the Nile Valley and the Nile Rat *A. niloticus* serves as a principal host [23].

Four mite species were identified in the present study; *Dermanyssus gallinae* with a low prevalence of infestation. This species is a common-blood sucking ectoparasite of birds, causing anemia that mostly leading to the death of affected hosts [24]. It also can infest small mammal besides humans and have been reported to infest the Nile Rat, *A. niloticus* [10]. The Tropical Rat Mite, *Ornitho-*

Table 3. Intensity of infestation and comparative analysis of ectoparasite according to sex and age of the Nile Rat *A. niloticus* (n=89) collected from Shendi area, Sudan between January and June 2018

Ectoparasite species	Intensity							
	Male (n=49)	Female (n=40)	<i>U</i>	<i>P</i> value	Adult (n=57)	Juvenile (n=32)	<i>U</i>	<i>P</i> value
<b>Insecta</b>								
<i>Xenopsylla cheopis</i>	16.3	5.6	21	0.02	14.9	6.4	29	0.09
<i>Leptopsylla segnis</i>	5.3	ND	ND	ND	5.3	ND	ND	ND
<i>Polyplax spinulosa</i>	8	7.5	4	1	8.4	5	1	0.4
<i>P. abyssinica</i>	ND	4.4	ND	ND	5.7	2.5	00	0.08
<i>P. serrata</i>	8.5	ND	ND	ND	8.5	ND	ND	ND
<b>Arachnida</b>								
<i>Rhipicephalus</i> sp.	14	1	00	0.2	8.5	ND	ND	ND
<i>Laelaps nuttalli</i>	12	6.7	4	0.2	13.6	6	2.5	0.06
<i>Ornityonyssus bacoti</i>	14	ND	ND	ND	14/1	ND	ND	ND
<i>Dermanyssus gallinae</i>	9.5	ND	ND	ND	9.5	ND	ND	ND
<i>Laelaps agilis</i>	22	4.5	00	0.08	15	ND	ND	ND
<b>Overall</b>	17.52	6.9	750.5	0.04	15.2	7.8	667.5	0.02

ND = no data

*nyssus bacoti* was detected with a very low prevalence of 1.1%. This species is a common ectoparasite of rodents and small mammals worldwide; however, it is most commonly on the rats, *R. rattus* and *R. norvegicus* [25]. A human can also be infested with this species accidentally [26]. *O. bacoti* mite was reported to transmit various pathogens causing diseases such as plague, tularemia, Chagas disease and Q fever [27]. The mite *Laelaps agilis* is an ectoparasite of the Yellow-necked Mouse *Apodemus flavicollis* and it can be found on other earth dwelling small mammals and in their nests [28]. Moreover, some of the Laelapidae mites were suspected as potential vectors of zoonoses [29] and could attack human in the absence of their preferred hosts. The mite, *L. nuttalli* is an ectoparasite of the rats, *R. rattus* and *R. norvegicus*, however, it infests other rodents and small mammals, mostly in the tropical and warm temperate zones [30].

*Rhipicephalus* sp. was the only tick species found in the present study, with a prevalence of 2.2% and intensity of 8.5 ticks on the host. *Rhipicephalus* is a genus of ticks consisting of various species; most of them are native to Africa [31], mainly parasitizing dogs. *Rhipicephalus* are of economic, medical and veterinary importance [32]. Previous investigation from Sudan revealed the infestation of the Nile Rat with undefined species of this tick [10].

In the present study, significantly higher prevalence and intensity of infestation was observed in adult rats. This finding is consistent with previous reports that adult rats tend to have more ectoparasites than juvenile individuals [33]. However, there are conflicting findings for host age with some studies reporting higher levels of infection in older hosts [34]. Differences in parasitic burdens between the host ages could be attributed to longer exposure time to infective stages in older rats [35], as parasites accumulation increases by time. Furthermore, parasite transmissions can occur when the host in a large number occupying a similar infested niche. Another explanation for this is due to higher surface area in adult host. For fleas, their abundance depends on host's surface area in contrast to mites and ticks which usually aggregate on specific location of host [36].

In the present study, both sexes were found to harbor ectoparasites with significantly higher prevalence and intensity of infestation in male rats compared to females. In this context, some previous studies on rodent parasites show that males tended to acquire more infestations than females [37]. This can be explained that some male individuals of rats are more mobile and have a wide home range, which enabling them to join other individuals of their species or others [38]; these behavioral characteristics may increase their chances to be exposed to a wide variety and number of parasites

[39]. In the case of the rat *R. rattus diardii*, males were found to be more susceptible to infection compared to females [40], and this has been explained that the male hormone has an inhibitory effect on the immunity of male rats [41]. Moreover, physical encounter among male hosts as a result of aggressive behavior may increase opportunities for ectoparasites transfer and accumulation [42]. Besides, a previous study in Sundevall's jird, *Meriones crassus* indicated the higher production of antibodies and clearance of immune complexes in females than males [43]. Although, most previous results show that rodents are infested with various ectoparasite with males harbor more infestation than females. However, others report that females are more heavily infected [44].

In conclusion, the Nile Rat, *A. niloticus* in Shendi area has found to be infested by various species of ectoparasites that many are of zoonotic importance when they carry pathogens. Thus, any possible contact or association between this rat and human or domestic animals may highly pose a potential risk to public health.

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