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https://borneoakademika.uitm.edu.my

Borneo Akademika
Volume 6(2) December 2022, 12-21
https://doi.org/10.24191/BA/v6i2/80386

e-ISSN: 2735-2250

The Prevalence of Gastrointestinal Parasites in Wild Rats (Muridae) in Pilajau Oil Palm Plantation of Sawit Kinabalu Group, Membakut Sabah Malaysia

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Received Date: 1 November 2022
Accepted Date: 19 November 2022
Published Date: 3 December 2022

ABSTRACT

Rats are pests and reservoirs for ectoparasites and endoparasites. This study was conducted at the Pilajau oil palm plantation to evaluate the prevalence of gastrointestinal parasite infection among wild rats. This study identified the rat species and sex based on its morphological characteristics. Gastrointestinal parasites were identified up to the genus level using formalin-ether concentration (FECT). Parasite eggs and oocysts were quantified with a modified McMaster method using Sheather's solution. The plantation rats included *Rattus rattus* and *Rattus norvegicus*. There were more captured males (60%) than females (40%) of *R. norvegicus* and *R. rattus.* This study also discovered a total of 11 parasite genera, and only one non-zoonotic genus, *Eimeria* spp. Most of the identified nematodes, cestodes and protozoa parasites were zoonotic. Additionally, the prevalence and mean intensity of parasite infection in wild rats were also calculated. *Strongyloides* spp. (100%) recorded the highest prevalence in wild rats, followed by *Nippostrongylus* spp. (86.67%), *Ancylostoma* spp. (76.67%), *Blastocystis* spp. (76.67%), *Trichuris* spp. (70%), *Eimeria* spp. (60%), *Ascaris* spp. (50%), *Capillaria* spp. (46.67%), *Entamoeba* spp. (33.33%) and *Cryptosporidium* spp. (26.67%). In terms of intensity, most readings obtained were below 500 EPG, which is suggestive of mild parasitic infection in wild rats. However, due to its zoonotic potential, workers and residents living near the plantation area are still exposed to zoonotic pathogens transmitted by wild rats.

Keywords: *Rattus rattus*; *Rattus norvegicus*; gastrointestinal parasites; prevalence; the plantation area

INTRODUCTION

Background of study

Rodents are the largest order of mammals. Rats, mice, and older rat species from the Old World make up the majority of rodents and the family Muridae (Aghová et al., 2018). The species are exceedingly adaptable and have a wide distribution on Earth, except in Antarctica (Meerburg et al., 2009). Rodents reside in cities, urban areas, and plantations, causing economic losses in agricultural and urban contexts. Rats are known as the most successful rodent species because of their exploitation in a wide range of ecosystems, thereby raising public concerns about their roles in spreading zoonotic illnesses. Murids spread minor to severe infections. Until recently, zoonotic

illnesses were a concern since they impact humans and animals. Nonetheless, the nocturnal mammal cannot directly infect humans without contracting their faeces or other secretory materials.

Previous studies and surveys on rodent gastrointestinal parasites focused on intestinal helminths and protozoa in urban areas. For instance, Premaalatha et al. (2017) found that wild rats carried either at least one helminth species or protozoa. The most common protozoa observed in wild rats are *Giardia* spp, *Cryptosporidium*, and *Entamoeba* spp (Isaac et al., 2018; Verma et al., 2021). Meanwhile, *Hymenolepis* spp., *Nippostrongylus* spp. and *Strongyloides* spp. are the most common helminths found in rats (Amin et al., 2019; Coomansigh-Springer et al., 2018; Lima et al., 2021). For comparison, helminths recorded the most endoparasites found in wild rats as protozoa (Coomansingh-Springer et al., 2019). Earlier studies revealed that oil palm estate workers in plantation areas were also potentially infected by common helminth species, *H. diminuta* and *H. nana* (Sinniah et al., 1978). This indicates that rats contribute to rodent-borne diseases in humans since protozoan and helminth parasites can be zoonotic and invade people.

Nonetheless, the occurrence of parasites in rodents is understudied, especially in the plantation area. Additionally, published reports and studies are still limited in East Malaysia. Parasitological studies and research on the prevalence of gastrointestinal parasites in rodents are needed to assess rodent-borne disease risk and increase public health awareness. Hence, this study aims to evaluate the prevalence of gastrointestinal parasites in wild rats, especially those found in oil palm plantation areas.

METHODOLOGY

Raw materials

Stool samples from trapped wild rats were obtained from the spontaneous defecation of wild rats. The samples were preserved using a sample container.

Chemicals

Dried fish, banana, peanut butter, 10% buffered formalin, 70% chloroform, 0.85% saline solution, Lugol's iodine, distilled water, and Sheather's sugar solution.

Fieldworks

Live trapping of wild rats

A capture-and-release trapping method was applied in this study. Dried fish, bananas, and peanut butter were used as bait. The traps were positioned at differing distances from young and old oil palm trees where rats' activities were expected. The traps were placed in the evening and checked the following morning. Wild rat faeces samples were placed in formalin-filled containers. The captured rats were anaesthetised and morphometrically analysed for species identification. All of the captured rats that were identified were freed.

Morphometric examination of wild rats

The trapped rats were morphologically examined and anaesthetised by placing them into a cloth bag containing cotton wool soaked with chloroform for 20 seconds. The wild rat species were determined and identified based on the morphological characteristics described by Herbreteu et al. (2011) and Francis (2019). The head and body, tail, ear, and hind feet lengths were measured as described by Aplin et al. (2003). Furthermore, physical appearance such as fur colour was recorded. According to Hebreteau et al. (2011), the sex of the rats was determined by observing their genitals. Male rats were identified by the presence of testicles, whereas female rats were identified by the presence of the vagina and mammary glands.

Collection of stool samples

Stool samples were obtained from the spontaneous defecation of wild rats. The faecal dropping was collected by placing some pieces of paper and tissue under the traps. The stool samples were picked using forceps and placed inside a sample container 10% buffered formalin solution was used to preserve the stool samples. Then, the sample containers were labelled using a permanent marker. Next, at a maintained temperature of 4℃, the samples were placed into a cool box containing dry ice to prevent the parasites' eggs from hatching. The temperature inside the cool box was checked frequently using a thermometer. Subsequently, the stool samples were transferred to a refrigerator at a temperature of 4℃ in the laboratory for further examination.

Laboratory Works

Microscopic examination of wet mounts

A direct smear of faecal material was prepared to detect the presence of parasite cysts. The wet mount was prepared following the procedure described by the World Health Organisation (1991). Saline and Lugol's iodine (Siti Shafiyyah, 2012; Majeed, 2016) solutions were used. To prepare the stool specimens, the slide was labelled, and a drop of saline solution and iodine solution was placed at the centre of the right and left halves of the slide using droppers, respectively on the same slide. Next, a small portion of the stool specimen was mixed with the saline and iodine on the slide. Each drop of saline and iodine was covered with a coverslip. The coverslip was held at an angle and gently lowered onto the slides to prevent the creation of bubbles. The specimen was examined from one corner of the slide using a lower power objective lens of 10x to a higher power objective lens of 40x.

Formalin-ether concentration technique (FECT)

An applicator stick was used to collect the sampled stools, which were then transferred to a centrifuge tube. About 8 µL of saline was added using a micropipette to the centrifuge tube and mixed vigorously using a vortex. Next, the mixture was filtered into a 15 µL centrifuge tube using a cotton filter net. The filtrate was collected for future investigation, while the lumpy remains were discarded. The filtrate was centrifuged at 1500 rpm for 5 minutes, and the supernatant was discarded. Then, 7 µL of 10% formalin solution was added to the tube, followed by 3 µL of ethyl-acetate using a micropipette. The liquid was mixed vigorously before centrifugation at 1500 rpm for 10 minutes. As a result, three layers were formed: ethyl-acetate, formalin, and sediment. The formalin and ethyl-acetate layers were carefully removed, leaving only the sediment. The layers were gently mixed with a dropper. A drop of the sediment was deposited on a clean, grease-free glass slide which was dyed with iodine, and covered with a coverslip. The specimen was examined under a microscope using a lower-power objective lens to a higher-power objective lens. The prevalence of intestinal parasite infection in the rats was calculated using the formula described by Egbunu and Dada (2016), where Total prevalence (%) = Total number of infected rats / Total number of rats examined × 100.

McMaster technique

The standard McMaster technique was applied using Sheather's solution (saturated sugar solution). The ratio of the faecal material to the flotation solution was 1g:15ml (Chandrawathani et al., 2015; Pouillevet et al., 2017). The sample size of the matches' heads was transferred into a centrifugal tube. Next, 15 µL of Sheather's solution was added into the centrifuge tube and mixed vigorously using a vortex. The mixture was transferred into another centrifuge tube using a cotton filter net, followed by pipetting the sediment into both chambers of the McMaster slide. The slides were examined under a microscope. The eggs found in the chambers were calculated using the following formula by Alowanou et al. (2021), Faecal egg counts (FEC) = (chamber 1 + chamber 2) × 50.

Statistical analysis

The analyses were performed using Microsoft Excel 2016 and IBM SPSS Version 28.0.1. The prevalence of wild rats between the species (*R. rattus* and *R. norvegicus*) and the sex of wild rats were compared using unpaired t-tests. The differences were calculated at $p < 0.05$ and a confidence limit of 95%. Additionally, the intensity of parasites between wild rats' species and sex was compared using the mean ± Standard Error of EPG/OCG.

RESULTS AND DISCUSSION

Identification of wild rats' species and sex

Table 1 illustrates that a total of 30 wild rats were trapped throughout the three sampling sessions. The rat species were identified using the pictorial keys. Only two main species of rat were identified in the Pilajau oil palm plantation area, which were *R. rattus* and *R. norvegicus.* 60% of the wild rats trapped in the oil palm plantation were *R. norvegicus.* This conclusion aligns with the research performed by Guerrero-Sanchez et al. (2021) in which only *R. norvegicus* was discovered in oil palm plantation areas, indicating that the species were the most common in the area. *R. rattus* also inhabited the plantation in the present study, thereby supporting the reports by Phua et al. (2017) that oil palm plantations are essential for *R. rattus'* survival. In this case, their spread may be attributable to rat migration and residential availability.

In terms of sex, each species displayed a pattern where male individuals were more prevalent than female rat individuals. Only 33.3% and 44.4% of *R. rattus* and *R. norvegicus* were female wild rats trapped during the sample, accounting for 40% of trapped female rats while 66.67% and 55.56% of *R. rattus* and *R. norvegicus* were male wild rats respectively, representing 60% of the trapped male wild rats.

Table 1. Overall data of captured wild rats in the Pilajau oil palm plantation area

Wild rat species		Sex	
Common name	Scientific name	Female	Male
Black rat	*Rattus rattus*	4	8
Brown rat	*Rattus norvegicus*	8	10
Total of Samples, n		30	

Gastrointestinal parasites in positive samples of wild rats

Three parasite phyla (nematodes, cestodes, and protozoa) and 11 parasite genera (Table 2). Nematodes contain six genera: *Strongyloides* spp., *Nippostrongylus* spp., *Ancylostoma* spp., *Trichuris* spp., *Ascaris* spp., and *Capillaria* spp., were discovered in this study. Most of the identified gastrointestinal parasites were compared to the other two phyla (cestodes and protozoa). A total of four genera of protozoa were also identified in the positive rat samples: *Blastocystis* spp., *Eimeria* spp., *Entamoeba* spp., and *Cryptosporidium* spp. Meanwhile, *Hymenolepis* spp. was the only cestode discovered among wild rats in this study. Thus, helminths accounted for most identified gastrointestinal parasites compared to protozoans. This result corroborates the study performed by Coomansingh-Springer et al. (2019) in which rats had fewer protozoa infections than helminthic parasites.

Despite the prevalence of helminths in this study, no trematodes were found. The absence of trematodes may have occurred due to the limitations in the methods employed. Rocha et al. (2014) found no trematodes parasites using formalin-ether sedimentation in a study comparing parasite detection approaches. The multiple phases in the sedimentation experiment could have contributed to the loss of trematode eggs. It was also reported that the variations in the sedimentation process could affect assay effectiveness, resulting in negative parasite detection. Rojekittikhun et al. (2015) similarly discovered that sugar flotation was unsuitable for trematode identification. However,

Utzinger et al. (2010) stated that a saturated zinc sulphate solution can be used to float trematode eggs.

Moreover, almost all the parasites discovered in the wild rats in this study were zoonotic. According to Firth et al. (2014) and Galan-Puchades et al. (2018), rats play an important role as a reservoir of zoonotic illnesses and in zoonotic transmission. According to Galan-Puchades et al. (2019), rats' stools can cause illnesses since most of the parasites therein are zoonotic. The only non-zoonotic protozoan parasite discovered in this investigation was *Eimeria* spp. Just like the zoonotic protozoa, helminths also pose a considerable risk to public health, and wild rats are accountable for the infection because of their extensive geographic range. The identified helminths are all important zoonotic parasites that can cause mild to severe sickness in humans, canids, and primates.

Table 2. Types of intestinal parasites in black rats and brown rats obtained

Types of gastrointestinal parasites	
Phylum	Genus
Nematodes	*Strongyloides* spp.
	Nippostrongylus spp.
	Trichuris spp.
	Ancylostoma spp.
	Ascaris spp.
	Capillaria spp.
Cestodes	*Hymenolepis* spp.
Protozoa	*Blastocystis* spp.
	Eimeria spp.
	Entamoeba spp.
	Cryptosporidium spp.

Gastrointestinal parasites in positive samples of wild rats

Prevalence of gastrointestinal parasite in wild rats by species

All samples were positive for gastrointestinal parasites (Table 3). The presence of gastrointestinal parasites in wild rats was due to their role as natural parasite hosts. In this study, 12 and 18 of the 30 rats caught were *R. rattus* and *R. norvegicus*, respectively. Despite their number, *R. rattus* was more prevalent than *R. norvegicus*. Zain et al. (2012) also found that *R. rattus* carried more intestinal parasites compared to *R. norvegicus*. Table 3 reveals that *R. norvegicus* had a slightly higher prevalence of infection with *Hymenolepis* spp. (61.11%) and *Blastocystis* spp. (83.3%).

Table 3. Prevalence of infected wild rats by species

Parasite species		Number of positive samples (%)		Overall infection (%)
Phylum	Genus	*R. norvegicus* (n = 18)	*R. rattus* (n = 12)	
Nematodes	*Strongyloides* spp.	18 (100)	12 (100)	100
	Nippostrongylus spp.	15 (83.33)	11 (91.67)	86.67
	Trichuris spp.	11 (61.11)	10 (83.33)	70
	Ancylostoma spp.	12 (66.67)	11 (91.67)	76.67
	Ascaris spp.	7 (38.89)	8 (66.67)	50
	Capillaria spp.	7 (38.89)	7 (58.33)	46.67
Cestodes	*Hymenolepis* spp.	11 (61.11)	5 (41.67)	53.33
Protozoan	*Blastocystis* spp.	15 (83.33)	8 (66.67)	76.67
	Eimeria spp.	9 (50)	9 (75)	60
	Entamoeba spp.	4 (22.22)	6 (50)	33.33
	Cryptosporidium spp.	4 (27.78)	4 (16.67)	23.33
O. P (%)		113/198 (57.07)	91/132 (68.94)	P = 0.194

O.P: Overall Prevalence

Meanwhile, *R. rattus* had a higher infection rate with almost all helminths and protozoa; *Nippostrongylus* spp. (91.67%), *Ancylostoma* spp. (91.67%), *Trichuris* spp. (83.33%), *Ascaris* spp.

(66.67%), *Capillaria* spp. (58.33%), and *Eimeria* spp. (75%). Both species were infected with *Strongyloides* spp. (100.0%). According to Premaalatha et al. (2010) and Amir (2019), *Strongyloides* spp is the most common helminth infection in rats.

Furthermore, protozoans were found to infect the rats' population in the plantation area. *Eimeria* spp. (50%) infected half of the population of *R. norvegicus,* while *Entamoeba* spp. was the intestinal parasite infecting half of the *R. rattus* population with an overall infection of 23.33%. *Cryptosporidium* spp. was the least parasite recovered, which recorded 16.67% in *R. rattus* and 27.78% in *R. norvegicus.* However, the overall infection level of helminths was higher compared to protozoan infection. Similarly, previous research by Nasiri et al. (2019) reported that higher prevalence of helminthic infections among wild rodents compared to the protozoa parasites. Hence, this study supported the findings by Premaalatha et al. (2017), reflecting that wild rats may carry at least one species of helminth or protozoa. Comparisons depicted no significant difference in the prevalence of protozoan or helminthic infection between *R. rattus* and *R. norvegicus* (P>0.05).

Prevalence of gastrointestinal parasite in wild rats by sex

Table 4 summarises the prevalence of gastrointestinal parasites based on host sex. Helminth infection (nematodes and cestodes) in females and males accounted for the highest prevalence compared to protozoan infection. The overall prevalence of infection appeared to have only a slight difference between male (62.12%) and female rats (61.36%). Despite the similar overall percentage, the male rats recorded more infection than the females. Tijjani et al. (2020) also found similar results as male individuals of rats recorded a higher prevalence of intestinal parasites than females. The female wild rats recorded a lower infection level in each genus of parasites compared to the male wild rats. However, *Strongyloides* spp. were observed in all female and male individuals at 100%.

Apart from *Strongyloides* spp., most helminths such as *Nippostrongylus* spp. (88.89%), *Trichuris* spp., (66.67%), *Ancylostoma* spp. (88.89%), and *Hymenolepis* spp. (55.56%) infected more than half of the male wild rat population. Similarly, *Strongyloides* spp. (100%), *Nippostrongylus* spp. (83.33%), *Trichuris* spp. (75%), and *Ancylostoma* spp. (58.33%). *Ascaris* spp. recorded the same prevalence in both male and female populations with a prevalence of 50%. Besides, the infection of gastrointestinal protozoa observed in both sexes was low. Nevertheless, the infection level in the female population (91.67%) was higher than in the male population. Only one female individual was not infected with *Blastocystis* spp. *Cryptosporidium* spp. was the least protozoan recovered in the female and male individuals with an overall prevalence of 26.67%. For *Entamoeba* spp., a similar prevalence (33.33%) was observed in both sexes. There was a significant difference in the prevalence of infection based on sex, which is consistent with a previous study conducted by Tijjani et al. (2020) in Selangor, Malaysia. Therefore, sex variables may affect the prevalence rate of wild rats.

Table 4. Prevalence of infected wild rats by sex

Parasite species		Number of positive samples (%)		Overall infection (%)
Phylum	Genus	Male (n = 18)	Female (n = 12)	
Nematodes	*Strongyloides* spp.	18 (100)	12 (100)	100
	Nippostrongylus spp.	16 (88.89)	10 (83.33)	86.67
	Trichuris spp.	12 (66.67)	9 (75)	70
	Ancylostoma spp.	16 (88.89)	7 (58.33)	76.67
	Ascaris spp.	9 (50)	6 (50)	50
	Capillaria spp.	8 (44.44)	6 (50)	46.67
Cestodes	*Hymenolepis* spp.	10 (55.56)	6 (50)	53.33
Protozoan	*Blastocystis* spp.	12 (66.67)	11 (91.67)	76.67
	Eimeria spp.	12 (66.67)	6 (50)	60
	Entamoeba spp.	6 (33.33)	4 (33.33)	33.33
	Cryptosporidium spp.	4 (22.22)	4 (33.33)	26.67
O.P (%)		123/198 (62.12)	81/132 (61.36)	P = 0.025

O.P: Overall Prevalence

The intensity of gastrointestinal parasite infection in wild rats by species and sex

Table 5 presents the intensity of gastrointestinal infection in positive samples of wild rat species. Overall, the mean of EPG/OPG obtained ranged from 0 to 499, indicating a mild parasite burden in both species. According to Upjohn et al. (2010), EPG less than 500 is considered mild, 500 to 1000 EPG is considered moderate and more than 1000 is considered severe. In *R. norvegicus,* the mean EPG for the helminth parasite ranged roughly from 130 to 506. Meanwhile, the mean EPG of protozoa parasites ranged from 62 to 233. Hence, this indicates that only the helminthic parasite recorded moderate intensity in *R. norvegicus*.

In *R. rattus,* the mean EPG for helminths ranged from 180 to 370. The OCG range from 100 to 237 in the protozoa. Among all the parasites, *Strongyloides* spp. recorded the highest parasitic burden in *R. norvegicus* and *R. rattus*, with mean EPG counts of 505.56 ± 56.43, and 370.83 ± 41.95, respectively. According to a previous study by White et al. (2019), the intensity of *Strongyloides* spp. was higher in *R. norvegicus* compared to other rat populations. *Hymenolepis* spp. recorded the lowest intensity in wild rats for both species. *Entamoeba* spp. recorded the lowest intensity for the intestinal protozoa with only 62.5 ± 5.89 and 83.33 ± 11.78 of mean OPG recorded for *R. norvegicus* and *R. rattus,* respectively. *Blastocystis* had the highest number of protozoa oocysts with an OPG of 233.33 ± 38.75 in *R. norvergicus* and 237.5 ± 46.13 in *R. rattus*. Eimeria spp., Entamoeba spp., and Cryptosporidium spp. recorded less than 200 OPG, indicating a lower burden in both species of wild rats.

In the case of the host sex, *Strongyloides* spp had the highest mean EPG for male (430.56 ± 50.19) and female (483.33 ± 64.35) wild rats. *Strongyloides* spp. recorded the most intense infection in both sexes and wild rat species. For the host sex, protozoa had a lower parasitic burden than helminths. However, the females had a higher intensity of intestinal protozoa parasites than the males. The males had a higher parasitic burden for helminths. *Blastocystis* spp. (240.91 ± 49.50), *Eimeria* spp. (233.33 ± 42.49), *Entamoeba* spp. (87.5 ± 13.82), and *Cryptosporidium* spp. (112.5 ± 18.16) were more intense in female than male rats. Although, both sexes were reported to have had the most *Blastocystis* spp. parasites.

Table 5. The intensity of gastrointestinal infection in positive samples of wild rats by sex

Parasites		Sex		Species	
		R. norvegicus (n=18)	*R. rattus* (n=12)	Male (n = 18)	Female (n = 12)
		Mean ± SE [EPG/OPG]		Mean ± SE [EPG/OPG]	
Nematodes	*Strongyloides* spp.	505.56 ± 56.43	370.83 ± 41.95	430.56 ± 50.19	483.33 ± 64.35
	Nippostrongylus spp.	300 ± 42.49	313.64 ± 61.27	318.75 ± 42.36	285 ± 62.01
	Trichuris spp.	300 ± 48.59	310 ± 42.38	291.67 ± 39.83	322.22 ± 55.95
	Ancylostoma spp.	450 ± 59.88	331.82 ± 44.38	406.25 ± 56.09	364.29 ± 48.39
	Ascaris spp.	400 ± 50	343.75 ± 33.59	405.56 ± 43.88	316.67 ± 44.41
	Capillaria spp.	364.29 ± 55.99	228.57 ± 32.12	356.25 ± 45.18	216.67 ± 50.55
Cestodes	*Hymenolepis* spp.	130.77 ± 14.06	180 ± 37.64	145.83 ± 23.28	141.67 ± 13.90
Protozoa	*Blastocystis* spp.	233.33 ±38.75	237.5 ± 46.13	229.17 ± 36.40	240.91 ± 49.50
	Eimeria spp.	194.44 ± 29.72	155.56 ± 22.18	145.83 ± 14.62	233.33 ± 42.49
	Entamoeba spp.	62.5 ± 5.89	83.33 ± 11.78	66.67 ± 6.09	87.5 ± 13.82
	Cryptosporidium spp.	112.5 ± 14.83	100 ± 11.78	100 ± 9.62	112.5 ± 18.16

SE: Standard Error (of Mean), EPG: Eggs per gram, OPG: Oocyst per gram

Wolff (2003) suggested that the varying infection or infestation rates in rat populations are due to the sex differences in the environmental exploitation of male and female rats. Carvalho-

Pereira et al. (2018) supported a conclusion stating that male rats have a broader home range than female rats, thereby increasing their exposure to contaminated food and surroundings. During reproduction, female rats spend more time in the nest (Sekarweni et al., 2019). Brown et al. (2003) also noted that female rats have a restricted activity range and roam around their nest to acquire food. This leads to fewer females getting trapped.

CONCLUSIONS

Overall, two species of wild rats namely *Rattus rattus* and *Rattus norvegicus* were found in this study. *R. norvegicus* had more individuals than *R. rattus,* showing its likelihood. Based the wild rats' sex, male rats were higher than female rats because of their behaviour, as males had more activity coverage and wandered more while hunting for food and mates. The wild rats from the Pilajau oil palm plantation were predominantly infected with zoonotic parasites, including *Strongyloides* spp., *Nippostrongylus* spp., *Trichuris* spp., *Ancylostoma* spp., *Ascaris* spp., *Capilaria* spp., *Hymenolepis* spp., *Blastocystis* spp., *Entamoeba* spp., and *Cryptosporidium* spp. Only *Eimeria* spp. was the only non-zoonotic parasite. This study revealed that wild rats in the Pilajau oil palm plantation had significant zoonotic potential for plantation employees and communities because they may carry parasites that can induce illness and a wide spectrum of diseases. Asides from that the prevalence was higher in *R. rattus* than in *R. norvegicus.*, males had a higher prevalence than females. In conclusion, the degree of parasitic load suggests mild gastrointestinal parasite infection in wild rats. Due to its zoonotic potential, individuals who come in contact with rodents' faeces risk contracting parasite-borne diseases.

ACKNOWLEDGEMENTS

The authors would like to express gratitude to the Mawao Estate of Sawit Kinabalu staff for their guidance and assistance throughout this study. The authors would also like to express gratitude to Sabah Biodiversity Centre (SaBC) for granting the research permit in conducting this study. We are thankful to staff members of Kompleks Makmal Sains dan Agroteknologi (KOMSAT), Universiti Teknologi MARA Sabah Branch for providing facilities and assistance to conduct this study. We declare that we have no conflict of interest related to this study.

CONFLICT OF INTERESTS

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

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