A study on the occurrence of pinworms in the hindgut of *Periplaneta americana*

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Abstract American cockroach, *Periplaneta americana* harbours pinworms in their gut. In the present study, 88 host cockroaches were dissected and the number of adult females of each pinworm species was recorded from Barasat, North 24 Parganas, West Bengal. Three species of Oxyurid nematodes were found: *Hammerschmidtella diesingi* (Hammerschmidt, Helminthologische Beiträge. Isis (oken), Leipz 5:351–358, 1838), *Leidynema appendiculatum* (Leidy in Proc Acad Natl Sci Phila 5:100–102, 1850) and *Thelastoma* sp. (Leidy in Proc Nat Acad Sci Phila 4:30, 1849). At a time two nematode infections (double infection) were also found. *H. diesingi* and *L. appendiculatum* mixed infection being more common than *H. diesingi* and *Thelastoma* sp. infection. *H. diesingi* shown highest prevalence (40.90%) and abundance pattern (1.227). It was the dominant species in most cases. Lowest prevalence (7.95%) and abundance pattern (0.272) was found in *Thelastoma* sp. *Thelastoma* sp. has the highest mean density (3.428) followed by *Hammerschmidtella diesingi* (3) and *Leidynema appendiculatum* (2.368). Three species were never found in the same host. This study suggests that host sex had no noticeable impact on the occurrence of pinworms.

Keywords Cockroach · Pinworm · Prevalence · Mean density · Barasat

Introduction

Cockroaches constitute one of the most diverse groups of insects with about 4500 species that inhabit the most varied environments on Earth (Rentz 2014). They belong to the order Blattodea and preferentially inhabit tropical and temperate forests (Beccaloni and Eggleton 2013). The animal parasitic nematodes belonging to Order Oxyurida, constitute two super-families Oxyuroidea (nematode parasitising vertebrates) and Thelastomatoidea (the nematode parasites of invertebrates essentially arthropods). The Thelastomatids are parasitic (or commensal) in the hind gut of most saprophytic insect and other arthropod hosts and feed on bacterial fauna (Jex et al. 2005). Oxyurid nematodes (commonly known as pinworms) are ubiquitous and abundant in *Periplaneta americana*, often occurring in 80% of laboratory populations (Tsai and Cahill 1970). It is still poorly understood how these worms affect their host. One of the genera of pinworm is *Leidynema*, which was first described by Schwenk 1926 (in Travassos 1929), with *L. appendiculatum* (Leidy 1850) as type species (Leidy 1850). Several parasitic nematode species like *Thelastoma bulhosi*, *T. periplaneticola*, *Hammerschmidtella diesingi*, *Leidynema appendiculata* sometimes co-infect American cockroaches (Dobrovolny and Ackert 1934; Chitwood 1932; Adamson and Noble 1993). In India, many authors have reported different species of nematodes of cockroach (*Periplaneta americana* L.) from different parts of India at different times (Basir 1940; Parveen and Jairajpuri 1980; Singh and Kaur 1988; Mathur and Khera 1989; Majumder and Khan 1992). However, detailed information on the occurrence and density of these parasites in *P. americana* is still limited in India. Thus the main objective of this study was to compare the prevalence, abundance and mean density of these closely related nematode species in *P. americana* collected from Barasat, North 24 Parganas, West Bengal, India.

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Materials and methods

Collection of cockroach host (*Periplaneta americana*) and isolation of parasitic nematodes

P. americana were collected from different regions of Barasat, West Bengal which is a suburb in the outskirts of Kolkata, West Bengal, India and the district headquarter of the district North 24 Parganas. The city is located at latitude 22.72 North and longitude 88.48 East.

Eighty-eight live cockroach specimens were collected and dissected between September 2016 and December 2016 and the number of adult females of each pinworm species was recorded. After collection, nematodes were dehydrated by slow dehydration process in alcohol glycerin mixture. After that the dehydrated nematodes were mounted on glass slides. Observations were made using an optical microscope equipped with an ocular micrometer. Photographs of the specimens were taken using Carl Zeiss Axio Scope A1 microscope. Taxonomic identifications were made following Chitwood (1932).

Estimation of parasites

Prevalence, abundance and mean density of the pinworms were estimated through the following formula proposed by Margolis et al. (1982) as: Prevalence of Infection = Total number of infected cockroach/Total number of cockroach host examined $\times$ 100. Parasite Abundance = Total number of parasites recovered/Total number of cockroach host examined. Mean Density = Total number of parasite recovered/Total number of infected cockroach host.

Statistical methods

The effect of sex on prevalence and mean density was assessed and compared in all the isolated nematode species. Average (mean value) was calculated using the relation. Average = mean value of individual observation/Total no.

of observations. Mean value of individual observation = Total no. of parasites found/No. of host dissected on a particular day (Shah et al. 2005). Tests of significance were determined at the probability level of $p < 0.05$ i.e. the differences were considered to be significant when the p value obtained was less than 0.05.

Results

Three species of Oxyurid nematodes were found in the gut of American cockroach. These are *Hammerschmidtella diesingi* (Hammerschmidt 1838) and *Leidynema appendiculatum* (Leidy 1850) and *Thelastoma* sp. (Leidy 1849) (Figs. 1, 2, 3). Single species infections were more common in nymphal stages of the hosts and double species infections are common in the adults. In the adult cockroach at a time two nematode species infections were found. Double infection of *H. diesingi* and *Thelastoma* sp. were less frequent than *H. diesingi* and *L. appendiculatum* infection. Co infection of *Leidynema appendiculatum* and *Thelastoma* sp. was never found. *H. diesingi* showed the highest prevalence (40.90%) and abundance pattern (1.227). It was the dominant species in most of the cases. Lowest prevalence (7.95%) and abundance pattern (0.272) was found in *Thelastoma* sp. (Table 1) *Thelastoma* sp. has the highest mean density (3.428) followed by *Hammerschmidtella diesingi* (3) and *Leidynema appendiculatum* (2.368). These three species were never found in the same host.

Sex wise prevalence: The prevalence of pinworm infection in the two sexes was also calculated separately. The available data also showed that there is no significant difference in prevalence ($p > 0.05$) between male and female *P. americana* (Table 2) for the three types of nematodes. So, probably, the prevalence of infection by these nematodes may have no sex-linked preference.

Mean densities of *Hammerschmidtella diesingi* and *Leidynema appendiculatum* and *Thelastoma* sp. in male *P. americana* were 3.647, 2.777 and 5.333 respectively

Fig. 1 Photomicrographic details of *Hammerschmidtella diesingi*. **a** Adult female head with pseudo bulb. **b** Egg filled Uterus. **c** Egg. Scale bars. **a** 100 μ m; **b** 100 μ m; **c** 40 μ m

Fig. 2 Photomicrographic details of *Leidyneria appendiculatum*. **a** Adult female head with end bulb. **b** Egg. **c** Adult female tail with lateral alae (arrow) Scale bars, **a** 100 µm; **b** 40 µm; **c** 150 µm

Fig. 3 Photomicrographic details of *Thelastoma* sp. **a** Adult female head with end bulb. **b** Egg filled Uterus. **c** Egg. Scale bars, **a** 100 µm; **b** 100 µm; **c** 40 µm

Table 1 Average prevalence (%), abundance and mean densities of nematodes from the hind gut of *P. americana* collected from Barasat, North 24 Parganas, West Bengal

No. of hosts examined	No. of host infected	No. of parasites recovered	Parasite species	Prevalence (%)	Abundance	Mean density
88	36	108	<i>Hammerschmidtella diesingi</i>	40.90	1.227	3
	19	45	<i>Leidyneria appendiculatum</i>	21.59	0.511	2.368
	07	24	<i>Thelastoma</i> sp.	7.95	0.272	3.428

(Table 3). Mean densities of *Hammerschmidtella diesingi* and *Leidyneria appendiculatum* and *Thelastoma* sp. in female *P. americana* were 2.421, 2 and 2 respectively (Table 2). As both male and female cockroaches were infected with three species of nematodes the mean number per host of each species was compared by means of a Student's *t* test for males versus females (Table 3). All tests of significance were determined at the probability level of $p < 0.05$. The results showed that there is no significant difference in mean densities between male and female pinworm infections.

Discussion

P. americana is infected by several pinworm species which also infects other host species (Ozawa et al. 2014) indicates that pinworms are less host specific.

In India, Basir (1940) described three species of Thelastomatidae in the gut of *Periplaneta americana* viz *Hammerschmidtella diesingi*, *Thelastoma aligarhica* and *Periplaneticola mirzaia* from Aligarh (Northern India). Only in one case, a single cockroach harboured all the three different species of nematodes. Subsequently, Parveen and Jairajpuri described a new species *Schwenkiella atheri* sp. from *P. americana* in 1980. Farooqui (1970) described for the first time *Thelastoma alli* from intestine of *Spirostreptus* species at Aurangabad, Maharashtra. Later it was redescribed by Singh and Malti (2003) from *P. americana* at Meerut (Uttar Pradesh). Shah et al. (2005) recovered a new species of the genus *Protrellus* from *P. americana* in Manipur, North East India. However, most of the previous studies were limited to morphological study and taxonomic identification.

Table 2 Sex wise prevalence of nematodes from the hind gut of *P. americana* collected from Barasat, North 24 Parganas, West Bengal

	No. of cockroach examined	No. of cockroach infected	Prevalence (%)	No. of observation	Average ($\pm$ SD)
<i>Hammerschmidtella diesingi</i>					
Male	44	17	38.63	4	0.372 $\pm$ 0.21
Female	44	19	43.18	4	0.427 $\pm$ 0.19
<i>Leidynema appendiculatum</i>					
Male	44	09	20.45	4	0.211 $\pm$ 0.15
Female	44	10	22.73	4	0.235 $\pm$ 0.49
<i>Thelastoma sp.</i>					
Male	44	03	6.818	4	0.230 $\pm$ 0.1
Female	44	04	9.09	4	0.307 $\pm$ 0.27

Table 3 Sex wise mean densities of nematodes from the hind gut of *P. americana* collected from Barasat, North 24 Parganas, West Bengal

Isolated parasites	No. of male cockroach infected	No. of parasites	Mean density	No. of female cockroach infected	No. of parasites	Mean density	Male (SD)	Female (SD)
<i>Hammerschmidtella diesingi</i>	17	62	3.647	19	46	2.421	$\pm$ 3.185	$\pm$ 2.116
<i>Leidynema appendiculatum</i>	09	25	2.777	10	20	2	$\pm$ 2.439	$\pm$ 1.414
<i>Thelastoma sp.</i>	03	16	5.333	04	08	2	$\pm$ 2.08	$\pm$ 1.4

Thelastomatid nematode parasitism was studied in the hindgut of *P. americana* by Majumder and Khan (1992). Effects of multiple species infection of nematodes in *P. americana* were reported by Renapurkar and Gosavi (1992). Shah and Jairajpuri (2000) showed the prevalence of some parasitic nematodes of insects in different season from Manipur, India. But, till date there is no comparative prevalence, mean density data of three species of gut nematodes of *P. americana* from West Bengal, India. The present study showed that *Hammerschmidtella diesingi* are most prevalent (40.9%) in adult cockroach among the three species of nematodes. On the other hand, *Thelastoma sp.* had lowest prevalence (7.95) but highest mean density (3.428) in *P. americana*. Interestingly, *Leidynema appendiculatum* were mostly found in juvenile cockroach. It is important to note that the population of nematodes was found to be dependent on the co-infected *Nyctotherus ovalis* in *P. americana*. Nematode population was usually less in protozoan infected hosts. The prevalence of nematode infection did not differ significantly between the two sexes. These data corroborated well with the observation of Yu and Crites (1990). Therefore, it can be concluded that host sex had no noticeable impact on the occurrence of the nematodes in *P. americana*.

It is important to note that the co-occurrence of *H. diesingi*-*Thelastoma sp.* were less than *H. diesingi*-*L. appendiculatum*. So it would be interesting to study in

future the individual role played by these species in nematode-host interaction and nematode–nematode interaction. Another interesting observation of the present study was that *L. appendiculatum* and *Thelastoma sp.* never coexisted in the same host. Thus, it raises the question whether any species antagonism between *L. appendiculatum* and *Thelastoma sp.* exist or not. The present study has generated several questions regarding species interaction which needs further investigation.

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References

- Adamson ML, Noble SJ (1993) Interspecific and intraspecific competition among pinworms in the hindgut of *Periplaneta americana*. J Parasitol 79:50–56
- Basir MA (1940) Nematodes parasitic in Indian cockroaches. Proc Indian Acad Sci Sect (B) 12:8–16
- Beccaloni G, Eggleton P (2013) Order blattodea. Zootaxa 3703:46–48
- Chitwood B (1932) A synopsis of the nematodes parasitic in insects of the family Blattidae. Parasitol Res 5:14–50
- Dobrovolsky CG, Ackert JE (1934) The life history of *Leidynema appendiculata* (Leidy), a nematode of cockroaches. Parasitology 26:468–480

- Farooqui MN (1970) Some known and new genera and species of the family Thelastomatidae Travassos, 1929. *Riv Parasitol* 31:195–214
- Hammerschmidt KE (1838) *Helminthologische Beiträge*. Isis (oken), Leipz 5:351–358
- Jex AR, Schneider MA, Rose HA, Cribb TH (2005) The Thelastomatoidea (Nematoda: Oxyurida) of two sympatric Panesthiinae (Blattodea) from southeastern Queensland, Australia: taxonomy, species richness and host specificity. *Nematology* 7:543–575
- Leidy J (1849) New genera and species of entozoa. *Proc Nat Acad Sci Phila* 4:30
- Leidy J (1850) Description of some nematoid entozoan infesting insects. *Proc Acad Natl Sci Phila* 5:100–102
- Majumder V, Khan E (1992) Thelastomatid nematode parasitism in the hind gut of *Periplaneta americana*. *Curr Nematol* 3:111–117
- Margolis LR, Anderson RC, Holmes JC (1982) Recommended usage of selected terms in ecological and epidemiological parasitology. *Bull Cand Soc Zool* 13:14
- Mathur N, Khera S (1989) The influence of host stage and sex upon the size and composition of the nematode parasitic in *Periplaneta americana*. *Res Bull Punjab Univ Sci* 40:275–280
- Ozawa S, Vicente CS, Sato K, Yoshiga T, Kanzaki N, Hasegawa K (2014) First report of the nematode *Leidynema appendiculata* from *Periplaneta fuliginosa*. *Acta Parasitol* 59:219–228
- Parveen R, Jairajpuri DS (1980) A new species of the genus *Schwenkiella* Basir, 1956 from the cockroach, *Periplaneta americana*, from Aligarh. *Indian J Parasitol* 4(1):41–43
- Renapurkar DM, Gosavi AV (1992) The effects of multiple species infection of nematodes in *Periplaneta americana* L. (The American Cockroach). *Indian J Helminthol* 46:128–132
- Rentz D (ed) (2014) A guide to the cockroaches of Australia. CSIRO Publishing, Clayton, p 318
- Schwenk JM (1926) Fauna Parasitologia des blattoides do Brasil. *Sciencia Medica Anno IV* 9:3–16
- Shah MM, Jairajpuri DS (2000) Some studies on prevalence of insect nematodes from Manipur India. *J Parasit Dis* 24(2):179–181
- Shah MM, Rizvi AN, Jairajpuri DS (2005) *Protrellus shamimi* n.sp. (Protrelloididae: Thelastomatoidea) from the cockroach *Periplaneta americana* from Manipur, North-East India. *J Parasit Dis* 29(1):47–52
- Singh HS, Kaur H (1988) On a new nematode, *Hammerschmidtella basiri* n.sp. from *Periplaneta americana*. *Indian. J Parasitol* 12(1):187–189
- Singh HS, Malti (2003) Studies of some nematode parasites of *Periplaneta americana* Linn. At Meerut, Uttar Pradesh India. *Flora Fauna* 2:59–66
- Travassos L (1929) Contribuicao preliminar a systematica dos nematodes dos arthropodos. *memorias do Instituto Oswaldo Cruz* 5:19–25
- Tsai VH, Cahill KM (1970) Parasites of the German cockroach (*Blattella germanica* L.) in New York City. *J Parasitol* 56:37–375
- Yu X, Crites JL (1990) The effectiveness of two anthelmintics, Vermox (mebendazole) and Povan (pyrvinium pamoate), on Thelastomatid nematodes (Nematoda: Oxyuroidea) of the cockroach, *Gromphadorhina portentosa*. *Ohio J Sci* 90:152–155