STUDIES ON THE SEASONAL VARIATIONS AND PREVALENCE OF HELMINTH FAUNA OF THE BLACK RAT, *Rattus rattus* (L) (RODENTIA: MURIDAE) FROM DIFFERENT MICROHABITATS IN NSUKKA, NIGERIA

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ABSTRACT

A twelve-month epizootic survey was conducted to evaluate the helminth fauna of the Nigerian strain of the black rat, Rattus rattus from six microecological habitats in Nsukka area of Nigeria and to assess the zoonotic and public health implications of the findings. Altogether 1458 rats (56.5 % males and 43.5 % females) were trapped and examined for helminths. A total of 1098 rats (55.7 % males and 44.3% females) harboured helminth parasites thus providing and overall prevalence of 75.3% and a mean worn burden of 1.3. The between-sex difference was statistically significant (x^2 =2.64, P < 0.05) with more males (53.2 %) than females (46.8 %) harbouring helminth parasites. There was no marked variation in the infection pattern in the rat host from the different habitats, but the parasite prevalence and distribution appeared to be season-dependent. Parasites (n = 1469) recovered were of 3 helminth groups (nematodes 72.4%, cestodes 27.5%, and trematodes 0.6%). Six nematode species identified were Nippostrongylus braziliensis (19.8%), Aspicularis tetraptera (17.5%), Syphacia muris 17.0 %), Angiostrongylus cantonensis 16.9%), Strongyloides ratti (16.0%) and Capillaria hepatica (12.8%). Also recovered from their rat hosts were the following six cestode species; Hymenolepis diminuta (22.7%), Taenia taeniaeformis (17.4%), T. muris (17.1%), T. hydatigera (16.6%), H. nana (16.4%) and Raillietina muris (9.8%). Trematodes (n=9) belonging to 3 species, Plagiochis muris, Platynosomoides muris and Corrigia muris were also recovered from five infected rats. A total of 103 rat hosts harboured single infections of nematodes, 818 (98.9%) had combined nematode/cestode infections, 5 (6.0%) haboured a combination of nematode/trematode whereas 4 (0.5%) showed concurrent cestode/trematode infections. The influence of seasonal fluctuations on the parasite-host relationship, life cycle patterns of the parasites and immunological potentials of the rat hosts are discussed.

Keywords: Epizootic, helminth, *Rattus rattus*, Nematode, Cestode, Trematode, Seasonal fluctuation

INTRODUCTION

The upsurge in urbanization in different geographic zones of the developing countries has been accompanied by considerable increase in the population of various vectors of parasites and free-living pests such as the synanthropic black house rat, *Rattus rattus*. This upsurge has attendant medical, social and economic implications. The black house rat is closely associated with residential houses, outbuildings, stores and garbage dumps. It is also predominant in both rural and urban dwelling areas of Nigeria and elsewhere. The increased population of *R. rattus* may be linked to the polyoestrous nature of its reproductive life cycle and their peridomestic feeding habits. This results in damages to household, office and industrial equipment. The destructive nature of *R. rattus* has therefore constituted problems in different parts of the world especially in areas of low standards of sanitation and hygiene.

Several reports on the parasite fauna of different species of rodents are available and these have suggested that *R. rattus* may be reservoir hosts of many enzootic and epizootic infections (Ayres, 1973; Nana and Parihar, 1976; Singhvi and Johnson, 1976; Udonsi, 1989). Studies have also implicated several species of rat as transmission agents of some helminth parasites of man and domestic animals (Alicata, 1969; Jacobs *et al*. 1971; Behnke, 1975; Malhotra, 1986; Yousif and Ibrahim, 1978; Renapurkar *et al.,* 1982; Udonsi, 1989). Black rats also serve as transport hosts of human pests, e.g. they harbour fleas (*Xenopsylla cheopis*), the vectors of the causative organism of human plague. There is no dearth of published data on the helminth parasites of *R. rattus* in Nigeria, but more information on the subject matter is needed to complement existing knowledge. Dipeolu and Ajayi (1976) working with the giant rat *Criceotomys gambianus*, recovered

Hymenolepis nana and *Hymenolepis diminuta* from all the rats examined.
Working also at Ibadan, Akinboade *et al.* (1981) identified *H. diminuta* from 71% of *R. rattus* examined. In the Niger delta area of Nigeria, Udonsi (1989) recovered 13 helminth species and established an overall mean worm burden of 11.3 in *R. rattus.*

The diversity of the miniecological habitats of *R. rattus* in both rural and urban environments has resulted in their differing exposure and ability to exploit different food items. These and other factors operating in the external and internal environments of *R. rattus* may therefore expose them to a diversity of helminth infections.

The present study was conducted to investigate the epidemiological importance of *R. rattus* in helminth transmission in habitats in Nsukka area of South East Nigeria. The zoonotic and public health implications of the findings were also assessed.

MATERIALS AND METHODS

Study Area: The study was conducted in the university town of Nsukka and its contiguous rural villages of Edem and Obukpa, all reflecting varying sanitary and microecological setting to which the study animals had been exposed. The area was further segregated into (a) Urban residential area (b) University residential area, (c) University farm houses, (d) Ogige market food stores, (e) Obukpa village houses and (f) Edem village houses. The study area is ecologically homogenous with high diurnal temperatures (27 ± 3^{o}C) and two distinct seasons; a rainy season of 7 months (April to October) and a shorter dry season period of 5 months (November to March).

Helminths Examination: In each study site the rats were trapped in metal cages measuring 76 × 89 × 229 mm baited with dried bread or fish or both (to increase trap's catchability and sustenance of the animals caught) strategically placed at their runway inside the buildings and outside within the premises. The traps were checked twice daily, at dusk and dawn to recover trapped animals for a period of 12 months. Captured animals were transported to the laboratory for examination in the same traps in which they were caught. During the transportation, the sides of the cages were covered with dark cloth to shield the animals form the outside environment and reduce undue excitement.

The sex of each rat was determined by physical examination of the ventral body surface for the external presence or absence of either the mammary glands or the single urinogenital penis. The rats were anaesthetized in chloroform after which each was dissected and examined for helminths. The gastrointestinal tracts were opened under water in Petri dishes and the mucosa was scraped with the edge of a glass slide and the scrapings examined under a low power binocular microscope. The helminths were recovered with forceps and pipette following the methods of Behnke (1975). The hearts and lungs were dissected *in-situ* in warm saline. The contents and washings of the scrapings of the gastrointestinal tract, the lungs and the kidneys were examined for helminths. The ventricles, the auricles and branches of the pulmonary arteries were opened and flushed with saline using the method of Renapurkar *et al.* (1982) and Udonsi (1989). The scraping (100g) from the gastric mucosa was digested in acid pepsin (1% pepsin in 3% hydrochloric acid at 27^{o}C) for 12 hours. The digest was passed through a 150 mm aperture sieve, using hot water to remove fat, and the fluid collected and sedimented. Twenty (20) gm of the liver, lungs and heart were ground and digested as above. The urinary bladder was incised, the urine collected, centrifuged and the sediment examined for helminths.

Helminths recovered from the different anatomical regions of the organs were counted and preserved in 70% alcohol. For identification nematodes were cleared in lactophenol and stained in aceto-alum carmine (Nana and Parihar, 1976). Cestodes were cleared in clove oil (Wertheim and Greenberg, 1970) and stained in aceto-alum carmine. Identification of the helminths recovered was based on Yamaguti (1961, 1971).

Data Analysis: Prevalence and mean number of parasites per rat host were used as indices of the infra population size of each parasite species. Student's t-test and analysis of variance were used to assess significance of differences of parasitological data. Fager's index of similarity was calculated to investigate the similarity or otherwise of the helminths within and between the habitats.

RESULTS

The gender-related, monthly and seasonal distribution of the helminths recovered from all the rats caught is summarized in Table 1. During the 12-month (comprising 2 seasons) period of study, a total of 1458 rats (824 (56.5 %) males and 634(43.5 %) females) were captured from the six different microhabitat locations. On the average,

Table 1: Gender-related seasonal distribution of helminths recovered from the black rat, *Rattus rattus* in Nsukka, Nigeria

Year/season	Month	Number of rats examined			Number of rats infected			Number of helminths recovered			Mean worm burden		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
2005/Rainy	April	65	36	101	49(57.6)	36(42.4)	85(84.2)	76(63.3)	44(36.7)	120(8.2)	1.6	1.2	1.4
	May	59	64	123	56(56.0)	44(44.0)	100(81.03)	58(55.8)	46(44.2)	104(7.1)	1.0	1.0	1.0
	June	78	50	128	51(56.0)	40(44.0)	91(71.1)	69(53.1)	61(46.9)	130(8.8)	1.4	1.5	1.4
	July	66	67	133	47(54.7)	39(45.3)	86(64.7)	62(58.5)	44(41.5)	106(7.2)	1.3	1.1	1.2
	August	58	72	130	53(57.0)	40(43.0)	93(71.5)	44(42.3)	60(57.7)	104(7.1)	0.8	1.5	1.1
	September	65	54	119	57(58.2)	41(41.8)	98(82.4)	87(60.8)	56(39.2)	143(9.7)	1.5	1.4	1.5
	October	75	45	120	61(57.5)	45(42.5)	106(88.3)	70(51.9)	65(48.1)	135(9.2)	1.1	1.4	1.3
2005/Dry	November	67	59	126	45(51.7)	42(48.3)	87(69.0)	79(53.7)	68(46.3)	147(10.0)	1.8	1.6	1.7
	December	73	48	121	54(54.0)	46(46.0)	100(82.6)	56(43.8)	72(56.2)	128(8.7)	1.0	1.6	1.3
	January	82	37	119	48(61.5)	30(38.5)	78(65.5)	62(55.9)	49(44.1)	111(7.6)	1.3	1.6	1.4
	February	71	49	120	43(50.0)	43(50.0)	86(71.7)	48(44.0)	61(56.0)	109(7.4)	1.1	1.4	1.3
	March	65	53	118	48(54.5)	40(45.5)	88(74.6)	71(53.8)	61(46.2)	132(9.0)	1.5	1.5	1.5
Total		824	634	1458	612(55.7)	486(44.3)	1098(75.3)	782(53.2)	689(46.8)	1469	1.3	1.4	1.3

Key: *Number in parenthesis = percentage prevalence*

Table 2: Pattern of helminth infections in different sexes of black rats from various microhabitats in Nsukka area

Study microhabitats	Number of rats examined	Number of rats infected	Number of helminths recovered			Total	Mean worm burden
			Nematodes	Cestodes	Trematodes		
University residential area	Male 61	51(83.6)	84(72.4)	31(26.7)	1(0.9)	116	2.3
	Female 44	44(100.0)	52(67.5)	25(32.5)	0(0.0)	77	1.8
Urban residential area	Male168	123(73.2)	208(82.2)	45(17.8)	0(0.0)	253	2.1
	Female 126	96(76.2)	121(78.9)	33(21.3)	1(0.6)	155	1.6
Edem village houses	Male 181	134(74.0)	64(65.3)	32(32.7)	2(2.0)	98	0.7
	Female 169	131 (77.5)	97(71.3)	39(28.7)	0(0.0)	136	1.0
Obukpa village houses	Male 163	120(73.6)	67(69.1)	30(30.9)	0(0.0)	97	0.8
	Female 142	87(61.3)	70(65.4)	35(32.7)	2(1.9)	107	1.2
University farm houses	Male 42	38(90.5)	77(68.7)	35(31.3)	0(0.0)	112	2.9
	Female 47	47(100.0)	94(76.4)	28(22.8)	1(0.8)	123	2.6
Ogige market food stores	Male 209	146(69.9)	62(58.5)	43(40.6)	1(0.9)	106	0.7
	Female 106	81(76.4)	67(75.3)	21(23.6)	1(1.1)	89	1.1
Sex totals	Male 824	612(74.7)	562(71.9)	216(27.6)	4(0.5)	782	1.3
	Female 634	486(76.7)	501(72.9)	181(26.3)	5(0.8)	687	1.4
Grand totals	14558	1098(75.3)	1063(72.4)	397(27.0)	9(0.6)	1469	1.3

Key: *Number in parenthesis = percentage prevalence* approximately 4 rats were caught daily from these locations and examined for helminths. During the 7 months period of rainy season, a total of 854 rats (466 males and 388 females) were caught whereas 604 rats (358 males and 246 females) were obtained during the dry reason period of 5 months duration.

Altogether 1098(75.3 %) rats (composed of 612(55.7 % males and 486(44.3%) females, were found to be infected with various categories of helminths, thus establishing and overall prevalence of 75.3%. The between- sex difference was statistically significant ($x^2 = 2.64$, $p < 0.05$).

Out of the 854 rats caught during the rainy season 659(77.2 %) comprising 374 (56.8%) males and 285(43.2 %) females were infected during the study period. In the dry season, out of the 604 rats examined, 439(72.7 %) consisting of 238(54.2 %) males and 201(45.8 %) females were also found to harbour helminth parasites.

A total of 1469 helminths, 782(53.2 %) from male rats and 687(46.8%) from female rats were recovered from the 1098 infected rats thus providing a mean worm burden of 1.3. Eight hundred and forty two (57.3%) of these helminths were recovered during the rainy months, while 627(42.7%) were obtained from the infected rats in the dry months. Generally, the variation in the number of helminths recovered were statistically significant ($p < 0.05$) and season dependent.

Table 2 shows the localities, gender-related distribution of *Rattus rattus* (n = 1458) used in the study as well as the distribution of the various categories of helminth parasites recovered from the rat hosts. Out of the total number of rats used in the study, the highest number (n = 350; 24.6 %) composed of 181 males and 167 females were captured at different locations including food stores, yam barns and rat runways in rural Edem village premises. On the other hand, the least number of the experimental rats (n = 89; 6.1%) comprising 42 males and 47 females were obtained from the university farm houses. The results indicate that more rats (n= 655; 44.9 %) were captured from the rural microhabitats of Edem and Obukpa combined, than from the urban and university residential habitats combined where rats (n = 399; 27.4%) were caught. The observed difference was statistically significant ($x^2 = 2.42$, df = 1, p = 0.04) ($p < 0.05$). The results further showed that the food store habitats within Ogige market provided substantial number of rats (n = 315; 21.6 %) for the study.

Altogether 1469 helminth parasites belonging to 3 helminth groups (nematodes, cestodes and trematodes) were obtained from the sampled *R. rattus* (n = 1498) providing an overall worm burden of 1.3. The proportion of the helminth groups recovered were: nematodes 72.4 % (range 58.5% - 82.2%), cestodes 27.0% (range 17.8% - 40.6%) and trematodes 0.6% (range 0.0% - 2.0%). No acanthocephalan was found. In all, 782 helminth parasites comprising (562 nematodes, 216 cestodes and 4 trematodes) were obtained from 612 infected rats pooled from the 6 microhabitats studied. Besides, 687 worms (501 nematodes, 181 cestodes and 5 trematodes) were got from 486 infected female rats during the same study period. However, although male rats appeared generally to bear greater helminth burden than the females, the distribution of the three helminth groups in both sexes was similar to the overall pattern and did not indicate any parasite preferential significant difference in both sexes ($p > 0.05$).

The distribution of the nematode species recovered from the experimental rats in relation to the microhabitats is shown in Table 3. Quantitatively, nematodes constituted the most prevalent helminth parasites recovered from *R. rattus* during the study period. Altogether nematodes (n=1063) belonging to 6 different species comprising *Nippostrongylus braziliensis* (19.8%), *Aspicularis tetraptera* (17.5%), *Syphacia muris* (17.0 %), *Angiostrongylus cantonensis* (16.9%), *Strongyloides ratti* (16.0 %) and *Capillaria hepatica* (12.8 %) were recovered. The overall mean nematode burden was generally low (1.3) (range 0.7 – 2.3). Furthermore, the inter-habitat nematode distribution pattern indicated that a greater number of nematodes (n= 329; 31.0 %) were recovered from the rats obtained from urban residential microhabitats than from any other study habitat (range 129(12.1 %) – 171(16.1 %). The observed differences in the distribution between the microhabitats were statistically significant ($p < 0.05$).

The strongylid nematodes *N. braziliensis*, *S. ratti* and the oxyuroid *S. muris* were all recovered from the scrapings of the mucosa of small intestine of the rat hosts. *A. tetraptera* came from the caecum, *C. hepatica* from the liver tissues while *A. cantonensis* were obtained from the digested lung tissues. Generally, the results appeared to indicate that the distribution pattern of the nematodes in their hosts was to some extent microhabitat- dependent. Table 4 is a summary of the distribution of cestode species recovered from the rat hosts in relation to the microhabitats. From 165 (15.0 %) cestode-infected rats pooled from 6 microhabitats, 397 cestodes belonging to 6 species were recovered thereby establishing a mean cestode burden of 2.4 (range 1.5 - 4.7). Six (6) cyclophyllidean cestodes were recovered including three (3) taenids; adult *Taenia*

Table 3: Distribution of nematode species recovered from black rats in relation to study microhabitats in Nuskka area

Study microhabitat	Number of rats examined	Number of rats infected	Number infected with nematodes	Total number of nematodes recovered	Mean number of nematode burden	Distribution of nematodes *Aspicularis tetraptera*	*Nippostrongylus braziliensis*	*Angiostrongylus cantonensis*	*Strongyloides ratti*	*Cappillaria hepatica*	*Syphacia muris*
University residential area	105	95(90.4)	85(89.5)	136(12.8)	1.6	28(17.4)	34(21.1)	10(12.4)	29(18.0)	15(11.2)	20(19.9)
Urban residential area	294	279(74.5)	183(83.6)	329(31.0)	1.8	57(17.3)	54(16.4)	61(18.5)	59(17.9)	45(13.7)	53(16.2)
Edem village houses	350	265(75.7)	221(83.4)	161(15.1)	0.7	23(16.9)	45(14.7).	26(19.1)	22(16.2)	19(14.0)	26(19.1)
Obukpa village houses	305	207(67.9)	188(90.8)	137(12.9)	0.7	25(18.2)	19(13.9)	23(16.8)	13(9..5)	27(19.7)	30(21.9)
University farm houses	89	85(95.5)	75(88.2)	171(16.1)	2.3	29(17.0)	31(18.1)	27(15.8)	23(13.5)	30(17.5)	31(18.1)
Ogige market food stores	315	227(72.1)	174(76.7)	129(12.1)	0.7	24(18.6)	27(20.9)	33(25.6)	24(18.6)	0.(0.0)	21(16.3)
Total	1458	1098(73.3)	926(84.3)	1063	1.3	186(17.5)	210(19.8)	180(16.9)	170(16.0)	136(12.8)	181(17.0)

Key: *Number in parenthesis = percentage prevalence*

Table 4: Distribution of cestode species recovered from Nigerian black rats in relation to their microhabitats

Study microhabitat	Number of rats infected with helminths	Number infected with cestodes	Total number of cestodes recovered	Mean number of cestode burden	Distribution of cestodes *Taenia muris*	*Raillietina muris*	*Taenia hydatigera*	*Hymenolepis nana*	*Taenia taeniaeformis*	*Hymenolepis diminuta*
University residential area	95	12(12.6)	56(14.1)	4.7	10(17.9)	5(8.9)	8(14..3)	12(21.4)	6(10.7)	15(26.8)
Urban residential area	219	25(11.4)	78(19.6)	3.1	12(15.4)	9(11.5)	10(12.8)	13(16.7)	14(17.9)	20(25.6)
Edem village houses	265	35(13.2)	71(17.9)	2.0	15(21.1)	7(9.9)	13(18.3)	11(15.5)	10(14.1)	15(21.1)
Obukpa village houses	207	29(14.7)	65(16.4)	2.0	10(15.4)	5(7.7)	9(13.8)	12(18.5)	13(20.0)	16(24.6)
University farm houses	85	21(24.7)	63(15.9)	3.0	9(14.3)	8(12.7)	12(19.0)	10(15..9)	11(17.5)	13(20.6)
Ogige market food stores	227	43(18.9)	64(16.1)	1.5	12(18.8)	5(7.8)	14(21.9)	7(10..9)	15(23.4)	11(17.2)
Total	1098	165(15.0)	397	2.4	68.(17.1)	39(9.8)	66(16.6)	65(16.4)	69(17.4)	90(22.7)

Key: *Number in parenthesis = percentage prevalence*

Table 5: Distribution of combined helminth infections in rats from different microhabitats in Nuskka area

Study microhabitat	Number of rats infected with helminths	Number of rats with combined infection
University residential area	95	82(86.3)
Urban residential area	219	198(90.4)
Edem village houses	265	167(63.0)
Obukpa village houses	207	150(72.5)
University farm houses	85	78(91.8)
Ogige market food stores	227	152(67.0)
Total	1098	827(75.3)
	Helminth combinations	
	nematode/ cestode	**nematode/ trematode**
University residential area	81(98.8)	0(0.0)
Urban residential area	197(99.5)	1(0.5)
Edem village houses	165(98.8)	1(0.6)
Obukpa village houses	(148(98.6)	1(0.7)
University farm houses	77(98.7)	0(0.0)
Ogige market food stores	150(98.7)	2(1.3)
Total	5(6.0)	5(6.0)
	cestode/ trematode	
University residential area	1(1.2)	
Urban residential area	0(0.0)	
Edem village houses	1(0.6)	
Obukpa village houses	1(0.7)	
University farm houses	1(1.3)	
Ogige market food stores	0(0.0)	
Total	4(0.5)	

Key: *Number in parenthesis = percentage prevalence*

muris (17.1%), strobilocerci of *Taenia taeniaeformis* (17.45) and *Taenia hydatigera* (16.6%). Also recovered were adult *Hymenolepis diminuta* (22.7%), cysticercoids of *Hymenolepis nana* (16.4%) and *Raillietina muris* (9.8%). The strobilocerci of *T. taeniaeformis* and *T. hydatigera* were obtained from the liver tissues of the rat hosts, *H. diminuta* from the anterior ileum while *H. nana, R. muris* and *T. muris* were all recovered from the intestinal villi of the infected rats.

The highest number of cestode-infected rats (n = 43; 18.9%) were caught at Ogige market food stores whereas only 12 (12.6 %) rats captured at the university residential quarters were infected with cestodes. The results further indicate that the distribution of cestode-infected rats followed a similar pattern with that of the nematodes, being higher in the rural residential houses of Edem (n = 35; 13.2%) and Obukpa (n = 25; 11.4%) or university residential area (n=12; 12.6 %). The observed differences in the inter-habitat distribution of cestode-infected *R. rattus* also appeared to be locality-dependent and were statistically significant (X^2_6 = 11.46, df = 5, p = 0.034).

The distribution of combined helminth infections in black rats hosts obtained from different microlocations within Nsukka area is summarized in Table 5. Trematodes (n = 9) belonging to three species (*Plagiochis muris*, *Platinosomoides muris* and *Corrigia muris* were recovered from 5 infected *R. rattus*. Altogether 827 (75.3%) of the infected rats had combined infections of two different helminth groups. Rats with nematode/cestode combinations constituted 98.9% of the total combined infections Nematode/ trematode and trematode/cestode combinations constituted only 6.0% and 0.5% of the combined infections respectively.

All the rats infected with cestodes also had either nematode or trematode helminth parasite, whereas those rats infected with trematodes had either cestodes or nematode parasites. None of the infected rats hosted all three helminth groups. A total of 103 rats had single infections with nematodes.

DISCUSSION

The results of this study show that both sexes of the Nigerian strain of the peridomestic black rat, *R. rattus* harboured varying numbers of parasitic helminths during the one year study period. The study further indicates that infection rates were higher during the rainy season period of considerable precipitation with a pooled prevalence of 60.0 per cent as against 40.0 per cent recorded during the dry season, although the monthly and seasonal variations in prevalence were not absolute (Table 1). The occurrence of these helminths in monthly samples taken of the black rat population seemed to suggest that the helminth infections were probably acquired continuously throughout the year. This observation was further enhanced by the absence of an overall seasonal variation in the infection rates. The lack of seasonal peaks in infection rates may be attributed, to a certain extent, to the longer duration of the rainy season (7 months) as against the 5 months of dry period (Table 1). Furthermore this lack of clear-cut seasonal variation in infection rates may probably be related to the polyoestrous breeding nature of the rat hosts and the life cycle patterns of the different helminth species which may be affected by other season-independent variables. Support of the observations recorded in this study is provided by the expressions of Dobson and Carper (1993) and Githeko *et al.* (2000) who stated that seasonal climatic changes can affect not only the biology and ecology of parasites, but also their hosts and subsequently their intensity and other transmission potentials. It could also be postulated that the ova of some of the gastrointestinal helminth species cannot survive and develop to infective stages in the usually dry, hot season. In addition, host susceptibility to infection may have played important role in the seasonal distribution of the helminth parasites in their rat hosts.

In determining the presence or absence of sex differences in host populations of *R. rattus* at least three parameters could be considered including mean parasite recovery, prevalence of infection and the frequency distribution of the parasites. The overall higher infection rate in males (53.2%) than female rats (46.8%) recorded in this study (Tables 1 and 2) was consistent with the findings of earlier investigators (Ayres, 1973; Nana and Parihar, 1976; Udonsi, 1989). In contrast with the above, Whitaker (1970) found no difference in the between-sex parasite burden although he recorded more mean number of parasites per rat in the male than in the female *R. rattus*. The present study further showed that the between-sex difference observed in the infection process was statistically significant ($p < 0.05$) and is in conformity with the results of Sharp (1964) and Behnke (1975). This feature of the infection process may be ascribed to the relatively more active foraging activities of the male than the female rat which ultimately results in a higher exposure to infection in different microhabitats. This accounts as an important factor in the epizootiology of helminth infection in *Rattus* populations. Besides, Mathies (1956), Dobson (1961), Behnke (1975) and Ivoke (2007) also attributed the sex-related variations in infections to differences in susceptibility to infection inherent in individual hosts.

With regards to the prevalence of cestodes, the presence of six species of cyclophyllideans probably was an indication of the level of exposure and the degree of susceptibility of the rat hosts (from different microhabitats) to this helminth (Table 5). The ability of the cysticerci of *T. hydatigera* and the strobilocerci of *T. taeniaeformis* to survive in the rat hosts may be attributed to a number of possible factors including the immunological competence of the rat hosts. Empirical studies have shown that rats harbouring the strobilocercus of *T. taeniaeformis* in their livers are resistant to challenge infections for several months (Smyth and McManus, 1989). A similar pattern of immunity also occurs in other larval taenids, such as *T. hydatigera*. The highest prevalence (22.7 %) recorded for *H. diminuta* indicates that *R. rattus* may possibly be the natural host for this cestode. That notwithstanding, it has been established by Kwa and Liew (1978) that rat hosts will support only low density infections (≤ 10) of *H. diminuta* indefinitely. Thus the overall low helminth burden recorded in this study could be a function of the immune response of the rat host or may be due to physiological alterations associated with crowding of worms in the gastrointestinal tract. It could be inferred therefore that for the human-dwelling adult cestodes, acquired immunity may play a controlling role with regards to the prevalence in their rat hosts.

The low prevalence of parasitic nematode species in rats obtained from the various microhabitats (Table 2) may be due to the differing life cycle patterns specific for each nematode species recovered in the study. Thus, among the monoxenous species such as *N. braziliensis*, *S. ratti*, *A. tetraptera* and *S. muris* that require direct development, their prevalence may be explained on the basis of their direct development in susceptible rat hosts. The presence of *A. tetraptera* in *R. rattus*, as observed in the study may be viewed as unusual since its natural host is the house mouse (*Mus musculus*). In that regard the house black rat may be considered an abnormal host of *A. tetraptera.* The absence of any intermediate hosts in the development of these nematodes is obviously an important factor in their prevalence.

The recovery of the metastrongyloid lung worm *A. cantonensis* in this study is an important finding because this is probably the second time this parasitic nematode is being reported in published work in Nigeria, having been reported earlier in the Niger delta by Udonsi (1989). The presence of *A. cantonensis* in rats caught inside food barns in rural residential areas of Edem and Obukpa where gastropod intermediate hosts are in abundance and eaten by inhabitants, indicate a possible link of *R. rattus* as a paratenic host of the parasite. This study indicates that the parasite may possibly be more widespread globally than has hitherto been known as earlier reported in Egypt (Yousif and Ibrahim, 1978) and India (Renapurkar *et al.,* 1982). It is probable that the cosmopolitan nature of *R. rattus* and their high mobility will increase the spread of *A. cantonensis* to other parts of Nigeria and other places where the molluscan intermediate hosts are present and are eaten. Its spread may have some public health implications since this parasitic nematode has been implicated in the aetiology of the nervous disorder called human eosinophilic meningoencephalitis (Rosen *et al.*, 1961; Alicata, 1962). The report that human infection could be acquired by eating improperly cooked snail intermediate hosts and by drinking or coming into contact with contaminated waters (Alicata, 1965) places a substantial human population of rural and urban dwellers in Nigeria and elsewhere at high risk of acquiring this nervous disorder. In this regard, a sustained survey to identify and delineate snail-eating human populations, followed by public awareness campaigns on the public health implications of such surveys is advocated.

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