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By

Clement Ameh Yaro, Ezekiel Kogi and Christian E. Mbah

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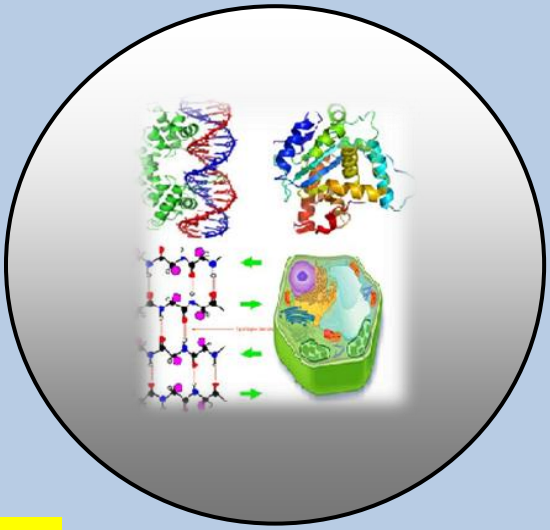

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C. Ameh Yaro
http:// www.sasjournals.com
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jbiolchemres@gmail.com
info@jbcr.in

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Cockroaches, *Periplaneta americana* and *Blatella germanica*as Carriers of *Strongyloides stercoralis* in Samaru Zaria, Kaduna State, Nigeria

Clement Ameh Yaro, *Ezekiel Kogi and **Christian E. Mbah
Department of Biological Sciences, Kogi State University, Anyigba, Nigeria
***Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria**
****Department of Biological Sciences, Federal University, Ebonyi, Nigeria**

ABSTRACT

A study was conducted to determine the role of cockroaches as potential carrier of Strongyloides stercoralis in Ahmadu Bello University Main Campus and Samaru Village, Zaria, Kaduna State. A total of 630 cockroaches, comprising of two species were collected from six areas and four areas from Ahmadu Bello University and Samaru Village respectively using hand gloved hands and examined for S. stercoralis using the sedimentation method. The findings from this study revealed that S. stercoralis are carried by cockroaches captured in Zaria at a prevalence of 8.57% with a prevalence of 9.26% in Ahmadu Bello University and 7.54% in Samaru Village, no significant difference (P>0.05) in the prevalence of S. stercoralis between the two communities.Cockroaches were observed to significantly (P≤0.05) carry S. stercoralis more on the external body surface (7.46%) than on the internal body surface (1.90%) and in nymph (44.14%) than adult (4.24%). No significance (P>0.05) in prevalence between Periplaneta americana(10.50%) andBlattella germanica (5.22%) and between male (7.38%) and female (9.64%) cockroaches. The mean load of S. stercoralis was highest in Queen Amina Hall (3.65) and least in Suleiman Hall in ABU (0.13). No S. stercoralis recovered from cockroaches from Akenzua Hall, ABU and Danraka Area, Samaru Village.Cockroaches serve as reservoir for S. stercoralis the causative agent of strongyloidiasis. Proper environmental hygiene should be instituted in homes, hospitals and schools to minimize the spread of infectious diseases in the study area.

Keywords: Cockroaches, Strongyloides stercoralis, Ahmadu Bello University and Samaru Village.

INTRODUCTION

Cockroaches are the world's most common insects and have been on earth for about 300 million years. They are considered one of the most successful groups of animals because of their adaptability (Salehzadeh*et al.*, 2007). Thirty species of cockroaches are associated with human habitations and about 4,500 species can be found in every part of the world with *Periplaneta americana* (Linnaeus, 1758) and *Blattella germanica* (Linnaeus, 1767)being the most common species (Robinson, 2005; Uneke, 2007).Cockroaches have been recognized as mechanical vectors of human pathogens (Cochran, 1982). They contaminate food by their droppings containing parasites and also transmit bacteria, fungi, and other pathogenic microorganisms in infested areas (CheGhani*et al.,* 1993).They serve as carriers of bacterial diarrhea and nosocomial infections in hospitals (Fotedar*et al.*, 1991).

Strongyloides stercoralis also called threadworms is a nematode helminth parasite that causes strongyloidiasis occurring widely in tropical and subtropical areas (Fardet*et al.,* 2006).It was first described in 1876 from stool specimens obtained from soldiers who had returned from Vietnam and were suffering from severe diarrhoea and other gastrointestinal symptoms. There are an estimated 100 million to 200 million people infected with *S. stercoralis* residing in 70 different countries (Vadlamudi*et al.,* 2006; Bianchi *et al*., 2006).There is a high prevalence of *S. stercoralis* in Brazil, Central America, and Australia. It is endemic in Africa, South and Southeast Asia, South America, rural parts of Italy, Papua New Guinea, and the Pacific Islands (Rose, 2008; Fardet*et al.,* 2006; Vadlamudi*et al.,* 2006).*Strongyloides stercoralis* infection is mostly asymptomatic and can remain undetected for several decades. Infections are mostly acquired in patients who travel to endemic areas (Rose, 2008; Fardet*et al.,* 2006). Symptomatic infections appear in the gastrointestinal, pulmonary, and cutaneous areas (Rose, 2008). The most common symptoms are anorexia, nausea, diarrhea, abdominal bloating, abdominal discomfort, ulcers, cough, dyspnoea, wheezing, acute pulmonary insufficiency, low-grade fever, rashes, tissue damage and sepsis (Rose, 2008; Fardet*et al.,* 2006; Vadlamudi *et al.,* 2006). *Strongyloides stercoralis* is different from all other soil transmitted helminthic infections because the female worm can reproduce by pathogenesis within the human host. Depending on the host immune response, this can lead to autoinfection and hyper-infection (Concha *et al.,* 2005; Genta, 1992; Keiser and Nutman, 2004; Prendki*et al.,* 2011). Clinically apparent strongyloidiasis can lead to cutaneous, gastrointestinal and pulmonary symptoms. Severe disseminated strongyloidiasis has a high mortality rate of up to 87%.Contamination of water and food sources with human wastes and insufficient hygiene are main causes of fecal-oral transmitted intestinal parasitic infections (Giacometti *et al.,* 1997; Ahmed *et al.,* 2010; Alyousefi*et al.,* 2011). The effects of *Strongyloides* are severe, therefore there is need to determine the role of cockroaches as carriers of *Strongyloides stercoralis* in Ahmadu Bello University, Main Campus and Samaru Village, Zaria.

MATERIAL AND METHODS

Study Area: Ahmadu Bello University Main Campus and Samaru Village lies on latitude $11^{o}10'$N and $7^{o}38'$E. They are two major settlements that make up the urban Zaria. The establishment of the Ahmadu Bello University resulted in the establishment of the Samaru village opposite it.

Sample Collection: Cockroaches were collected from different Halls of Residence in Ahmadu Bello University Main Campus and from residential buildings in Samaru Village. The following are the sampling areas for collection of cockroaches;

(a) Ahmadu Bello University Main Campus; Akenzua, Suleiman, Danfodiyo, Yar'adua, Amina and Ribadu Halls.

(b) Samaru Village; Danraka, New Layout, Hayin Dogo and Hanyin Dan Yaro Areas

Samples were collected daily between the hours of 10:00 pm and 4:00 am. During the period, cockroaches were collected from kitchens, basements or bathrooms of residential area, hostels, and toilets. Each cockroach was collected using gloved hands and placed in a sterile test tube containing 5 ml of sterile normal saline (0.9%) (Adeleke*et al.,* 2012); samples were transported to the laboratory and immobilized by freezing at 0^{o}C for 5 min. The cockroaches were identified morphologically using standard taxonomic keys (Tawatsin*et al.,* 2001). Only cockroaches captured whole and live was utilized for the study.

Isolation and Identification of Parasite Cyst and Ova/Larvae from External Surfaces:

After identification, the cockroaches were thoroughly shaken for 2 minutes. The washings was decanted into centrifuge tubes and centrifuged at 2000 rpm for 5 minutes. The sediment obtained was transferred to a clean glass slides, and a drop of 1% Lugols Iodine solution was added. The slide was then covered with a cover slip and examined under a light microscope at x10 and x40 magnifications. The larvae of *Strongyloides stercoralis*seen was identified and counted (Siddiqui and Berk, 2001; Cheesbrough, 2006).

Isolation and Identification of Parasite Cyst and Ova/Larvae from Internal Surfaces

After external washings, cockroaches were placed in flasks rinsed with 70% alcohol for 5 min (to decontaminate external surfaces as 70% alcohol is bactericidal), transferred to sterilized flasks, and allowed to dry at room temperature under sterile conditions. Cockroaches were then washed with sterile normal saline for 2 to 3 minutes to remove traces of alcohol.

Dissection of Cockroaches for Internal Parasites

The head was first severed out, and next are the legs, with the help of fine pointed forceps and scissors. The body was then pinned to a small dissection tray with thin but rigid pins (the best are the kind used by entomologists to pin their specimens, but you can use the thinnest and longest steel hand sewing needles). With the scissors, the ligaments was cut on the right hand side of the abdominal sternites, beginning at the rear end, and the ventral plate so released is hinged towards the left side, clearing its adhesions to the internal organs with sharp needles or with a microscalpel, and was discarded or pinned down.

Isolating the Alimentary Canal

With thin and sharp teasing needles and or very fine pointed forceps, the fat that surrounds the abdominal organs was removed. The alimentary canal was isolated and was then set free from its ties, it was then separated more or less completely, the gizzard was moved with the tweezers until the esophagus was seen and then it was cut distally. The rest of the digestive tract was then liberated with the needles, and cut at the other end, at the level of the anus (or cloaca).

The intestinal cecae was identified. With the help of the forceps and the scissors, two cuts were made in the intestine: one below the cecae, and another one at the level of the cloaca. The separated intestine was then transferred to a capsule with clean physiological solution. With the two rigid teasing needles, fine and sharpened, the intestine was open alongside, releasing its content.

After dissection, the cockroach intestines were macerated aseptically in a sterile pestle and mortar in 5 ml of sterile normal saline. The resulting macerate was then processed in a similar way as described previously and the results recorded (Garcia and Bruckner, 1997).

Statistical Analyses

Descriptive statistics was used to analyze the prevalence and Analysis of Variance (ANOVA) was used to show level of significance between the locations, species, sex and stage of development. Comparison of data obtained from the external and internal body of cockroaches collected from Samaru Village and Ahmadu Bello University Main Campus, Zaria was subjected to independent and paired t-test. Statistical Package for Social Sciences (SPSS) version 21.0 was used for the Analyses.

RESULTS

This study revealed prevalence of*Strongyloides stercoralis* carried by cockroaches captured in Zaria is 8.57% (54 cockroaches) with a prevalence of 9.26% (35 cockroaches) in Ahmadu Bello University and 7.54% (19 cockroaches) in Samaru Village. No significant difference (P>0.05) in the prevalence of *S. stercoralis* between the two communities.

Table 1. Distribution of *Strongyloides stercoralis* on Body Surfaces of Cockroaches Captured from Ahmadu Bello University Main Campus and Samaru Village.

Locations	Sampling Areas	Total Captured	External	Internal	Total Number Positive (%)
			Number Positive (%)	Number Positive (%)	
ABU	Akenzua Hall	63	0 (0.00)	0 (0.00)	0 (0.00)
	Suleiman Hall	63	1 (1.59)	1 (1.59)	2 (3.18)
	Yar'adua Hall	63	6 (9.52)	0 (0.00)	6 (9.52)
	Danfodiyo Hall	63	5 (7.94)	0 (0.00)	5 (7.94)
	Queen Amina Hall	63	7 (11.11)	5 (7.94)	11 (17.46)
	Ribadu Hall	63	10 (15.87)	2 (3.17)	11 (17.46)
		378	**29 (7.67)**	**8 (2.12)**	**35 (9.26)**
SV	Danraka	63	0 (0.00)	0 (0.00)	0 (0.00)
	New Layout	63	1 (1.59)	2 (2.17)	2 (3.18)
	Hayin Dan Yaro	63	8 (12.70)	2 (2.17)	8 (12.70)
	Hayin Dogo	63	9 (14.29)	0 (0.00)	9 (14.29)
		252	**18 (7.14)**	**4 (1.59)**	**19 (7.54)**
Total		**630**	**47 (7.46)**	**12 (1.90)**	**54 (8.57)**

	t value	df	P value
Between External and Internal	2.976	9	0.016*
Between ABU and SV	0.373	8	0.719ns

Cockroaches were observed to significantly (P≤0.05) carry *S. stercoralis* more on the external body surface than on the internal body surface with a prevalence of 7.46% (47 cockroaches) and 1.90% (12 cockroaches) respectively.

Table 2. Distribution of *Strongyloides stercoralis* According to Species of Cockroaches Captured from Ahmadu Bello University Main Campus and Samaru Village.

Locations	Sampling Areas	*Periplaneta americana*			*Blattella germanica*	
		Number Examined	**Total (%)**		**Number Examined**	**Total (%)**
ABU	Akenzua Hall	40	0 (0.00)		23	0 (0.00)
	Suleiman Hall	40	1 (2.50)		23	1 (4.35)
	Yar'adua Hall	40	4 (10.00)		23	2 (8.70)
	Danfodiyo Hall	40	4 (10.00)		23	1 (4.35)
	Queen Amina Hall	40	8 (20.00)		23	3 (13.04)
	Ribadu Hall	40	11 (27.50)		23	0 (0.00)
		240	**28 (11.67)**		**138**	**7 (5.07)**
SV	Danraka	40	0 (0.00)		23	0 (0.00)
	New Layout	40	2 (5.00)		23	0 (0.00)
	Hayin Dan Yaro	40	5 (12.50)		23	3 (13.04)
	Hayin Dogo	40	7 (17.50)		23	2 (8.70)
		160	**14 (8.75)**		**92**	**5 (5.43)**
Total		**400**	**42 (10.50)**		**230**	**12 (5.22)**

	t value	df	P value
Between *P. americana* and *B. germanica*	1.942	9	0.084ns

Table 3. Distribution of *Strongyloides stercoralis* According to Developmental Stages of Cockroaches Captured in Ahmadu Bello University Main Campus and Samaru Village.

Locations	Sampling Areas	**Male**		**Female**	
		Number Examined	**Number Positive (%)**	**Number Examined**	**Number Positive (%)**
ABU	Akenzua Hall	29	0 (0.00)	34	0 (0.00)
	Suleiman Hall	29	0 (0.00)	34	2 (5.88)
	Yar'adua Hall	32	2 (6.25)	31	4 (12.90)
	Danfodiyo Hall	29	2 (6.90)	34	3 (8.82)
	Queen Amina Hall	33	8 (24.24)	30	3 (10.00)
	Ribadu Hall	31	5 (16.13)	32	6 (18.75)
		183	**17 (9.29)**	**195**	**18 (9.23)**
SV	Danraka	27	0 (0.00)	36	0 (0.00)
	New Layout	24	0 (0.00)	39	2 (5.13)
	Hayin Dan Yaro	31	3 (9.68)	32	5 (15.63)
	Hayin Dogo	33	2 (6.06)	30	7 (23.33)
		115	**5 (4.35)**	**137**	**14 (10.22)**
Total		**298**	**22 (7.38)**	**332**	**32 (9.64)**

	t value	df	P value
Between Male and Female	-1.256	9	0.241ns

According to the species of cockroaches captured, *Periplaneta americana* had a higher carriage of *S. stercoralis* (10.50%, 42 cockroaches) compared to *Blattella germanica* (5.22%, 12 cockroaches). Meanwhile, no significant difference was observed in the carriage.

Table 4. Distribution of *Strongyloides stercoralis* According to Developmental Stages of Cockroaches Captured in Ahmadu Bello University Main Campus and Samaru Village.

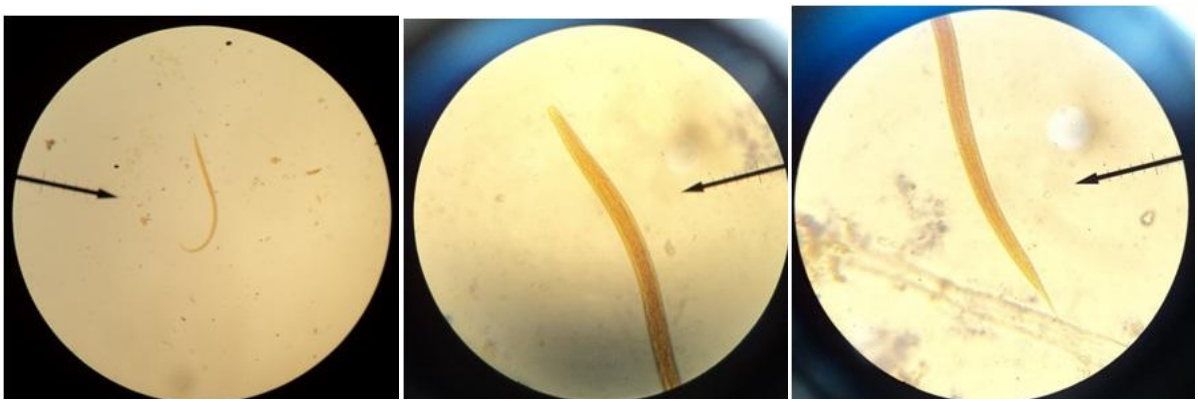
Locations	Sampling Areas	Adult		Nymph	
		Number Examined	Number Positive (%)	Number Examined	Number Positive (%)
ABU	Akenzua Hall	49	0 (0.00)	14	0 (0.00)
	Suleiman Hall	50	2 (4.00)	13	0 (0.00)
	Yar'adua Hall	53	6 (11.32)	10	0 (0.00)
	Danfodiyo Hall	54	5 (9.26)	9	0 (0.00)
	Queen Amina Hall	49	10 (20.41)	14	1 (7.14)
	Ribadu Hall	52	9 (17.31)	11	2 (18.18)
		307	**32 (10.42)**	**71**	**3 (4.23)**
SV	Danraka	53	0 (0.00)	10	0 (0.00)
	New Layout	53	2 (3.77)	10	0 (0.00)
	Hayin Dan Yaro	53	7 (13.21)	10	1 (10.00)
	Hayin Dogo	53	8 (15.09)	10	1 (10.00)
		212	**17 (8.02)**	**40**	**2 (5.00)**
Total		**519**	**22 (4.24)**	**111**	**49 (44.14)**
		t value	df	P value	
Between Adult and Nymph		3.162	9	0.012*	

Table 5. Mean Load of *Strongyloides stercoralis* from Sampling Areas in Ahmadu Bello University Main Campus and Samaru Village.

Locations	Sampling Areas	Total Captured	Number of Parasites (Mean)
ABU	Akenzua Hall	63	0 (0.00)
	Suleiman Hall	63	8 (0.13)
	Yar'adua Hall	63	32 (0.51)
	Danfodiyo Hall	63	143 (2.27)
	Queen Amina Hall	63	230 (3.65)
	Ribadu Hall	63	176 (2.79)
		378	**589 (1.56)**
SV	Danraka	63	0 (0.00)
	New Layout	63	15 (0.24)
	Hayin Dan Yaro	63	51 (0.81)
	Hayin Dogo	63	75 (1.21)
		252	**141 (0.56)**
Total		**630**	**731 (1.16)**

Comparison of prevalence of parasite according to sex also revealed no significant difference (P>0.05) with the female cockroaches having a higher prevalence of 9.64% (32 cockroaches) while the male had a prevalence of 7.38% (22 cockroaches). Based on the developmental stages of the cockroaches, this study revealed highly significant difference in prevalence of *S. stercoralis* carried by the nymphs and adults with a prevalence of 44.14% (49 cockroaches) in the nymphs and 4.24% (22 cockroaches) in the adults.

The mean load of *S. stercoralis* was observed to be highest in Queen Amina Hall (3.65) followed by Ribadu Hall (2.79) and Danfodiyo Hall (2.27), all in Ahmadu Bello University Main Campus while the least mean load was in Suleiman Hall in ABU. No *S. stercoralis* recovered from cockroaches from Akenzua Hall, ABU and Danraka Area, Samaru Village.



(a) **(b)** **(c)**

Plate I: *Strongyloides stercoralis* (magnification = X10) (a) larvae of Strongyloides (Magnification = X10 (b) anterior part of larvae (Magnification =X100 (c) posterior part of larvae (Magnification = X100).

DISCUSSION

Cockroaches are an important reservoir of infectious agents. The findings from this study confirm that cockroaches have being involved in the transmission of parasitic organisms irrespective of its species, age and body parts as 8.57% of cockroaches examined for parasites in this study carried *Strongyloides stercoralis*. Several studies reported the isolation of microorganisms from cockroaches, captured from houses and hospitals. Although, studies on the carriage of parasitic organisms by cockroaches do not focus more on *Strongyloides stercoralis* despite its cosmopolitan distribution and its disease effects. Pennapa*et al*. (2011) reported few occurrence of *S. stercoralis* in cockroaches captured in a province of Thailand and Tatfeng*et al.* (2005) also recovered larvae of *S. stercoralis* from cockroaches captured in a study carried out in Ekpoma, Edo State, Nigeria. In all these studies, the actual prevalence of *S. Strongyloides* from cockroaches was not reported.

S. stercoralis isolated from external body surface of cockroaches was higher than those from the internal body surface. This shows that the parasites may be disseminated by contact more than their food habits. Similar observation was reported by Nagham*et al.* (2011). The sexes of the cockroach had equal carriage potential as both sex move in sex of food, mate and reproduction.

The highly significant difference observed between the nymph and adult might be due to the high nutrient need by the nymph for the development of body structures which prone it to high parasite carriage compared to the adults which need nutrient just for daily metabolism.

CONCLUSION

The control of cockroaches should be emphasized to stop the transmission of *Strongyloides stercoralis* which is the causative agent of Strongyloidiasis and this will also help to stop the spread of other infectious diseases.

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Corresponding author: Clement Ameh Yaro, Department of Biological Sciences, Kogi State University, Anyigba
Email: acyarocity@yahoo.com