

Nigerian J. Ent. 3(2), January 1979

DOI.10.36108/NJE/9791/30.0260

A Study of the Gastro-intestinal Parasites of domestic populations of the Cockroach Periplaneta americana Linnaeus at Nsukka, Nigeria

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Abstract

The gastro-intestinal parasites of Cockroaches Periplaneta americana Linnaeus from three domestic sources at Nsukka, Nigeria, were studied. Five species of protozoa and six of helminths (including cysts of Entamoeba sp. and eggs of Ascaris sp. and Trichuris sp.) were found in the insects.

Cockroaches from sewage had comparatively the greatest parasite infestations while those from household boxes showed the least infection rates. Successive nymphal stages of the insects showed significant increase in their parasite loads, upwards to the adult stage.

Most of the parasites were found in the hindgut region, and practically none in the foregut. Stained histological sections of the insects' gut revealed close association between the parasites (especially Gregarina blattarum Sprague and Syphacia obvelata Rudolph) and the endothelium.

The epidemiology and ecological implications of the types, distribution, and loads of parasites found in the insects are discussed in relation to their common occurrence in and around human homes.

## Introduction

Cockroaches are notorious pests, known for their habits of infesting and damaging food and other domestic items. Furthermore, they have often been incriminated as carriers and/or intermediate hosts of a wide range of pathogens ordinarily infective to man and domestic animals (Roth and Willis, 1957; Guthrie and Tindall, 1968).

Among the more common of the pathogenic organisms carried by roaches are bacteria such as Shigella spp. and Salmonella spp., (Cruickshank, 1965; Leclercq, 1969), adults and larvae of various parasitic helminths such as Moniliformis spp., Hymenolepis sp. and Gongylonema spp. (Laing, 1946; Smart et al, 1965; Lavoipierre and Lavoipierre, 1966). Like a number of other domestic insects therefore, cockroaches are of great importance in the ecology of various human infections, and have indeed been associated with epidemics of salmonellosis, amoebiasis and various gastro-intestinal helminthiases in different parts of the world (Davey and Wilson, 1965; Busvine, 1966; Manson-Bahr 1968).

Although much of the insects' involvement in disease transmission have usually been attributed to the extent of access they have to human and animal food, faeces and refuse etc., the available evidence is still largely circumstantial.

This paper reports a study of the gastro-intestinal parasites of samples of the American cockroach Periplaneta americana Linnaeus collected from various domestic locations at Nsukka, Nigeria.

## Materials and Methods

Adults and nymphs of the American cockroach Periplaneta americana Linnaeus were used for this study. The insects were collected from domestic premises at the University of Nigeria, Nsukka campus, and from three neighbouring villages, viz: Nru, Amaeze and Nguru in Nsukka Division of Anambra State of Nigeria. In each area, the cockroaches were sampled from three distinct environments, viz: sewage and lavatories, kitchens and food stores (pantries), and book shelves/cupboards and clothes boxes/cartons. The insects were collected alive, using impro-

vised bait traps for their attraction on a large scale. A few samples were also picked up manually. All the cockroaches were killed with chloroform, and their particulars such as source, stage of development, sex and measurements recorded.

Immediately after killing the cockroaches were dissected individually, and their internal organs/tissues were examined for parasites. In particular, the various regions of the alimentary canal, viz: oesophagus, crop, mesenteron, etc., were cut out, slit open longitudinally with scissors, and fresh smears/impressions made of their contents. These smears were stained with Lugol's iodine for direct microscopic examination. Also wet preparations of the gut contents of individual cockroaches were made by carefully slitting each gut (and portions thereof) and rinsing out the contents thoroughly in 5 ml. drops of saline. Samples of these wet preparations were then pipetted and examined for parasites.

Permanent preparations made of the gut smears were fixed with 90% alcohol and stained initially with Ehrlich's haematoxyline. They were next differentiated in descending series of acid alcohol (70%, 50% and 30%) to limit any adverse effects on the morphology of the parasites present. The smears were subsequently counter-stained in aqueous eosin, and dehydrated by passing through increasing strengths of alcohol, viz: 30%, 50%, 70%, 90% and 100%). Each preparation was finally cleared in xylene, and mounted in Canada balsam for microscopic examination. Parasites found in the gut smears of each insect were carefully identified and noted, while quantitative estimates of the parasite load of each cockroach were made using a tally counter and a counting chamber.

Average parasite loads of large numbers of the cockroaches from the different habitats were also assessed. This was by using a mortar and pestle to crush thoroughly whole lengths of alimentary tracts of the insects (in batches of 10 each), and subsequently suspending the material in 5 ml. of 70% alcohol for centrifugation (at 2,500 r.p.m. for 2 minutes), following which the filtrate was decanted, and the sediment pipetted unto microscope slides and examined for parasites. Specific portions of the alimentary tracts of the cockroaches were also processed in like manner, and examined for parasites, and the average load of parasites per gut region was determined.

In addition portions of the alimentary tracts of samples of the cockroaches were processed through alcohol, embedded in wax, and subsequently sectioned, using a Baird and Tatlock microtome. The histological sections were later stained, using Ehrlich's haematoxyline, and examined for location of parasites and the pathological effects of the latter on the host gut wall.

Regional distribution of the parasites along the lengths of the insect's guts were noted, and comparative assessments were made of the infection rates of male and female cockroaches trapped from various locations, and of the adults and nymphs of these insects.

### Observations and Results

A total of 625 cockroaches (including 200 nymphs) were examined for parasites. Eleven species of parasites were found. These were as follows:

#### PROTOZOA

- i. Nyctotherus ovalis (Meglitsch) (Ciliata: Heterotrichida)
- ii. Gregarina blattarum (Sprague) (Sporozoa: Gregarinida)
- iii. Diplocystis schneideri (Jameson) " "
- iv. Lophomonas striata (Macadown) (Mastigophora: Hypermastigina)
- v. Entamoeba sp. (Sarcodina: Amoebina) (Cysts only)

#### HELMINTHS (NEMATODA)

- i. Leidynema appendiculata (Leidy) (Phasmodia: Ascaridata)
- ii. Heterakis spumosa (Cram) " "
- iii. Syphacia obvelata (Rudolph) " "  
(Eggs only)
- iv. Enterobius sp. (Phasmodia: Ascaridata) (Eggs only)
- v. Ascaris sp. " " " "
- vi. Trichuris sp. " " " "

In terms of numbers and frequency of occurrence, the protozoa (especially *N. ovalis* Meglitsch and *G. blattarum* Spraque) were the most common parasites of the insects, with the helminths accounting only for very limited infection (Fig. 1).

Infection rates were more in cockroaches from sewages/lavatories than in those from kitchens and food store and even more in the latter than in roaches collected from boxes and bookcases. In particular, *L. striata* Macadow and cysts of *Entamoeba* sp. were found only in samples of cockroaches from the sewage environment, as were the eggs of *Ascaris* sp. and *Trichuris* sp. Comparative infection rates of the adults and nymphs of the cockroaches differed considerably with the parasite load, showing near exponential increase in successive nymphal stages and in the adults. For example, close examination of the mean parasite infestation rates of the adults and different nymphal stages of roaches collected from lavatories (Table 1) showed that the adults harboured 21-88 times as much *N. ovalis* Meglitsch and 9-25 times as much ova of *Enterobius* sp. as did the 1st and 2nd nymphal instars.

As for the parasites' distribution along the guts of the roaches, only the midgut and hindgut bore parasites; greater numbers being observed in the hindgut than in the midgut. The only exceptions were *S. obvelata* Rudolph and *G. blattarum* Spraque which were more in the midgut region.

The stained histochemical sections of the gut walls revealed varied degrees of damage, and the partial attachment of some worms (especially *L. appendiculata* Leidy and *S. obvelata* Rudolph) to the thin endothelium of the mesenteron. Cross sections of some of the worms revealed fully developed reproductive organs and numerous eggs. The protozoan parasites and free helminth eggs were found mainly in the gut lumen although quite a number of trophozoites of *G. blattarum* were found in close association with cells of the gut endothelium.

## Discussion

The differential rates of infection of adult cockroaches from the three habitats sampled (Fig. 1), emphasize the probable impact of the insects' environment on their parasite loads. Of special interest is the occurrence of cysts of *Entamoeba* sp. and the

eggs of Ascaris sp. and Trichuris sp. only in roaches trapped from sewage environment. This points to infection through contact with human faeces, especially as some important parasite species belonging to these genera are known to have man as their proper host. The same may be said of Enterobius sp., although eggs of the latter were found also in roaches trapped from kitchens, cupboards and book cases.

As for the definitive species of each of the parasites, the indications are that the Entamoeba cysts, based on their sizes and nuclear characteristics may be those of either E. moshkovskii (Tshalaia) (the common sewage Entamoeba) or E. histolytica (Schaudinn) of man; while the Ascaris ova are most probably those of A. lumbricoides (Linnaeus), although eggs of the latter may ordinarily resemble those of A. suum (Linnaeus) of pigs. Similarly the eggs of the Trichuris sp. (probably T. trichiura Linnaeus) may be likened to those of Trichuris species of pigs, sheep and other livestock animals; while those of Enterobius sp. (probably E. vermicularis Linnaeus of man) are commonly similar to those of Oxyuris equi Linnaeus of horses. There was however no evidence of mixture of human and animal faeces in any of the locations sampled. Hence human parasite species are by and large incriminated as the probable species recovered from the insects.

The relatively high numbers of S. obvelata Rudolph and H. spumosa Cram. found in the roaches are indicative of a close association between man and house rats, in the homes and areas sampled, especially as the latter are the normal hosts of those parasites.

As for N. ovalis (Meglitsh) and G. blattarum (Sprague), these have generally been known to be specific parasites of cockroaches (Noble and Noble, 1965). Their differential rates of occurrence in relation to the habitats of the insects are nonetheless worth noting.

Whereas presence of only the cysts and the eggs respectively of Entamoeba sp. and Ascaris sp. indicate the "passive carrier" role of cockroaches in the life histories of these parasites, the finding of N. ovalis Meglitsh trophozoites and mature adults of L. appendiculata Leidy show the insects to be their normal hosts.

Regional distribution of the parasites in the gastro-intestinal tracts of the cockroaches is in conformity with the ecological preference of particular microhabitats by endoparasites, a phenomenon generally influenced by the physiological and biochemical conditions prevalent in the particular habitats, plus the presence or absence of particular organisms in the same niche (Smyth, 1971; Holmes, 1973). Hence the relatively high numbers of helminths found in the hindgut regions of the roaches may depend not only on factors of pH and redox potential, but also on the presence and activity in this region of a rich-bacterial flora, and the sizeable crop of protozoa that contribute potentially to the food of the worms.

Also Crompton (1973) had noted the existence of a posterior migrational pattern in the distribution of many helminths along the gut tracts of their hosts. This would seem to apply to a reasonable extent in the case of gastro-intestinal parasites of the cockroaches examined in this study (Table 2), especially as many of them were found in both the midgut and hindgut regions, with the bulk of them featuring in the latter region. The total absence of parasites from the fore-gut region of cockroaches is also of interest in this regard, although this may be attributed in part to the presence in the crop and fore-gut of these insects of some acid-producing anti-bacterial agents (Guthrie and Tindall 1968) that do not support the growth of micro-organisms, etc.

Proximity of the parasites to the gut endothelium of the cockroaches (especially in the case of *G. blattarum* Sprague and the nematode worms), may be related not only to their attachment and food supply, but also to their oxygen requirements; with oxygen being more readily available in the gut wall than in the lumen.

The sequential increase in the parasite loads of successive nymphal stages of the cockroaches is also of special interest, as it reflects increase in infection rates with the age and exposure of the insects.

#### Acknowledgement

We are grateful to Professor I. Okpala and Dr M. Uzoukwu, both of the University of Nigeria, Nsukka for useful suggestions and assistance during the course of this work, and to Professor J. B. E. Awachie, Head, Department of Zoology, University of Nigeria, Nsukka for the facilities made available for this study.

## References

- Baker, J. R. (1969) Parasitic Protozoa. Hutchinson & Co. Ltd. (London) 176pp.
- Busvine, J. R. (1966) Insects and Hygiene. Methuen & Co. Ltd. (London), 467pp.
- Crompton, D.W.T. (1973) The sites occupied by some parasitic helminths in the alimentary tract of vertebrates. Biol. Rev., 48: 27-83.
- Cruickshank, R. (1955) Medical Microbiology: A guide to the Laboratory Diagnosis and Control of Infection. E & S Livingstone Ltd. (Edinburgh), 1067 pp.
- Davey, T. H. and T. Wilson (1965) The Control of Disease in the Tropics (3rd ed.) H. K. Lewis & Co. (London), 432pp.
- Guthrie, D. M. and A. R. Tindall (1968) The Biology of the Cockroach. Edward Arnold Publishers Ltd. (London) 260 - 380.
- Holmes, J. C. (1973) Site selection of parasitic Helminths. Can. J. Zool., 51: 333-347
- James, M. T. and R. F. Harwood (1969) Herms' Medical Entomology. Macmillan Co. Ltd. (London), 484pp.
- Laing, F. (1948) The Cockroach. British Museum Nat. History (London), Econ. Series (No. 12), 24pp.
- Lavoipierre, M. M. and M. Lavoipierre (1966) An arthropod intermediate host of a pentastomid. Nature (London), 210: 845-846.
- Leclercq, M. (1968) Entomological Parasitology - The relations between Entomology and the Medical Sciences. Pergamon Press Ltd. (Oxford), 158pp.
- Manson-Bahr, P. Sir, (1968) Manson's Tropical Diseases: A manual of the Diseases of warm climates. Balliere Tindall & Cassel Ltd. (London), 1131pp.



Table 1 - Comparative parasite infection rates of the nymphs and adults of cockroaches (Periplaneta americana Linnaeus) collected from sewage environments in Nsukka, Nigeria.

Instars examined	No. of roaches	Mean number of parasites per cockroach								
		PROTOZOA				HELMINTHS				
		<u>Nyctotherus ovalis</u>	<u>Gregarina blattarum</u>	<u>Diplocystic schneideri</u>	<u>Lophomonas striata</u>	<u>Leidynema appendiculata</u>	<u>Heterakis spumosa</u>	<u>Syphacia obvelata</u>	<u>Enterobius sp. (eggs only)</u>	
N Y M P H S	1st instars	50	0.56	0.32	-	-	-	-	0.18	
	2nd instars	50	2.37	0.84	-	-	0.25	0.38	-	0.48
	3rd instars	50	9.20	2.76	0.73	-	0.76	0.53	-	1.32
	4th instars	50	22.78	8.76	1.54	-	1.25	0.89	1.27	2.13
Adults	100	49.51	21.01	3.58	2.14	4.94	4.62	3.17	4.5	

- Noble, E. R. and G. A. Noble (1965) Parasitology - The Biology of Animal Parasites. Lea and Febiger, (Philadelphia), 724pp.
- Roth, L. M. and E. R. Willis (1954) The Medical and Veterinary Importance of Cockroaches. Smithsonian Misc. Coll., Vol. 134, No. 10, 147pp.
- Smart, J., K. Jordan. and R. J. Whitick (1965) A handbook for the identification of Insects of Medical Importance. British Museum Nat. History (London), 303pp.
- Smyth, J. D. (1971) Some interface phenomena in parasitic protozoa and platyhelminthes. Can. J. Zool., 51: 367-377.

Table 2

Regional distribution of various parasites along the alimentary tract of adult cockroaches collected from sewage

Parasites	Mean numbers (and percentage) of parasites in different regions of the alimentary tract		
	Foregut	Midgut	Hindgut
PROTOZOA			
<u>Nyctotherus ovalis</u> Meglitsch	0.0 (0%)	11.2 (22.6%)	38.31 (77.4%)
<u>Gregarina blattarum</u> Spraque	0.0 (0%)	12.05 (57.3%)	8.96 (42.7%)
<u>Diplocystis schneideri</u> Jameson	0.0 (0%)	0.44 (12.3%)	3.14 (87.7%)
<u>Lophomonas striata</u> Macadow	0.0 (0%)	0.19 ( 8.9%)	1.95 (91.1%)
HELMINTHS			
<u>Leidynema appendiculata</u> Leidy	0.0 (0%)	0.83 (16.8%)	4.11 (83.2%)
<u>Heterakis spumosa</u> Cram	0.0 (0%)	1.1 (23.8%)	3.52 (76.2%)
<u>Syphacia obvelata</u> Rudolph	0.0 (0%)	3.09 (97.5%)	0.08 ( 2.5%)

Fig I: Parasite infection rates of Adult Cockroaches from three domestic niches.

