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Terrestrial Snail Fauna and Associated Helminth Parasites in a Tropical Semi-Urban Zone, Enugu State, Nigeria

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ABSTRACT

The productivity of snails consumed in Nigeria is affected by parasites they harbour. Some of these parasites endanger humans as well. This study was conducted to determine the terrestrial snail species and associated helminth parasites in Ugwueme agricultural zone of Enugu State, Nigeria. The snails were collected from two communities. Light and teasing methods were used for recovery of parasites from the snails. A total of 618 snails belonging to 7 species (*Achatina achatina, A. belteata, A. degneri, Limicolaria aurora, L. flammea, Lamellaxis gracilis* and *Orthalicus* sp.) were collected. *A. achatina* was the most abundant species (35.6%) while *A. degneri* was the least (1.3%). Overall, 388 snails (62.8%) were infected. *A. achatina* had the highest (76.4%) prevalence of infection; *A. degneri* had the least (37.5%). A total of 1 563 helminthes belonging to three species *Cosmocercoides* sp., *Capillaria* sp. and *Philonema* sp. were recovered. Mean intensity of *Capillaria* in *A. achatina* was 8.33 (5.00 – 12.00 [95% CI]) while *Cosmocercoides* sp. intensity in *L. gracilis* was 7.67 (6.00 – 11.00 [95% CI]). Diversity of parasite species in the snails assessed using diversity indices accorded *A. balteata* highest values for Shannon-Wiener (1.03) and Brillouin (0.90) indices with the 3 species harboured being very abundant (Reciprocal Simpson index = 2.80). A thorough understanding of the snails helminthes parasite life cycles, associated host morbidity, and direct and indirect cost of such parasitism to human is important, first for human health and welfare, secondly for sustainable snail farming, and finally for maintenance of snail biodiversity.

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GCO, CDN and FCO designed the study and wrote the article. IOA, JOO, NE and NSO conducted the field and laboratory work. IOA did statistical analysis. All the authors participated in editing and reviewing the article.

Key words
Snails, Ugwueme, Cosmocercoides sp., Capillaria sp., Philonema sp., Prevalence.

INTRODUCTION

Land snails are pulmonates and vary greatly in size. The largest species being the giant African land snail (GALS) usually referred to as Tiger snail (*Achatina achatina*) which can grow up to 30cm in length (Cobbinah *et al*., 2008; Anim *et al*., 2001). Land snails live in habitats that are often damp or wet. Many such as *Archachatina* and *Achatina* species are normally confined to humid forested areas where they occur in great numbers. Snails hibernate during dry seasons in the tropics but are usually abundant in the rainy periods when fresh vegetation is available. Many gastropods particularly aquatic species are known to serve as intermediate hosts for different parasites especially trematodes that cause diseases such as fascioliasis, schistosomiasis and paragonimiasis, in both humans and other mammals. Recent findings also show that terrestrial snails can habour parasites and may serve as reservoir hosts. Rhabditis species have been recorded to show high infectivity in different snails (Azzam, 1998; CDC, 2013a, b). Rashed (2008) reported the recovery of a new parasite metacercaria of the *Brachylaima* from the kindney of infected land snail, *Monarcha obstucta* in Egypt. A prevalence of 32% was obtained even though this snail host was considered a new host for the parasite in this country.

GALS which are known for their voracious feeding habit and wide food range are considered as important reservoir and intermediate host of parasites that can infect human (Kishinioto and Asato, 1974). They have been incriminated in transmission of the human disease, eosinophilic meningoencephalitis also known as angiostrongyltiasis which result in severe neurological disorder and can cause death of the patient. The GALS serve as the intermediate host for the causative organism *Angiostrongylus cantonesis*, a nematode commonly known as the rat lungworm. The adult worm lives in the pulmonary arteries of the definitive host usually a rodent. Land snails become infected by ingesting infected rat droppings. Different species of land snails and slugs namely *Cyclophorus* sp., *Acusta despecta, Achatina fulica*, *Satsuma mercatoria* (snails) and *Limax* sp., *Deroceras varians, Phiomycus billineatus*, (slugs) from Kadena AB Okinawa Japan were studied for parasitic infection (Asato, 1974). The result revealed a moderately to high percentage of snails harbouring the infective larvae of *A. cantosis*.

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Cyclophorus sp. being the most infected with 73% testing positive for the infective larvae of rat lungworm.

Dicrocoeliasis, a helminth disease caused by *Dicrocoelium dendriticum* and *Dicrocoelium hospes* infect bile duct of humans. The land snail *Coinella lubrica* serve as the first intermediate host for the parasite (CDC, 2013a). Even though this disease is common among ruminants, human are equally infected (El-Shiekh Mohammed and Mumery, 1990; Rack *et al*., 2004). Human infection with *Dicrocoelium* sp. occurs by accidental ingestion of infected ant, *Formica fusca* which is the secondary intermediate host. Grazing animals and human once infected serve as definitive hosts. Clinical presentations of dicrocoeliasis in human include digestive disturbances associated with bloating and diarrhoea (Rack *et al*., 2004). Enlargement of the bile duct and biliary epithelium and fibrosis of the duct surrounding tissues may occur in heavy infection. The condition may result to hepatomegaly and cirrhosis (John and William, 2006).

Despite disease causing organisms harboured by land snails, they are being consumed in many parts of the world such as the Mediterranean countries of Europe and Africa (Christie *et al*., 1982). *Achatina fulica*, the giant East African snail is sometimes canned, sliced and sold to consumers as escargot. In many parts of West Africa, *Achatina achatina* is served as a delicacy. Cameroonians particularly natives of South West region take it as a delicacy called 'nyamangoro'. Also, in Northern Morocco, small snails are eaten as snacks in spicy soup. Apart from being good sources of nutrients, snails are used for medicinal purpose in the treatment of certain ailments. In some parts of Nigeria, *Archachatina marginata* haemolymph is used for oral rehydration therapy and administered orally too for the treatment of diarrhoea and vomiting (Adekunle *et al*., 2012).

Due to the public health and nutritional importance of the snails in Nigeria and Enugu State in particular, this study was carried out to identify the edible terrestrial snail fauna of Ugwueme community in Enugu State Nigeria and their associated parasites.

MATERIALS AND METHODS

Study area

The study was carried out in Ugwueme agricultural zone which is located in Awgu Local Government Area of Enugu State, Nigeria. The zones consist of two autonomous communities, Eziobu and Agulese (Fig. 1). These communities lie within latitude 6º00' N - 6º04' N and longitude 7º12' E - 7º37'E. Eziobu lies specifically at 6.03047ºN and 7.37210ºE, and Agulese at 6.02529 ºN and 7.36506 ºE. Majority of the land mass of the area is occupied by hills; and vegetations falls within the rainforest-savanna mosaic.

Snail sample collection

The snails were collected from different quarters of the Eziobu and Agulese communities in Ugwueme agricultural zone. They were picked from different niches such as underside of logs and leaves, refuse dumpsites, buttresses of large trees and base of houses. The snails were sorted, identified and examined for endoparasites. Identification of snails was carried out using field guide to the land snail and slugs by Herbert and Kilburn (2004).

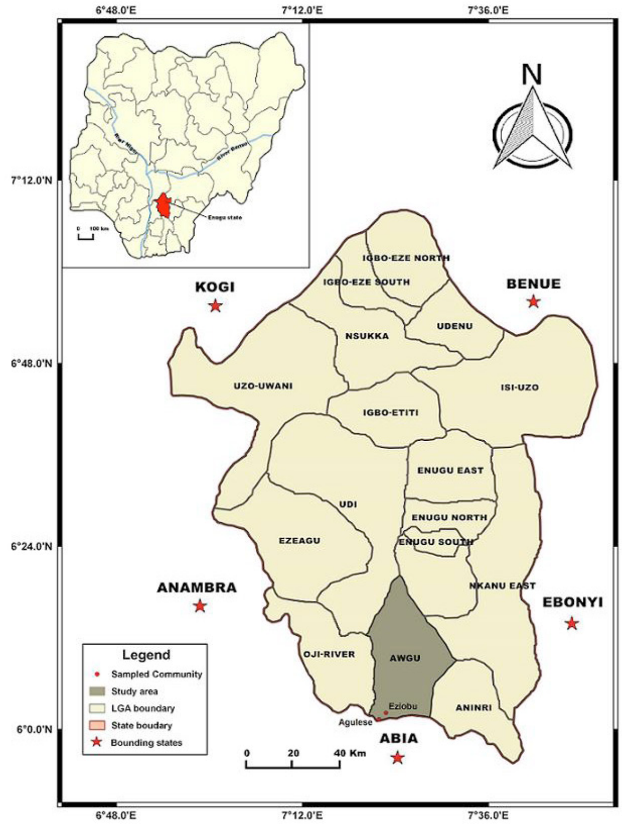

Fig. 1. Map of Enugu State showing Eziobu and Agulese communities in Awgu Local Government Area.

Recovery of endoparasitic helminths

Light and teasing methods were used to recover the helminthes. For the light method, each snail was placed in a small plate containing water exposed to electric lightening of 100 watts bulb lowered to a height of 16 cm above it for 3 h. The water from the plate was transferred to a petri dish and a drop of iodine was added. This waster was viewed with microscope in search of parasites. The teasing method involved the dissecting of the snail to expose the viscera.

The alimentary canal was cut into sections and placed in petri dishes containing normal saline. The stomach, intestine and other internal organs were cut and then teased out to isolate the helminth parasites.

Data analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 20 (IBM Corp., Amonk, New York) and Microsoft Office Excel 2007 (Microsoft Corp., Redmond, USA). Mean intensity calculations and Chi-square analysis for prevalence of infection were done in SPSS. Diversity indices and charts were done in Microsoft Office Excel 2007. Level of significance was set at $p < 0.05$.

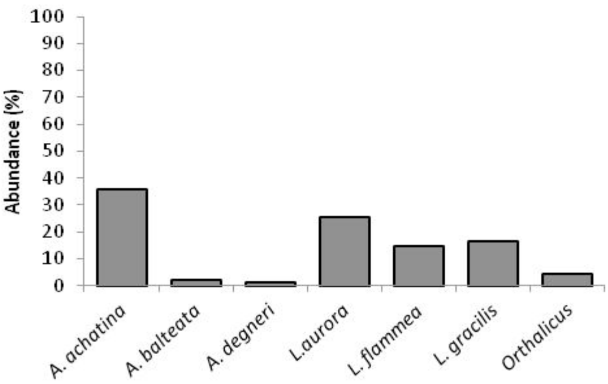

Fig. 2. Abundance of snail species in Ugwueme agricultural zone.

RESULTS

Six hundred and eighteen (618) snails belonging to four genera-*Achatina* (Lamarck 1799), *Limicolaria* (Schumacher 1817), *Lamellaxis* (Strebel and Pfeffer 1882) and *Orthalicus* (Beck 1837) were examined for helminth parasite infection. The snails were in the species *Achatina achatina* (Linnaeus 1958), *Achatina belteata* (Reeve 1849), *Achatina degneri* (Bequaert and Clench 1936), *Limicolaria aurora* (Jay 1839), *Limicolaria flammea* (Muller 1774), *Lamellaxis gracilis* (Hutton 1834) and *Orthalicus* sp. *A. achatina* (35.6%) was the most abundant in Ugwueme agricultural zone followed by *L. gracilis* (16.7%); the least abundant was *A. degneri* (1.3%) (Fig. 2). Out of the 618 snails examined, 388 (62.8%) were infected (Table I). *A. achatina* had the highest prevalence of infection (76.4%) followed by *Limicolaria flammea* (67.4%) while the least (37.1%) was observed in *Orthalicus* sp. The disparity in prevalence of infection was significant (p = 0.000).

The helminth parasites isolated from the snails were in the genera *Capillaria* (Zeder 1800), *Cosmocercoides* (Wilkie 1930) and *Philonema* (Kuitunen-Ekbaun 1933) (Table II). The highest number of parasitic helminths was recovered from *A. achatina*. The mean intensity of *Capillaria* in *A. achatina* was highest, 8.33 (5.00-12.00 (95% CI)) followed by *Cosmocercoides* sp. intensity in *L. gracilis* at 7.67 (6.00-11.00 (95% CI)). *Orthalicus* sp. harboured only *Capillaria* sp. at an intensity of 2.00 (1.60-2.40 (95% CI)). In *A. achatina* and *A. degneri, Cosmocercoides* sp. was the most prevalent (55.0% and 37.5, respectively) (Fig. 3). The prevalence of *Cappillaria* sp. in *Orthalicus* sp. was 38.8%.

Table I.- Prevalence of helminth parasites in some terrestrial snails of Ugwueme community.

Snail species	No. examined	No. infected (%)
Achatina achatina	220	168 (76.4)
Achatina belteata	12	5 (41.7)
Achatina degneri	8	3 (37.5)
Limicolaria aurora	156	99 (63.5)
Limicolaria flammea	92	62 (67.4)
Lamellaxis gracilis	103	41 (39.8)
Orthalicus sp.	27	10 (37.0)
Total	618	388 (62.8)
	$\chi^2 = 53.643$	p = 0.000

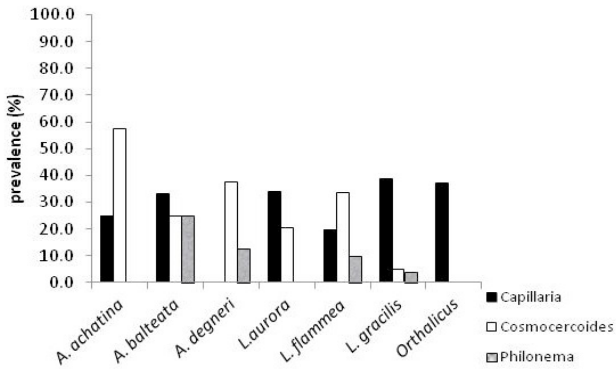

Fig. 3. Prevalence of helminth endoparasites in snail hosts.

In the land snails the diversity of parasite species assessed using diversity indices accorded *A. balteata* the highest, 1.03 (Shannon-Wiener index) and 0.90 (Brillouin index) with approximately 3 species being dominant (Reciprocal Simpson index=2.80) and a species richness of 3. *A. flammea* had the second highest parasite diversity (H=0.87) and also with a parasite richness of 3, but approximately 2 dominant species (1/D=2.24). The snail species with the most restricted parasite species infection were *L. gracilis* and *Orthalicus* sp. (H=0.00, Margalef's index=0.00, McIntosh index=0.00 and species richness=1 for both of them).

Table II.- Mean intensity of endoparasitic helminth isolated from snail hosts.

Snail species examined	Parasites species recovered	No. of parasites recovered (N = 1563)	Mean intensity	
			Mean	95% CI
Achatina achatina (n_1 = 220)	*Capillaria* sp.	413	8.33	5.00 – 12.00
	Cosmocercoides sp.	557	4.00	3.00 – 5.00
Achatina belteata (n_2 =12)	*Capillaria* sp.	13	3.67	2.00 – 5.00
	Cosmocercoides sp.	5	1.67	1.00 – 2.00
	Philonema sp.	8	2.67	2.00 – 4.00
Achatina degneri (n_3 = 8)	*Cosmocercoides* sp.	8	3.00	1.00 – 4.00
	Philonema sp.	2	2.00	-
Limicolaria aurora (n_4 = 156)	*Capillaria* sp.	82	2.33	2.00 – 3.00
	Cosmocercoides sp.	59	3.00	2.00 – 4.00
Limicolaria flammea (n_5 = 92)	*Capillaria* sp.	121	4.33	3.00 – 6.00
	Cosmocercoides sp.	135	6.00	5.00 – 7.00
	Philonema sp.	14	2.00	2.00 – 2.00
Lamellaxis gracilis (n_6 = 103)	*Capillaria* sp.	77	2.33	2.00 – 3.00
	Cosmocercoides sp.	36	7.67	6.00 – 11.00
	Philonema sp.	13	3.00	3.00 – 3.00
Orthalicus sp. (n_7 = 27)	*Capillaria* sp.	20	2.00	1.60 – 2.40

N, total number of endoparasitic helminth recovered. n_1, n_2,….n_i, number of snail species examined; CI, confidence interval.

Table III.- Diversity characteristics of parasite communities found in different species of land snails.

Diversity index	*A. achatina*	*L. aurora*	*L. gra*	*L. flam*	*Orth*	*A. deg*	*A. balt*	Total
Shannon-Wiener index (H)	0.68	0.68	0.00	0.87	0.00	0.50	1.03	0.77
Reciprocal Simpson (1/D)	1.96	1.95	1.00	2.24	1.00	1.55	2.80	2.08
Brillouin index	0.68	0.66	0.00	0.86	0.00	0.38	0.90	0.77
McIntosh index	0.29	0.31	0.00	0.35	0.00	0.26	0.46	0.31
Margalef index	0.15	0.20	0.00	0.35	0.00	0.43	0.61	0.27
Berger-Parker index of dominance	0.57	0.59	1.00	0.49	0.00	0.80	0.50	0.49
Species richness	2	2	1	3	1	2	3	
Dominant species	Cos	Cap	Cap	Cap	Cap	Cos	Cap	

L. gra, *L. gracilis*; L. flam, *L. flammea*; Orth, *Orthalicus*; A. deg, *A. degneri*; A. balt, *A. balteata; Cos, cosmocercoides* sp.; Cap, *Capillaria* sp.

DISCUSSION

Snails are common molluscs found in Nigeria. *A. achatina, L. gracilis, L. degneri, L. belteata* and *Orthalicus* sp. have been reported from different parts of Nigeria (Fashuyi and Adeoye, 1986; Gadzama, 2012; Chukwuka *et al*., 2014). The abundance and distribution of these snails are determined by factors such as food availability, weather, predation, human consumption and diseases. The tropical Guinea Savannah vegetation of Ugwueme probably favoured the wide diversity of edible terrestrial snails. Favourable weather condition especially the rainy season in Nigeria is conducive for terrestrial snail population. This is as the moist environment and associated high humidity facilitate snail proliferation (NAERLS, 1995; Martin and Sommer 2004; Sulikowska-Drozd, 2005; Nunes and Santos, 2012); this also enables the growth of rich vegetation which serves as food for them. The different species found reflect diversities in niches of snail species (El-Sorogy *et al*., 2016). Weather and human are probably acting as factors selecting against species such as *A. balteata* and *A. degneri* which were in low abundance. Also, *A. achatina, A. fulica* and *A. marginata* are widely reported as highly productive such that within a short period can displace other snail species on one hand, and in the other impose monumental economic loss to farmers when they act as pest (Raut and Barker, 2002; Ugwu *et al*., 2011; Nelson, 2012; Nyameasem and Borketey-La, 2014).

Comocercoides sp. and *Capillaria* sp. are known to infect slugs and snails, some acting as paratenic, intermediate or definitive hosts (Bolek, 1997; Grewal *et al*., 2003). Snails in the spe

cies *Agriolimax* sp., *Deroceras leave, Cepaea nemoralis* and *Cepaea hortensis* are definitive hosts to

Cosmocercoides dukae (Grewal *et al*., 2003). *Capillaria* sp. are ubiquitous parasites infecting a wide range of organisms including human. *Capillaria philippiensis* is still remembered for the devastation of Pudoc West (Cross, 1992). However, reports of *Philonema* sp. infection in snail are rare if not completely lacking. *Philonema* sp. have, however, been reported to parasitize freshwater fish (Berg *et al*., 1995). Studies on snail helminthes parasites in Nigeria have focused mainly on *Schistosoma* sp. intermediate hosts (*Bulinus* sp., and *Biomphelaria* sp., *etc*.) neglecting other parasites. The aquatic snails *Bulinus globosus, B. truncatus, B. senegalensis, B. forskalii, Biomphalaria pfeifferi, Lanistes varicus* and *Lymnaea natalensis* have been widely reported in different parts of Nigeria to host Schistosome parasites (Okafor, 1990; Okafor and Ngang, 2004, Ayanda, 2009). Reports on parasitic helminthes of terrestrial land snails in Nigeria are lacking. Studies from parts of Africa and beyond have, however, reported helminthes infection in terrestrial snails (Kishinioto and Asato, 1974; Rashed, 2008; CDC, 2013; McLaughlin, 2016).

The occurrence of *Capillaria* sp. infection in all the snail species examined except *A. degneri* highlights its ubiquitous nature. From invertebrate, through Prochordate to Chordate, all probably have their fair share of *Capillaria* sp. In fish, amphibian, reptiles, birds and mammals more than 250 *Capillaria* species have been found including four in human (Cross, 1992). Parasitism as an evolutionary adaptation imposes a restriction, tolerance, on both the host and its parasites (Miller *et al*., 2006; Mazè-Guilmo *et al*., 2014; Råberg, 2014). This disparity in biochemical and nutritional demands of parasites determines their host and localization within same. Host antagonistic response and parasites evasive adaptations are factors that also define a parasite life cycle. *Capillaria* sp. appear to be highly suited to parasitic life: well adapted to antagonistic responses of hosts and well tolerated.

The prevalence of helminth infection in *A. achatina* (76.4%), *L. aurora* (63.5%) and *L. flammea* (67.4%) and the overall prevalence of 62.8% in snails in Ugwueme agricultural zone are high. Parasitism is associated with debilities that sometimes significantly erode functions and structure of the host. Such disruption of wellbeing is associated with morbidity, low productivity, reduced growth and mortality. This reduction in wellbeing carries with it a cost for Nigerians who consume these snails as a source of protein. The high prevalence of infection may definitely result to depletion in the quality and quantity of the meat of these infected snails thereby depriving the consumers the benefits of the nutrients that healthy snails offer. This may result to protein–calorie malnutrition particularly in poor rural communities that often depend on animals from the wild as their main source of protein. This further reduces the likelihood that food sufficiency will be attained. Another aspect of the problem is where these snails are intermediate hosts to human parasites. Snails have been reported as intermediate hosts of human and livestock diseases (CDC, 2013a, b; McLaughlin, 2016). Aquatic snails are well documented as intermediate hosts of human diseases. Terrestrial snails though not as remarkable as their aquatic counterparts, transmit human diseases such as angiostrongytiasis and dicrocoeliasis. Human infections with these parasites which may be by ingestion of ova occur through improper handling of the snails when being processed for consumption.

The examined snail species haboured parasitic helminthes; a thorough understanding of these parasites life cycles, associated host morbidity, and the direct and indirect cost of such parasitism to human is important, first for human welfare, secondly for sustainable snail farming, and finally for maintenance of snail biodiversity.

Statement of conflict of interest

Authors have declared no conflict of interest.

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