Malacological Survey Of The Freshwater Systems Of Anambra River Basin Area In Anambra State, Nigeria

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Abstract

A malacological survey was undertaken in the freshwater systems within Anambra River basin from July 2000 to June 2001. Three stations were selected within which 13 sites were studied. The survey revealed the presence of a rich molluscan fauna including those endemic in the basin alone. The species collected included 5 pulmonates and 12 prosobranchs (all gastropods). Otu Idoko was identified as the habitat having the richest snail fauna while the burrow pits at Mmiata had the lowest snail population. Habitat type, rainfall and desiccation had tremendous effects on the population dynamics of snails. Thus the highest density in flowing water habitats was recorded between July and September, whereas the highest density in stagnant pools was recorded in May to June. Other factors found to impact severely on the populations of snails causing visible fluctuation in their density include: electrical conductivity, dissolved oxygen, calcium ions and pH. Three genera: *Pila, Lanistes and Bulinus* were found to contain infected species. The dominant snails found in this basin were *Pila* and *Potadoma* species. The finding of *Gabiella sp* was the most exciting find as it is very rare in Nigerian waters. The findings were used to discuss the health implications for the people living and working in the basin area.

Key words: Malacological Survey, Freshwater Systems, Anambra State

Introduction

Because of the role gastropod molluscs play in disease transmission, it is always very important to have first-hand knowledge of the species endemic in any and every freshwater system. Also important is the study of their infections and interactions that determine the distribution and abundance of the snails, and the prevalence of snail-transmitted diseases. Control of snails can only be achieved with a thorough knowledge of their biology and ecology. Against this background, many malacological surveys have been conducted worldwide, with emphasis on tropical freshwater systems because the region is endemic for many snail-borne diseases prominent of which are schistosomiasis, paragonimiasis, fascioliasis and heterophiasis.

In Nigeria, surveys of snails in fresh waters have been going on for a long time and such studies have helped to delimit the foci of transmission of these diseases of public health and veterinary importance. They include studies on such habitats like small temporary ponds, streams, rivers (Hira, 1969 ; Betterton, 1984; Ozumba et al., 1989; Okafor, 1990a; Imafidon, 1991); Large lakes (Adewunmi et al., 1990; Emejulu et al., 1992) ; quarry pits, and borrow pits (Okafor,1984; Anya and Okafor, 1986) and irrigation canals (Ndifon and Yahaya, 1990) to mention a few. In most or all of these surveys, people devote time searching for possible hosts of endemic snail-borne diseases while some also delve into the ecology of the snails including their population dynamics or the transmission potential of the snails in some habitats (Ndifon and Yahaya, 1990; and Okafor,1990b).

This study was scheduled and prosecuted in Anambra river basin covering the areas omitted by Okafor (1990a) in a similar study. The aim of the study is to provide a full checklist of gastropods and other molluscs inhabiting the freshwater system of this thickly populated agrarian part of Anambra State, Nigeria. The study serves as a baseline providing a basis for comparison of what was present before the road to Abuja was constructed and what will be found in the future. The present work is also to study the relationship of snail distribution to certain habitat factors.

Materials and Methods

The study area: The survey was done in some river systems located within Anambra River basin, in Anambra East, Oyi, and Ayamelum Local government areas of Anambra State, Nigeria. The study area enjoys tropical climate characterized by marked rainy season (from May to September) and dry season (from October to April) and a short harmattan period in January. Rainfall is heavy supporting rain forest vegetation in the area. This has been transformed into forest-Guinea Savannah Mosaic in some areas due to agricultural activities of the people.

The majority of the people living in the area are farmers and fishermen. The major crops are yam, cassava, potato, maize and rice. The predominant fish species are *Clarias* and *Tilapia spp*. Crabs and mussels (e.g. *Mutela dubio*) are also caught as part of the fisheries. The preponderance of palm trees (*Elais guineensis*) in the area makes them one of the major suppliers of palm oil, palm kernel and brooms.

The soil is chiefly made up of clay and silt and because of the heavy rains, most roads are inaccessible during the rainy season. It also makes the rivers in this area to appear muddy due to water run-offs from the surrounding banks.

Collection of snails and snail preservation: The survey was undertaken between July 2000 and June 2001 using the scoop net method of Hairston et al., (1958), and Okafor, (1984, 1990a). Fractional sampling method which involved collections of snails from a given area of habitat for specified period of time was adapted using the long handle scoop net to sweep the whole length of the chosen site for 15 minutes in each site. Thus the snails in each site were collected from a fixed area (100m^2 at 50m intervals) for a standard time (15 mins). Usually, the areas were measured with ropes and pegs.

Three stations: Umueze, Umudiora and Mmiata were chosen. 12 sampling sites namely: Ezu, Omambara, Ezichi, Okuruma, Otu idoko, Otu nkunkwu, Ojeiruagu, Azuechelue, Otu Osile, Burrow pits, ponds and seasonal pools were selected for the study.

After collection, the snails were transported to the laboratory in several bowls where they were maintained on fresh lettuce leaves. Also, the water was changed every two days to avoid accumulation of substances lethal to the snails.

Sampling for density: Density counts, which gave the number of snails per square metre, were made following the methods used by Okafor (1984). Consequently, the number of snails caught per square meter was used as an index of abundance. These values were used to calculate the diversity index.

Identification of snails: The snails were sorted out and identified using the field guide to West African freshwater snails prepared by the Danish Bilharziasis Laboratory Charlottenlund, Denmark. Prof. F. C. Okafor using his reference snail collections confirmed these identifications.

Searching for cercariae: The snails were observed for shedding of larval trematodes mainly cercariae. In the process, 300ml and 1000ml beakers filled to the halfway mark with distilled water were used. Individual snails were put in each beaker and the beaker with the snails exposed to sunlight from 9.00 am – 12.00 noon (i.e. for 3 hrs). Subsequently, they were each examined for cercaria shedding. They were also checked at night around 8.00pm for any cercaria. Droppers, slides and microscopes were used in this exercise.

Physico-chemical characteristics of the habitats: The water characteristics were assessed for each site. The methods used were those followed by Okafor (1984).
The following studies were made:

(a) Conductivity using conductivity – temperature probe
(b) Total hardness (as $CaCo_3$)
(c) Calcium ions
(d) Magnesium ions
(e) pH
(f) Depth

B-d items were determined by EDTA titration, while for e, portable pH meter was used and for f, weighted calibrated rope was used.

Result

Molluscan fauna: Most of the sites were stabilized slow flowing streams, ponds and burrow pits. These habitats have identical aquatic macrophytes, which include *Nymphaea lotus*, *Commelina* sp, *Alternetera sessilis*, etc. There were numerous other plant species, which provided attachment for snails and their eggs.

The snails collected and identified belong to 12 genera and 17 species. These were made up of

(a) The pulmonates: *Bulinus globosus*, *Bulinus truncatus*, *B.*

forskalii, Biomphalaria pfeifferi and *Lymnaea natalensis*.

(b) The Prosobranchs: *Pila wernei, Pila ovata, Lanistes libycus , Lanistes varicus, Melanoides tuberculata, Gyraulus costulatus, Potadoma moerchii, P. freethii, Bellamya unicolor, Gabiella verdicourti, Cleopatra bulimoides and Bithynia tentaculata*.

(c) Bivalve: *Mutela dubio*

All stages of snails: the juveniles, young adults, adults and egg masses at different stages of development were collected.

Trematode infections: All the snail species collected were screened for cercarial shedding and only two types of cercariae were isolated, namely gymnocephalus cercariae (from *Lymnaea, Pila and Lanistes*) and furcocercous cercariae (from *Bulinus globosus*).

Altogether, 4000 snails were collected and screened. Out of this number, only 250 (6.3%) shed cercariae. The rest 3750 (93.7%) did not shed any cercariae.

Distribution of snails: The distribution of the snails by site is presented in Table 1. The table indicates that the snail community in this river basin area is dominated by *Potadoma* spp (about 47.5%). In all the sites, pulmonate snails occurred, even though their abundance in many sites was low. Analysis of the whole collection showed a unimodality of the frequency distribution of the species and no species was found in the range 60-100%. The diversity index obtained from this collection was low (-0.670). There was also no correlation between snail abundances. However, there was a significant positive correlation between host age and diversity indices ($r=0.425$, $p<0.01$); and also between host age and number of helminth cercariae isolated ($r=0.637$, $n=380$, $p<0.01$).

Monthly collection of snails were analysed. The snails collected for each month is presented in table 2. This table shows that the number of all the species varied according to the seasons. The snail population at the various sites was low in the dry season and rose sharply during the rainy season months especially in the slow flowing streams and seasonal pools. It is note-worthy that in the river systems, snails (especially prosobranchs) were found all the year round being more abundant towards the dry season. The juveniles of all the snails predominated in October and February while the egg masses were commonly found in July and September.

Physico-chemical characteristics of the water: Various physico-chemical factors were evaluated and the results are presented in table 3. Temperature varied between 22 and 34 °C, pH varied between 4.8 and 9.0. Calcium ions varied between 0.5 and 124 mg/l, etc. Water depth varied from 13 cm to 72 cm and significantly varied with rainfall within each habitat. The electrical conductivity was generally high in the dry season months with the mean monthly value of 180 umos (highest) and 90 umos (lowest). Table 4 shows the relationship between some vital physico-chemical characteristics of the habitat and the number

Table 1: Number of snails according to species collected from the survey

Snail spp.	*Habitat*										
	Burrow pit	Pond	Burrow pit	Otu Osile	Azuechelue	Ojeiruagu	Otu Nkwunkwu	Otu Idoko	Otu Orama	Ezichi	Oma mbara
Pila wernei	2	1	7	20	40	48	63	90	17	60	75
Pila ovata	-	-	-	2	21	12	30	76	-	40	54
Lanistes varicus	-	-	-	2	3	-	-	20	15	15	18
Lanistes libycus	-	-	-	-	-	5	14	-	-	5	5
Melanoides tuberculata	15	5	4	28	52	35	76	179	10	88	100
Gyraulus costulatus	-	2	5	1	-	9	-	3	-	15	5
Bulinus forskalii	-	-	-	-	7	-	-	10	-	11	8
B. globosus	3	3	3	10	8	11	16	27	3	9	20
B. truncatus	-	-	-	-	-	14	14	10	-	11	10
Lymnaea natalensis	1	16	4	2	14	12	20	25	3	23	20
Biomphalaria pfeifferi	4	4	4	5	5	2	20	25	10	16	17
Gabiella verdicorti	-	8	3	-	-	5	8	12	-	9	6
Cleopatra bulimoides	-	-	-	-	-	-	6	5	-	13	-
Bithynia tentaculata	-	-	-	-	-	-	1	8	-	11	-
Belamya unicolor	-	15	-	-	-	5	20	25	-	15	-
Potadoma freethii	36	57	14	8	80	120	163	450	90	96	100
Potadoma moerchii	-	50	-	-	52	66	100	103	-	40	38
Total	**67**	**177**	**44**	**76**	**282**	**339**	**527**	**1135**	**148**	**441**	**576**

of snails collected. This table indicates that there is a highly significant correlation between snail numbers and the calcium ion concentrations; and a low correlation with pH in these habitats. To check for dominance among the snails collected, the snail species were ranked according to the number of individuals as percentages of the total collection. This is presented in table 5. From this table, *Potadoma* spp is the dominant genus in these habitats. The diversity indices of the various species in the habitats

Table 2: Monthly distribution of snail genera in the sampled habitats

Months	*Pila spp*	*Lanistes spp*	*Melanoides spp*	*Gyraulus sp*	*Bulinus spp*	*Biomphalaria sp*	*Potadoma spp*	*Lymnaea sp*	*Gabiella sp*	*Cleopatra sp*	*Bellam. sp*
July	236	23	139	15	47	22	413	25	8	10	10
August	121	20	100	10	31	6	216	20	6	5	10
September	93	15	88	9	25	26	318	20	8	2	20
October	67	13	75	5	30	20	186	16	5	-	40
November	51	3	45	1	15	-	90	4	-	-	10
December	17	-	-	-	3	-	55	2	-	-	5
January	-	2	10	-	3	-	26	-	-	-	5
February	2	-	2	-	3	-	8	1	-	-	-
march	-	-	5	-	3	-	4	3	-	-	-
April	-	5	28	3	10	16	107	23	3	5	-
May	32	14	52	5	38	15	265	12	9	3	-
June	81	20	76	2	18	17	132	14	12		-
Total	700	115	620	50	226	122	1820	140	51	25	100

Table 3: The various physico-chemical characteristics of the snail habitats

...tions		Mmiata			Umudiora				Umueze			
...at	Burrow-pit	Pond	Burrow-pit	Otu Osile	Azuechelue	Ojelruagu	Otu Nkwunkwu	Otu Idoko	Otu Orama	Ezichi	Omambara	Ezu
...erature	*28.5	*28	*30	*32	*27	*27.4	*32	*30	*26.5 (28-34)	*28.5 (34-32)	*30	*30
	(24-34)	(22-32)	(24-32)	(28-34)	(23-30)	(24-30)	(26-34)	(27-32)			(25-32)	(24-32;
	-	*7.8	6.8	5.5	8.1	7.2	7.5	7.8	8.0	8.0	7.4	8.1
		(4.8-8.1)	(5.7-7.2)	(5.0-6.7)	(7.5-8.4)	(6.7-7.5)	(7.0-7.8)	(7.2-8.0)	7.5-9.0	(7.8-8.9)	(7.1-7.8)	(7.8-9.C
...)	-	*4.8	4.7	4.8	8.0	7.6	7.8	8.0	7.6	8.0	7.0	8.0
...)		(2.0-5.8)	(2.0-5.8)	(2.0-12.0)	(2.0-11.6)	(2.0-11.8)	(2.0-12.0)	(2.0-11.6)	(2.0-12.0)	(2.0-12.0)	(2.0-11.0)	(2.0-12
	-	*12.7	4.4	141.5	39.3	368	78	72	[illegible]	259	168.9	200
...inity (µg/l ...)		(8.0-27.0)	(1.07-15.4)	(24-262)	(27-48.8)	(232-504)	(36-120)	(51.05-300	[illegible]	(38-342)	(163-200)	(98-54
...um (mg/l)	-	*57.4	1.8	8.0	39.1	63.0	69.5	91.5	[illegible]	70.3	48.8	28.5
		(24.8-96.8)	(0.5-4.6)	2.64-16.0	(24.4-52.8)	(4.4-87.5)	(50.5-75.3)	29.6-114.3	([illegible])	(36.0-104.6)	(18.2-123.9)	(10.7-40
...+ (mg/l)	-	*2.5	4.5	0.3	4.5	32.5	6.5	8.68	11.4	17.87	14.8	4.0
		(1.9-24.7)	(1.6-8.7)	(0.1-0.8)	(1.27-10.7)	(20.8-46.5)	(0.1-15.5)	(6.4-12.0)	(1.9-41.4)	(2.4-58.0)	(6.8-24.7)	(2.3-6.
...(mg/l)	-	*40	74.6	24	144	92.4	32	42.4	104	92.8	84	48
		(6-120)	(34-98)	(8-36)	(60-160)	(80-114)	(12-58)	(24-65)	(96-112)	(70-98)	(60-100)	(42-54
...f Snails ...cted.	67	177	44	76	282	339	527	1135	148	441	576	186

Table 4: Relationship between some of the physico-chemical characteristics of the water and snail numbers collected

Physico-chemical characteristics	Correlation coefficient	P
pH	+0.46	<0.05
Bicarbonates	+0.495	<0.05
Total alkalinity	+0.515	<0.05
Calcium ions	+0.65	<0.05

sampled are shown in table 6. The result shows that there is a high diversity of mollusca species in this river basin (H! = -0.670).

Discussion

Information about the incidence and prevalence of diseases at the population level is frequently required for benchmarking, for advocacy of particular policies, to assist in setting funding priorities, for monitoring achievements towards internationally accepted goals and targets and to guide technical strategies and responses (WHO 2002). Such I nformation comes in

Table 5: Ranking of the snail species according to abundance (using number of collection as an index)

	Ranking of species by abundance	A	B	C
1	*Potadoma spp*	1820	45.50	45.50
2	*Pila spp*	700	17.50	63.00
3	*Melanoides sp*	620	15.50	78.50
4	*Bulinus sp*	226	5.65	84.15
5	*Lymnaea sp*	140	3.50	87.65
6	*Biomphalaria sp*	122	3.05	90.70
7	*Lanistes spp*	115	2.88	93.58
8	*Bellamya sp*	100	2.5	96.08
9	*Gabiella sp*	51	1.28	97.36
10	*Gyraulus sp*	50	1.25	98.61
11	*Bithynia sp*	31	0.78	99.39
12	*Cleopatra sp*	25	0.61	100.00

A = number of individuals, B= Percentage of samples, C = Cumulative Percentage of samples

Table 6: Showing calculation of diversity index for the snail species

Species	Abundance	Pi	Pi (Ln Pi)
Potadoma spp	1820	0.46	-0.156
Pila spp	700	0.175	-0.132
Melanoides sp	620	0.155	-0.125
Bulinus spp	226	0.057	-0.07
Lymnaea sp	140	0.035	-0.051
Biomphalaria sp	122	0.0305	-0.045
Lanistes spp	115	0.0287	-0.043
Bellamya sp	100	0.025	-0.040
Gabiella sp	51	0.012	-0.022
Gyraulus sp	50	0.012	-0.022
Bithynia sp	31	0.007	-0.014
Cleopatra sp	25	0.006	-0.013
Total	4000		-0.670

Diversity index $H' = -\sum Pi\ (Ln\ Pi) = -0.670$ Note: $Pi = ni/N$; $Ln\ Pi = \log Pi$

the form of disease prevalence surveys, vector bionomics and population surveys, ecological studies, knowledge and practices of the people studied and case control studies, etc. Often, such studies rely heavily on the indigenous knowledge of the people of the area to be studied.

A disease process can be described by a number of variables such as incidence, prevalence, transmission, remission, case fatality, duration, mortality and vectors. In principle, these can all be measured in populations but with different degree of difficulty (WHO 2002). Vector biology and ecology is one area that has contributed immensely to disease control. For snail-borne diseases, malacological surveys have become mandatory even though it is often limited to given geographical areas and also limited in time. The information from such surveys is used in identifying human-snail contact points, transmission foci, and transmission season of particular disease agents. Health planning often proceeds with data from such studies. It is against this background that the relevance of this work should be viewed.

This survey shows that habitats in the Anambra river basin harbour snail intermediate hosts of schistosomiasis: *Bulinus globosus, Bulinus truncatus and Biomphalaria pfeifferi* and that the *Bulinus* shed bifid cercariae indicating that there is an on-going transmission of schistosomiasis in the area. The studies also showed that *Lymnaea natalensis* and *Lanistes* spp were shedding cercariae of different parasites, which are yet to be identified. Using experience from other studies, these parasites should be *Fasciola gigantica (Lymnaea) and Cotylophoron (Lanistes).* Other snails that may serve as intermediate hosts for various trematodes, even though they are not shedding any parasite now include: *Pila wernei, Pila ovata, Potadoma freethii, Potadoma moerchii, Melanoides tuberculata, Cleopatra bulimoides, Bellamya unicolor, Gabiella verdicourti.* It is interesting to note that this is the first record of the last three genera anywhere east of the River Niger in Nigeria and the only endemic site of note in the country for the species. These snails were indicated in the malacofauna of the freshwater systems of the Cameroon and Congo (Mandahl – Barth, 1965).

Another interesting find in the study is the collection of *Bulinus forskalii*, a snail that has been involved in a lot of controversy as to its role as an intermediate host of *Schistosoma haematobium*. It was earlier stated that its role in this respect is suspect despite the fact that it is capable of transmitting *Schistosoma bovis* and *Schistosoma haematobium*. In this study, no *Bulinus forskalii* collected was shedding any cercariae. In earlier surveys elsewhere (Okafor et al (1985) incriminated the species also in the transmission of a veterinary parasite, *Paramphistomum cervi* showing that it is an intermediate host snail one way or the other and should be considered as such.

The finding of snails in close association with macrophytes agrees with the studies of Odei (1973) and Okafor (1984). Both reported recovering snails that had attached themselves to aquatic macrophytes especially *Ceratophyllum* and recovering the eggs behind the leaves of *Lemna sp*, a situation we also observed in these habitats.

Other results of the study show the interactions of climate, physico–chemical characteristics of water and habitat types to produce seasonal fluctuations in the total populations of the fresh water snails especially the pulmonates.

For example, during the period February to April , there was a large scale increase in snail population in flowing water habitat while similar situation for stagnant water habitat was recorded in may to June(seasonal pools) and November to January (perennial habitat). According to Okafor (1990a) these differences in abundance can be attributed to speed of water flow and dilution effects of rain. These fluctuations have also been observed by Onabamiro (1972) and Hira and Muller (1966).Onabamiro (1972) suggested that the determining factor was rain fall, which was making the habitat very suitable for snail growth. Of all the physico–chemical characteristics studied, two will receive special mention for the way they operated on the snail populations. The pH seemed to affect snail distributions as no snails were collected in any site with p H less than 6.0. Malek (1958) earlier suggested that snails thrive better in pH range 6-9 and the finding here is consistent with that old result. The dissolved calcium ions from this study reveal that the habitat that supports higher abundance of snails contained higher concentrations of calcium ions. Calcium has been isolated as having an important role in the structural integrity of the shell of snails and plays vital physiological roles in snail establishment in nature (Okafor 1984).

The Anambra river basin therefore can be considered to have a rich fauna of fresh water snails including those that have the potential to transmit schistosomiasis , paragonimiasis ,and fascioliasis e.t.c' so care must be applied in the area in any road or agricultural project that may increase the habitats of these snails. The potential health implications of endemic genera (*Cleopatra* , *Bellamya and Gabiella*) need serious investigation to know the role they are playing in the public health of the adjoining communities. An important development in this area is that a road had been built running through the basin area to Abuja the federal capital. This means that this area which was hither to inaccessible is now opened up. So many possibilities follow this development in the light of the finding from this study. One of these is the export of endemic snail borne diseases like schistosomiasis from this area to other areas. The other is the importation of other trematode diseases whose snail hosts are abundant in the basin area. These possibilities should worry the public health policy makers in this area, so vigilance and monitoring machineries should be set up to keep the situation as stable as possible.

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