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Observation on bionomics, prevalence and survival value of geohelminth in the rural communities of Rivers state

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Abstract

A study was conducted to observe on the bionomics, prevalence and survivability of geohelminths in six communities of Rivers State, Nigeria, between February and May 2018. 1,000 soil samples were taken at different locations in the study areas of Rumuewhor, Ubimini, Ulakwo 1, Ulakwo 11, Elibrada and Okomoko. The parasitological technique used in examination of the soil samples, was centrifugal floatation method. Soil physic-chemical parameters of the soil were also determined to ascertain parasite survivability. Results revealed that geohelminths are prevalent in the study sites and higher contamination of 22 (10.6%) was observed in Rumuewhor community, followed by Ubimini 18 (8.7%), and Ulakwo 11 recorded the least contamination of 11(3.0%). Among the parasite recovered, *Ascaris lumbricoides* was most frequently observed followed by Hookworm while *Enterobius vermicularis* and *Strongyloides stercoralis* were less observed. However, statistical analysis shows prevalence of parasites was statistically significant ($p < 0.005$). It was found that loamy soil had the highest proportion of parasites followed by clayey soil, while sandy soil recorded the least parasite prevalence. The soil physic-chemical parameters such as adequate soil moisture, moderate acidicity of the soil, acceptable content percentage organic matters, and optimum temperature of the soil indicates suitability of the soil to parasite survivability and embryonation with the contaminated foci. To control geohelminths prevalence to the bearest minimum, there is need for intense public enlightment to stop indiscriminate or open defecation system as this has contributed to soil contamination.

Keywords: *Geohelminth, Bionomics, Prevalence, Survivability*

1. Introduction

Parasitic infection among world of infections has a great impact on humans, resulting to morbidity and mortality amongst world populations (Odikamnoro *et al*., 2013). Their emergence and reemergence in the tropical region, sub-tropical, Asia, and North America and other developing countries has been a great concern, as it affect the health, wealth and welfare of human populations. Approximately 1.5 billon people or 24% of

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the world's population are infected. And Disability Adjusted Life Years (DALYs) estimated in 2012, a total loss of 3.8 million years due to infection with nematode parasites globally (WHO / UNICEF, 2011; and Hotez, 2008). Amongst the underdeveloped countries of the world, many personal hygiene and human behavioral dispositions regarding to pattern of sanitation and climatic environmental factors have been shown to greatly influence the prevalence of these infections (World Health Organization, 2011). The climatic condition within the tropical areas and sub-tropical is pattern in a way that supports development, survivability and transmission of parasites within foci (Uga *et al*., 1995; and Chinwe et al., 2016).

These infections with geohelminths are caused by different species of parasitic worms, and they are been transmitted by eggs present in human faeces, which contaminate the soil in areas where is poor sanitation (Ejima and Ajogun, 2011; Nwaizugbo and Ajero, 2007; and Hassan *et al*., 2017). Subsequently, prevalence of intestinal parasite species in a population is an indicator of the level of development of an area, in terms of good health care facilities, adequate provision of water, and maintenance of good hygiene standard, together with awareness of parasitic infections (Damen *et al*., 2010; Taiwo *et al*. 2016; and Uga *et al*., 1995). Infections with geohelminth parasites amongst tropical neglected diseases (NTDs) are second leading cause of mortality amongst children, and especially pregnant adult. Infections with these parasites impair the nutritional status of the infected person. The worm feed on host tissues, including blood, which leads to loss of iron and protein, Hookworms and roundworm may possibly compete for vitamin A in the intestine, and may also cause loss of appetite and, therefore, a reduction of nutritional intake and physical fitness. In particular *Trichuris trichiura* can cause diarrhea and dysentery (WHO / UNICEF, 2011). The eggs are swallowed as a result of ingestion of soil or contact with contaminated inanimate objects.

These nematode parasites, also known as Soil Transmitted Helminths (STHs) parasites, have an essential phase of their sexual life in the soil. Humans are the reservoir of these infections which is been spread by faecal pollution of the soil and most infections with these parasites occurs through the oral route (9A). There is no direct person to person transmission, or contamination from fresh faeces, because eggs passed in faeces need about three weeks to mature in the soil before they become infective. Precisely, these co-infecting parasites; *Ascaris lumbricoides, Trichuris triciura* and species of Hookworm do not multiply or self-replicate in their host. This is because intestinal nematode parasites have a direct life cycle; re-infection occurs only as a result of host exposure to the parasites in their infective larvae stages (Amadi *et al*., 2010). According to Hassan *et al*. (2017) and Brooker *et al*. (2006) several environmental and socioeconomic agents have aided in the distribution and acquisition of the parasitic infections and incidence and prevalence may be higher in some areas depending on prevailing conditions. Thus, development, survival and transmission are dependent on bionomics of the parasites and the physico-chemical parameters of the environment. The prevalence of parasitic infections, result from environmental pollution arising from indiscriminate dumping of human and animal waste and use of dungs for fertilizer, which is chief source of human infection with these geohleminths parasite (Ejima and Ajogun, 2011; and Nwoke *et al*., 2013).

In Nigeria, the importance of human environment in the transmission maintenance of the endemic status of the infections has been intensively studied, and proven that environmental intervention and sanitation remains the hallmark of soil-transmitted helminthes control and prevention (Nwaizugbo and Ajero, 2007; and Amadi and Uttah, 2010). Infection with these parasites is purely an ecological relationship because the host and environmental factors determines the parasites chances of development, survivability and transmission. For proper control of infections with these nematode parasite, there is, therefore need for continuous scanning and monitoring of the distribution, and spread of this infection in our local areas.

2. Materials and methods

2.1. Study area

The study was conducted in six communities of Rivers state, which comprises three in Etch Local Government Area and three in Emohua Local Government Area. The stations are located in (Figure 1). These study stations lies within the tropical rainforest zone of Africa and the climate is characterized with dry and wet seasons. Vegetation type is evergreen and could be up to 60 mm in height with broad leaves. Annual rainfall is over 2000 mm throughout the year. Average temperature of the area is between 22°C-29°C in Emohua Local Government Area and 22°C -28°C in Etch Local Government Area. These areas are upland Rivers State, exhibiting commonly behavioral habits and sharing similar occupation. Over time, there has been neglect of Mass

Administration of Antihelminth Drugs (MAADs). Sanitation facilities were grossly inadequate especially in the school and probably at homes. Indiscriminate disposed faeces were commonly spotted and good hygiene practices are not common amongst the children. Thus, these conditions were noted as predisposing factors to much parasitic infections.

2.2. Ethical approval for the study

Prior to sampling, approval to carry out the study in the areas were sought from school headmasters, headmistresses, and principles of secondary schools. Assent was also obtained from the model primary health care center officers, to lead in order to take soil samples from surroundings of families. As relevance of the study, especially personal and public health significance was communicated to them.

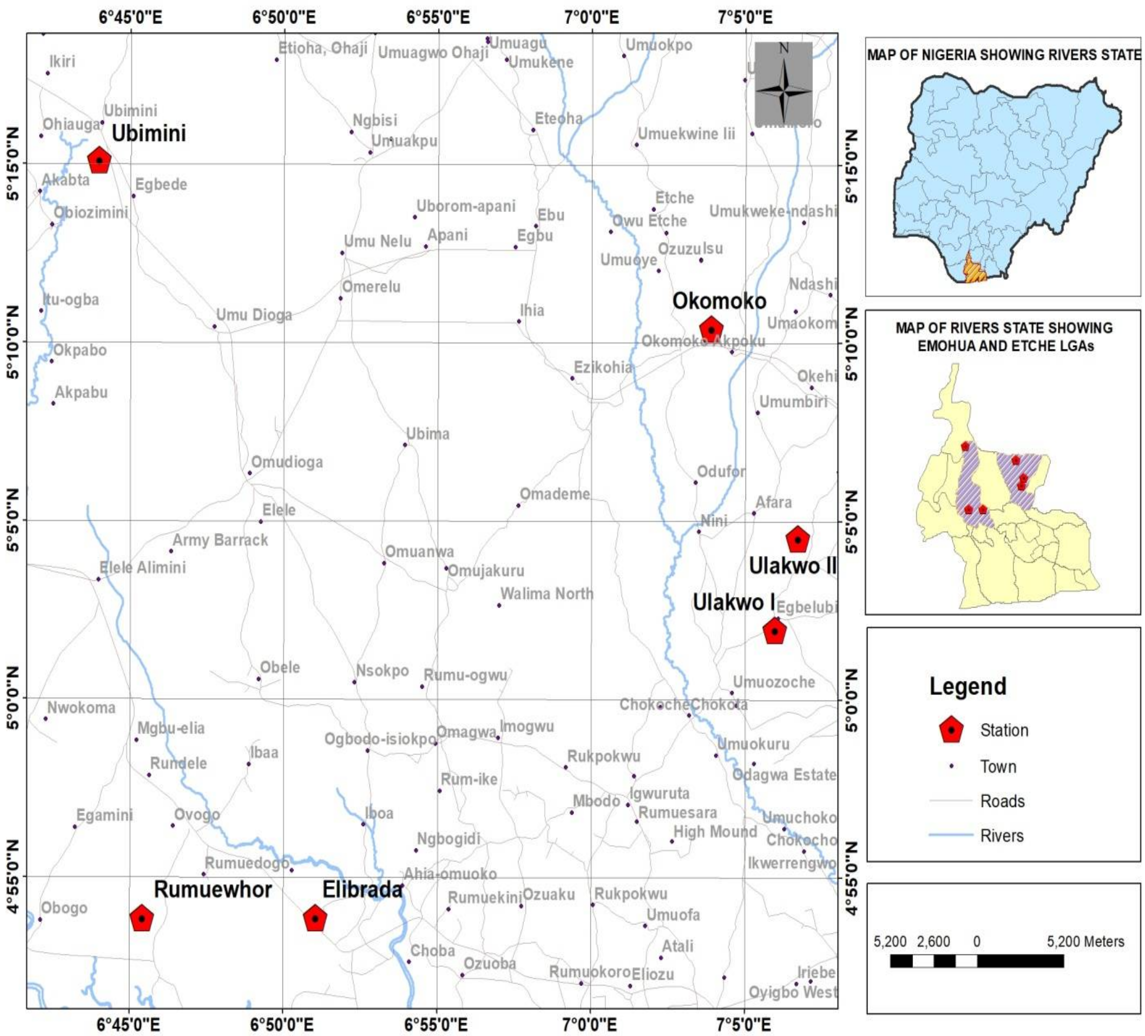

Figure 1: Map of the study areas

2.3. Sample collection

Soil samples were collected in the morning from 7.00 am till 11.00 am, when humidity was favorable with soil full of moisture, promising an enabling environment to sustain ova and larvae of parasites. During sampling, a hand trowel was used to collect 2-3 cm topsoil. Temperature *in situ* was taken using thermometer at the point of soil collection. Samples were taken around homes, gardens, school premises and play grounds where economic trees such as *udara*, plantain, mango, guava, are planted. Collected soil samples were kept in a sterile polythene bags and 10% formalin was added to preserve the soil samples. Samples were labeled accordingly and taken to the laboratory and allowed to dry under room temperature before further analysis.

2.4. Sampling protocol

2.4.1. Sampling techniques

A total of 1,000 soil samples were collected in different locations from all the study areas between the month of February and May 2018. Out of which 500 samples were taken from Etch Local Government Area and 500 samples from Emohua Local Government Area. The parasitological technique used in examination of the soil samples was centrifugal floatation method. The soil samples taken were filtered using fine sieve of 212 μm diameter pore in order to remove larger particles and allow small size particles to pass. From the sieve portion, 2 g of soil was weighted out and then placed into10 ml test-tube, 3 ml of sodium hypo-chloride (NaOCl) solution was added and shaken intermittently for 10 min. After shaken, 5 ml of Conc. saccharine solution were added to the sample already containing 3 ml of NaOCl and samples were thoroughly shaken and centrifuge at 1,500 rpm for 15 min. After centrifuging, the samples were added more of the Conc. Saccharine solution to fill to brime, to float the helminths. After which the samples were then covered with a slip and allow standing for 15 min. Afterward the cover slip was carefully removed from the top of the test-tube and placed on a microscopic slide. The slide was then examined microscopically for the presence of parasites using ×10 and ×40 objectives.

2.4.2. Soil examination for physico-chemical parameter

Soil physic-chemical parameters of the collected soil samples from the study areas were assessed, thus; Temperature in *situ* with thermometer at the sites during sample collection was taken by inserting the thermometer into the soil and reading taken at the spot. Soil texture which is particle size analysis of soil involving separation of soil particles into various sizes, using hydrometer method based on gravitational sedimentation as governed by Stroke law (Rowell, 1994), which certain amount of sample from a known depth was observed. Soil pH was measured, using a reference electrode of corning pH meter**.** The electrode was inserted into a buffer solutions having pH value close to the expected of the soil, meter needle was adjusted to read. Meter was then inserted into the top of the moist soil surface and knob was switched on for 30 min and values of the readings were taken.

Determination of soil % organic matters, as modified by Bouyoucos (1962). Concentrated sulphuric acid was added to a representative sample of finely ground soil and mixed with aqueous potassium dichromate. The heat caused by mixing sulphuric acid and water raised the temperature of the soil sufficiently to induce very substantial oxidation of the organic matter within a given time. After 10-20 min, the residual potassium dichromate was titrated against standard ammonium ferrous sulphate solution and readings were taken. Soil moisture was also determined by weighing the empty crucible in the weighing balance, and a representative wet soil sample was put in the crucible and content recorded. The crucible and the sample were put into the oven for about 15 min at certain temperature. After which the dried sample was allowed to cool, then weight. Moisture was obtained by calculation.

3. Statistical analysis

The results obtained from the samples were entered and analyzed using descriptive statistics, such as percentages and results were presented as tables. Chi-square (χ^2) calculation was also used to analyze the result obtained and to test for significance differences.

4. Results

The result of the study shows that geohelminths are prevalent in Etche and Emohua Local Government Area of Rivers State. In the different study stations, which are Rumuewhor, Elibrada, Ubimini, Okomoko, Ulakwo 1 and Ulakwo 11, (Table 1) shows that higher contamination of 22(10.6%) was recorded in Rumuewhor, 18(8.7%) was recorded in Ubimini, 17(6.5%) was recorded in Okomoko, 15(5.8%) recorded in Ulakwo 1, 12(4.3%) recorded in Ulakwo 11 and 11(3.0%) was recorded in Elibrada.

The contamination of the soil, showed most frequently observed parasite species was *Ascaris lumbricoide* 48(11.3%), followed by Hookworm 25(8.0%), *Trichuris trichiura* 14(6.5%), *Strongloides stercoralis* and *Enterobius vermicularis* recorded the least prevalence of 4(2.0%) and 4(2.1%) respectively. However, statistics show, variation in prevalence of parasites is statistically significant ($p < 0.005$). See Table 1. In the study sites, observed parasite species *Ascaris lumbricoides, Trichuris trichiura* and Hookworm were found in all the foci, while *Strongloides stercoralis* was limited to Okomoko, Elibrada and Rumuewhor. *Enterobius vermicularis* was also limited to Elibrada, Ubimini and Okomoko.

Table 1: Isolated parasites from the soil samples in the soil areas						
Study areas	***Ascaris lumbricoides***	***Trichuris trichiura***	**Hookworm**	***Strongloides stercoralis***	***Enterobius vermicularis***	**Total**
Rumuewhor	8	4	8	2	-	22 (10.6%)
Elibrada	6	1	2	1	1	11(3.0%)
Ubimini	10	2	5	-	1	18(8.7%)
Okomoko	7	3	4	1	2	17(6.5%)
Ulakwo 1	7	3	2	-	-	12(4.3%)
Ulakwo 11	10	1	4	-	-	15(5.8%)
Total	**48(11.3%)**	**14(6.5%)**	**25(8.0%)**	**4(2.0%)**	**4(2.1%)**	**95(45.0%)**

Distribution of helminthes parasites based on soil texture in (Table 2), shows higher contamination occurs in loamy soil 38(23.5%), moderate contamination occurs in clayey 30(18.7%) while sandy soil recorded the least contamination of 27(15.9%). However, statistical analysis shows no significant difference (*p*-value (0.989) > 5%).

Table 2: Helminthes parasite distribution based on soil texture				
Parasites species	**Textural distribution of helminths distribution of helminthes**			**Frequency (%)**
	Sandy soil	**Clay soil**	**Loamy soil**	
Ascaris lumbricoides	16	12	20	48(30.2%)
Trichuris trichiura	3	4	7	14(10.0%)
Hookworm	5	11	9	25(16.0%)
Strongloides stercoralis	1	2	1	4(3.1%)
Enterobius vermicularis	2	1	1	4(3.1%)
Total	**27(15.9%)**	**30(18.7%)**	**38(23.5%)**	**95(48.0%)**

Soil physic-chemical parameters examined during the sampling period shows, soil type in Rumuewhor = clayey loamy, temperature in situ was 26^{o}C, soil pH was 5.8, soil moisture = 80%, and soil % organic matter = 2.13. In Elibrada, temperature in situ = 25-26^{o}C, soil moisture = 80%, soil % organic matter =2.33, soil pH = 6.0 and soil type = clayey loamy. In Ubimini study station, soil type =sandy loamy, % organic matter from the soil was 2.15, soil pH = 6.5, soil temperature = 26^{o}C and soil moisture content = 80%. In Okomoko, Ulakwo 1 and Ulakwo 11, soil textural class of the study stations were sandy loamy, soil, moisture content =80%, temperature in situ = 26^{o}C for Ulakwo 1 and Okomoko while Ulakwo 11 recorded 27^{o}C. % organic matter of the soil within the study sites shows Ulakwo 11 recorded 5.30 while 3.28 were recorded for Okomoko and Ulakwo 1. See Table 3. Analysis of relationship between the three classes of soil samples screened from the study site shows loamy soil is positively correlated with clayey soil with correlated coefficient of 0.978; sandy soil is significantly correlated with loamy soil with correlated coefficient of 0.954. Result further indicating that clayey is significantly correlated with sandy with correlated coefficient of 0.995. However, Statistical analysis shows there was a significant relationship between clayey, sandy and loamy soil (*p*- value = 0.00, < 0.5). see Table 4.

Table 3: Soil physic-chemical parameters analysis of soil in the study areas						
Parameters	**RUM**	**ELI**	**UBI**	**OKO**	**ULA 1**	**ULA 11**
Soil type	**Clay loamy**	**Clay loamy**	**Sandy loamy**	**Sandy loamy**	**Sandy loamy**	**Sandy loamy**
Soil temperature (ºC)	26	25-26	26	26	26	27
Soil pH	5.8	6.0	6.5	5.9	6.8	6.10
Soil moisture (%)	80	80	80	80	80	80
% Organic matter	2.13	2.33	2.13	3.28	3.28	3.30

Note: RUM = Rumuewhor; ELI = Elibrada; UBI = Ubimini; OKO = Okomoko; ULA 1 = Ulakwo 1; and ULA 2 = Ulakwo 2.

Table 4: Physic-chemical correlation analysis of contaminated soil textural class					
Variables	**df**	**r**	***p*-value**	**Significant level**	**Decision**
Clayey vs. sandy	15	0.995	0.00	0.05	*p*-value <0.05
Clayey vs. loamy	15	0.978	0.00	0.05	*p*-value <0.05
Sandy vs. loamy	15	0.954	0.00	0.05	*p*-value <0.05

5. Discussion

It is obvious from the findings of this survey that geohelminths parasites are prevalent in all the study stations, and this can contribute to constitute a major public health challenges amongst the people of the study areas. The prevalence of these parasites in the soil is also an indication of great epidemiological significance. It shows poor sanitary behavior leading to contamination of soil. The result obtained established that people of the study sites are at risk of contacting the infection with poor behavioral life style. This is consistent with (Simon-Oke *et al*., 2014), the prevalence of infection in studied areas can be considered as a result of community life style. Kelechi *et al*. (2015) stated that poor sanitary behavior contaminate, the soil environment with human intestinal parasites, reflecting also the poor socioeconomic status of the study subjects leading to this behavioral practices, thus prevalence further indicating the significance of a high public health hazards amongst the population residing in these endemic areas and the country at large. From the result, *Ascaris lumbricoides* was the most frequently observed parasite in the study. This corroborates findings of other studies in Nigeria (Nwoke *et al*., 2013; and Asaolu and Ofoezie, 2003). The *Ascaris lumbricoides* abundance in soil is related to the chemical analyses of the soil together with favorable ecological conditions. It could also be attributed to the dry season, within the period when this study was carried out. Optimum temperature aided with moisture of the soil, account on the development and survival of egg, although ascaris has the tendency to withstand higher temperature due to the presence of tough integument. Ascaris abundance could be as a result of the longevity ova. Their tendency to survive up to six years in the soil under favorable ecological conditions further explains their resistant nature to harsh environmental conditions (Onyido *et al*., 2017; and Pullan and Brooker, 2012). The persistence of ascaris egg in the soil could also be an indication of soil humification within the contaminated foci. The survival of the egg is made possible by the partial decomposition of plant or animal matter which forms organic portion of the foci making the soil suitable for the parasite survival (Amadi and Uttah, 2010). Thus, these explain the higher prevalence observed. Hookworm showed second most observed parasite in the study foci. Larvae survival could be linked with favorable ecological conditions such as in the contaminated foci. Larvae development depends upon warm temperature and adequate moisture and shade from the environment (Sam-Wobo *et al*., 2012). The presence of economic trees such as plantains, guava, mango, udara, etc., provides cover for conducive environment for development and survival of the larvae. The ecological conditions within the contaminated foci favors larvae of hookworm and *Strongloides stercoralis* that enables them remain quiescent in the moisture films of the contaminated soil (Nwoke *et al*., 2013; Chinwe *et al*., 2016; and Onyido *et al*., 2017). Soil Physico-chemical parameters are significant in survival and development of parasites. The soil physic-chemical parameters provide conditions under which development to the infective stage of parasites can take place. Soil Temperature, moisture, % organic matter, and soil pH determines the extent of parasite survival in the soil. Soil texture also determines parasite survival and migration of larval stages of the parasites.

The chemical analysis of the contaminated soil in all the study area of Rumuewhor, Elibrada, Ubimini, Ulakwo 1, Okomoko, and Ulakwo 1, shows optimum temperature of 26-27^{o}C, soil pH showed 6.0-6.10 indicating acidic nature of the soil. Moisture content of soil showed acceptable moderate range of 80%. The % organic matter shows 2.13-3.28 value in the contaminated foci indicating soil humification. Above all soil type shows clay loamy in both Rumuewhor and Elibrada, while Ubimini, Okomoko, Ulakwo 1 and Ulakwo 11, soil type shows sandy loamy accounting on *Ascaris lumbricoides* aboundance as eggs develop best in less permeable clayey soils with survivability increasing with soil depth. Accepetable moderate range of soil moisture, non-adhesive sandy loamy soil and soil humification, promotes hookworm egg hatching, their larval development and survival in the contaminated foci. Soil pH within the study sites shows acidification. Acidic soil harbors microorganism which larvae feeds on within their free-living stage, also accounting on the prevalence of Hookworm species.

6. Conclusion

The study revealed that geohelminths parasitic infections are prevalent in rural areas and prominently detected parasites were *ascaris lumbricoides* and Hookworm. And the role of soil as reservoir in maintaining the transmission cycle of the parasites cannot be overstated. The soil provides conditions under which development and survival to the infective stage can take place, it gives further protection for the infective stages of the parasite for a period, during which it may be brought into contact with a susceptible human host. This therefore, implies that soil contamination seems to be the most direct indicators of human intestinal parasitic infection amongst study populace.

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