JASEM ISSN 1119-8362

Full-text Available Online at www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *December*, 2010
Vol. 14 (4) 117 - 121

Impact of Physico-Chemical Factors of Contaminated Foci on the Survival of Geohelminths in Abua Communities, Niger Delta Nigeria

*[1]AMADI, E C; [2]UTTAH, E C

[1]*Faculty of Science, Department of Applied and Environmental Biology (Parasitology unit), Rivers State University of Science and Technology, PMB 5080, Nkpolu, Port Harcourt, Nigeria*

[2]*Faculty of Science, Department of Biological Sciences, Cross River State University Of Technology, Calabar Nigeria*

ABSTRACT: Physio-chemical analysis of 200 soil samples collected from contaminated foci was investigated in six communities of Abua, Niger Delta Nigeria. The Jackson's method was used in the chemical analysis of contaminated soils while Cobb's decanting and sieving method was used in the extraction of geohelminths. The data showed that temperature, pH, Calcium (Ca^{2+}), magnesium (mg^{2+}), potassium (k^{+}) ions and electrical conductivity had much effect on the survival of eggs and larval development of geohelminths. It was also observed that the nature of the soil in the study communities was clay-loam and sandy-loamy. The continuous deposition of human faeces in these contaminated foci should be discouraged. This can be achieved by the construction of toilet facilities of whatever description in the study area by the government. @JASEM

Geohelminths are soil-transmitted parasitic nematodes with lifecycle that involves no intermediate host or vector and are among the most prevalent of chronic human infections worldwide (Ndenecho, et al, 2002). Recent estimates suggest that *A. lumbricoides* infects over one billion people, *T. trichiura* 79 millions and hookworm (*A. duodenale* and *N. americanus*), 740 million people (WHO, 2008). Geohelminth infections are most prevalent in tropical and sub-tropical regions of the developing world, where adequate water and sanitation are lacking (de Silva et al, 2003). To understand and ultimately predict, the global distribution of geohelminths, it is essential to understand their biology, ecology and transmission dynamics. The dynamic process involved in geohelminth transmission, such as free-living stages and survival depend on the prevailing conditions, therefore, free-living infective stages present in the environment develop and die at temperature – dependent rates (Anderson, 1982). Experimental studies suggest that the maximum temperature for the development of *A. lumbricoides* and *Trichuris trichiura* is between 5^0C – 38^0C (Bear, 1976), while the development of hookworm larvae ceases at 40^0C (Udonsi and Atata, 1987, Smith and Schad, 1990). It is suggested that *A. lumbricoides* eggs are more resistant to extreme temperature than *Trichuris* eggs (Bundy and Cooper, 1989). Further, soil moisture and relative atmospheric humidity also are known to influence the development and survival of eggs and larvae and higher humidity is associated with faster development of ova and at low humidity (<50%), the ova of *A. lumbricoides* and *Trichuris* do not embryonate (Otto, 1929). Field studies show that the abundance of hookworm larvae is related to the atmospheric humidity (Nwosu and Anya, 1980, Udonsi, et al, 1980). It is important to note, that none of the above studies were conducted in the Niger Delta of Nigeria, therefore, the present study is aimed at determining the impacts of physical and various chemical factors of contaminated foci (soils) on the survival and infectivity of geohelminth eggs and larvae in the study communities.

MATERIALS AND METHODS

Study Area and Population: The study was conducted in six communities of Abua, Niger Delta, Nigeria. Abua is located at 4.45^0 – 4.45^0 North of the equator and 6.30 – 6.43^0 East of Greenwich and has a mainland that extends from the borders of Orasi river in the East to sombrero in the West, North and South. The area is a lowly region with many complicated system of natural water channels, which arise from below 45m along the eastern boundary to above 48m in the northern limit. Apart from the northern boundary, the inhabited area would have been an Island. Based on 2003 census, the area has a population of over hundred thousand with an area exceeding 320.45sqkm, therefore, its population density is 78 per sqkm. There are many creeks and ox-bow lakes which find its way into the main rivers. The area is made up of two vegetational belts – mangrove and freshwater swamps in the eastern parts of the area. The drainage system is poor due to numerous water channels particularly during the wet season, when many of the creeks and lakes overflow their banks. The rainfall pattern is between 200mm – 300mm. The annual rainfall has its peak in July, a short-break occurs and in the month of September, the rain comes again which declines between October and November each year. The average temperature of the area is 29^0C during rainy season and 32^0C in dry season (December – April). Many economic trees are found in the forest which include – mahogany, iroko,

E-mail: amadichiec@yahoo.com

raffia, oil palm etc. The main occupation of the area is farming at subsistent level, fishing and trading.

Ethical Clearance for the Study: Consent was obtained from the community heads to conduct the study after a bottle of wine was presented as custom demands. During routine visits to the community heads, the relevance of the study was explained to them and they inturn explained to their subjects. It is regrettable that some villagers were angry, alledging that the contaminated soil samples were to be used for rituals. Surprisingly, one woman opted to tell her husband, who later came to the site and the aim of the study was explained to him and that the study was permitted by the community heads.

Collection of Soils from Contaminated Foci: In the six villages studied, there are communal defaecation spots where males and females (young and adult) inhabitants pass out faeces. The villages are Owerewere, Amnigboko, Egunighan, Emesu, Obrany and Okoboh. These contaminated sites have been used for many years without changing the sites. The sites have many economic trees that form canopy, leading to humid environment. Samples collection started in the morning from 6am – 12 noon when the larvae and eggs of geohelminths are still alive and fresh. A quadrat was thrown at random on the stooling sites and shovel was used to collect 15cm topsoil from each quadrat area. The soil samples collected was kept in black polythene bag and taken back to the laboratory for analyses. The random collection of contaminated soils occurred at five different sites from each of the study communities.

Physico-Chemical Examination of Contaminated Soils: Some physico-chemical parameters of contaminated soil in the study area were assessed. They include the following:

Temperature: The temperature of the soils when tested with thermometer during sample collection was averagely 28^0C at Owerewere, Amnigboko 24^0C, while Egunighan, Emesu, Obrany and Okoboh have temperatures ranging between 21^0C – 22^0C.

Measurement of Soil pH: The reference electrode of the corning pH metre was inserted into the top 1cm of the moist soil surface. The knob of the pH metre was switched on for about 30 seconds and the value of pH metre was recorded. Later, the reference electrode was rinsed with distilled water taken to the site from the laboratory between each soil sample reading. After the reading, the knob of the pH metre was switched off. The pH of the soils were moderately acid with pH = 6.0.

Determination of Organic Matter in the Contaminated Foci: The organic matter (carbon) was determined by wet as modified by Jackson (1964). Concentrated sulphuric acid was added to a finely ground soil collected from the contaminated foci and aqueous potassium dichromate. The heat caused by mixing sulphuric acid and water raised the temperature of the contaminated soil sufficiently to induce very substantial oxidation of the organic matter within a given time. After 10-20 mins, the residual potassium dichromate was titrated against standard ammonium ferrous sulphate solution and readings or values were obtained. The organic carbon was 3.07.

Determination of Total Nitrogen / Nitrate in the Contaminated Soils: The method adopted was Bremner (1965b). This involves a pre-treatment of soil samples collected from the contaminated foci with acidified permanganate to oxidize nitrite to nitrate and with reduced iron and sulphuric acid, the nitrate was reduced to ammonium. A Kjeldahl digestion was then used to convert all organic nitrogen to ammonium form. The ammonia that evolved by the dilution of 40% sodium hydroxide (NaOH) was steam-distilled, using a quickfit steam distillation apparatus with 100ul sample flask into a Boric acid indicator. Cross-contamination was avoided by distilling 15ml of 95% ethanol after each steam distillation to flush the distillation head and condenser. The total value of nitrogen did not exceed 0.35. Also, potassium (k+), magnesium (mg^2+), calcium (Ca^{2+}) ions were analysed using the same method.

Determination of Electrical Conductivity of Contaminated Foci: About $10cm^2$ of air-dry soil collected from contaminated foci was measured and placed into a beaker. 20mls of distilled water was added into the beaker. The beaker was stirred thoroughly and the suspension allowed to settle for at least 30mins or long enough for the solids to settle. The supernant was drawn into a conductivity pipette to slightly above the constricted part of the pipette or the electrode was immersed into the pipette in the beaker and the reading was taken with a conductivity metre or alternatively, pH metre was used in the determination of electrical conductivity of the contaminated soils.

Examination of Contaminated Soil Samples for Eggs and Larvae of Geohelminths: The method adopted in the extraction of geohelminth eggs and larvae was Cobb's decanting and sieving method (Cobb's 1998). This method requires three buckets (white plastic bucket preferably) and three series of sieves of

1000µm, 212µm and 63µm. The contaminated soil samples taken back to the laboratory were turned into a white plastic bucket and water was added to it, so that it can mix properly when stirred. The mixture was filtered through 1000 µm aperture into the second bucket, leaving behind heavy soil particles which settled on the top of the sieve, while the filtrate was collected in another bucket which inturn will be turned into the third bucket through the 212 µm sieve. The heavier soils that cannot pass through the sieve was taken as residue and was put into a value and eosin was added to stain the soil. The filtrate of the second sieve was turned into the third sieve of 63 µm. The filtrate of this sieve was left overnight so that the water can settle down until next day, excess water was decanted while the residue was put into a value and preserved overnight with eosin. Later, eosin was washed off from the soil samples. The eggs and larvae sorted out were placed into a container where 10% formalin was added to allow for proper identification.

Identification of Eggs and Larvae of Geohelminths: The identification of eggs and larvae of geohelminths was based on Cheesbrough, (1992). The eggs of *T. trichiura* are barrel-shaped with mucous plug at each pole and measure 50-53µm by 22-23µm in size. The eggs of *Ascaris* are oval or rounded with warty appearance. Larvae of hookworm are not flattened but posses pointed tail (J_3 stage) while eggs poseses grey cell or dark-brown and measure between 50-60µm.

RESULTS AND DISCUSSION

The result of the study shows a relationship between physico-chemical factors of contaminated soils and occurrence of geohelminths in the study communities. It was shown that eggs of *Ascaris*, hookworm and *Trichuris* were recovered in the study area (Table 1,2,3). Chemical analyses of contaminated soils, showed greatest effect of organic carbon, which was 3.07, calcium was high with 3.80mol/kg, magnesium ions (2.18mol/kg) and moderate potassium ion, with the least total nitrogen (N_2) which did not exceed 0.35. The carbon-nitrogen values in the contaminated foci showed advanced level of humification. Electrical conductivity was high in six communities, with clay-loamy and sandy-loamy soils, with moderately acid pH = 6.0 occurring in all the study communities (table 4).

In an earlier study, it has been shown that geohelminths such as *A. lumbricoides, Trichuris trichiura* and hookworm occur in abundance in the contaminated foci often used by the inhabitants for passing out faeces. In the present study, physico-chemical analyses of the contaminated soils showed that the temperature of the contaminated soils was suitable for geohelminth survival. The soil temperatures in all the study communities ranged from 21-28^{0}C. In all study sites, the soils were rich in nutrients with carbon- nitrogen values that show advanced level of humification as a result of decay of shaded leaves from plants that form canopy over the defaecating area. This is consistent with Anderson (1982) who reported that the survival of eggs and larvae of geohelminths is temperature-dependent.

Table 1: Eggs of Geohelminths recovered from the Study Communities

Study Area	*Species of Geohelminth eggs*		
	A lumbricoides	*Trichuris*	Hookworm
Owerewere	52	38	22
Amnigboko	72	12	23
Emebu	41	12	25
Obrany	50	12	25
Okoboh	31	12	53
Egunighan	16	16	25
Total	**262 (44%)**	**102 (17%)**	**173 (29%)**

The eggs of *Ascaris* are resistant to chemical due to lipid layer of the egg-shell which contains ascarosides. As a result of this, eggs of *Ascaris* are able to survive the influence of organic carbon, pH, potassium (k^+) and mg^{2+} ions present in the soils. It is believed that the presence of Ca^{2+} perhaps, strengthens the egg-shell which gives it greater capacity for survival in the environment.

For the eggs and larvae of hookworm, the condition that enhance the survival of eggs of *Ascaris* and *Trichuris,* also ensure their survival. It is possible, that the presence of Ca^{2+} and Mg^{2+} ions in the contaminated soils increase the curticular strength of the larvae, thereby ensuring its survival and transmission to the human host. Embryonation of eggs rapidly occur under warm and moist faecal environment and hatching could occur within 24 hours. Therefore, the continuous deposition of infested faeces in the contaminated soils with suitable pH, result in a build up of larvae of different physiological and chronological ages which rarely exceed four weeks (4 weeks). This is in line with Udonsi (1999). The longevity of the infective larvae in the soil is an important factor in the epidemiology of hookworm infection. Since the deposition of human faeces containing viable hookworm eggs is a continuous process and with favourable soil temperature, pH, atmospheric humidity for the development and survival of larvae are provided by the canopy in the defaecating area, there will be continuous transmission of these geohelminths to the human population of the study area. In field studies, larvae of 6-12 days old are most infective and their infectivity decrease after three weeks. The decreased infectivity may result from physiological age and depletion of lipid content. These factors may be influenced by physico-chemical conditions of the contaminated soils. This is supported by Udonsi et al (1981) and Udonsi (1984).

Table 2: Larvae of geohelminths recovered from study communities

	Species of geohelminth eggs		
	A lumbricoides	*Trichuris*	Hookworm
Owerewere	0	0	38
Amnigboko	0	0	29
Emebu	0	0	24
Obrany	0	0	42
Okoboh	0	0	125
Egunighan	0	0	65
Total	**0 (0.0%)**	**0 (0.0%)**	**323 (54%)**

In *Trichuris trichiura*, the combination of physical and chemical characteristics of the contaminated soils ensures egg survival and development. These factors include- high rainfall, humidity, moisture-retaining soil from dense shade, clay-loamy and sandy-loamy soils. Finally, the electrical conductivity of the contaminated foci favour the survival of eggs of hookworm, thereby enhancing it's migration and penetration into the human host.

Table 3: Combination of eggs and larvae of geohelminths in the study communities

Starchy area	*A. lumbricoides (eggs)*	*Trichuris (eggs)*	**Hookworm (lavae)**
Owerewere	72	38	60
Amniaboko	76	12	52
Emesu	46	12	49
Obrany	60	12	67
Okoboh	39	12	178
Equunighan	24	16	90
Total	317 (53%)	102 (17%)	496 (83%)

Table 4 – Physico – Chemical analyses of contaminated soils

	PARAMETERS	*A*	*B*	*C*	*D*	*E*	**F**
1	P^H	5.27	6.30	6.31	5.21	6.10	6.12
2	Electrical conductivity	51	85	52	59	81	114
3	% age organic carbon	3.28	2.13	2.30	2.33	3.07	2.75
4	Total nitrogen	0.39	0.21	0.28	0.28	0.35	0.31
5	Carbon/nitrogen nitrogen ratio	8	10	8	8	9	9
6	Nitrate ($N0_3$)	16.9	7.7	12.1	11.8	15.0	14.4
7	Potassium cation (k+)	1.47	0.58	0.71	0.70	1.24	0.96
8	Calcium cation (Ca^2+)	4.33	2.05	2.70	2.51	3.80	3.24
9	Magnesium cation (mg^2+)	3.07	1.43	1.81	1.84	2.70	2.25
10	Sandy soil	20.0	78.0	78.0	78.2	74.0	76.0
11	Silt soil	41.2	8.0	6.5	7.0	4.5	4.0
12	Clay soil	38.8	14.0	15.5	14.8	21.5	20.0
13	Textural class	Clay Loamy	Sandy Loamy	Sandy Loamy	Sandy Loamy	Sandy Loamy	Sandy Loamy
KEY:-		A = Obrany;	B = Emesu;	C = Aminigboko	D = Egunighan	E= Owerewere	F= Okoboh

In conclusion, the combination of sanitation technology, personal and community health education is necessary as an effective control measure of geohelminths. Sanitation technology in the geohelminth infections has to do with the construction of safe, functional and easily accessible faecal disposal facilities of whatever description that is suitable and adaptable to the local conditions. This is the challenge to the local government and state ministry of health in order to alleviate the suffering of these communities from geohelminth infections.

REFERENCES

Anderson, R.M. (1982): The population dynamics and control of hookworm and roundworm Infections. In Anderson, R.M (1991): population dynamics of infectious diseases; Theory and Applications, Chapman and Hall, London, 6-102.

Baer, R.J. (1976): The relationship between *Trichuris trichiura* of man and *Trchuris suis* of the pig. *Research in Veterinary Science*, 20:47-54.

Bremner, J.M, (1965b):Total nitrogen. In methods of soil Analysis, Part 2 CC.A. Black et al ed.) *American science of Agronomy* Inc. Madison, Nisconsin U.S.A 1149 – 1178.

Bundy, D. A.P and Cooper, E.S. (1989): *Trichuris* and trichuriasis in humans. *Advances in parasitology* l 28: 107-173.

Cobb. N.A. (1920): Estimating the nematode of the soil: Agricultural Tec. Cir. Bur. Pl. Ind. U.S Department of Agriculture, XW19-24.

De Silva, N.R. Broker S, Hotez PJ., Montessori A, Engels D., Savioli L. (2003): Soil - transmitted helminths infections. Updating the global picture. *Trends in parasitology* 19. 547-557.

Jackson, M.L. (1964): Soil Chemical Analysis. Engelwid Cliffs, New York, Printice Hall. 32-77.

Ndenecho L., Ndamukong, K.J, Matute, M.M (2002): soil-transmitted nematodes in children in Buea Health, District of Cameroon. *East Africa Medical Journal* 79:442-445.

Nwosu, A.B.C. and Anya, A.O. (1980): Seasonality in human hookworm infections in an endemic area of Nigeria and its relationship to rainfall. *Tropenmedizin Und parasitologia* 31:201-208.

Otto, G.F (1929): A study of the moisture requirement of the eggs of the home dog, humans and pig *Ascaris*. *American Journal of Hygiene*, 10: 497-520.

Smith, G. and Shadi, G.A (1990): *Ancylostoma duodenale* and *N. americanus*: Effect of temperature on eggs development and mortality. *Parasitolog today* 99: 127-132.

Udonsi, J.K (1999): Parasites and Parasitic diseases- A textbook of General and medical parasitology in tropical Africa. Josany press, Port Harcourt, Nigeria 177- 162.

Udonsi, J.K. (1984); Changes in lipid contents of infective third-stage larvae of *Necator americanus* during desiccation and revival *Zeit. Parasit* 79:81-86.

Udonsi, J.K. and Atata, G. (1987): *N. americanus*. Effect of Temperature, pH., light and larval development, Longevity and desiccation tolerance. *Experimental parastology* 63:136-142.

Udonsi, J.K. Nwosu, A.B.C and Anya, A.O. (1980): *N. americanus*: population structure, distribution and fluctuations in population densities of infective larvae in contaminated farmland. *Zeit. Parasit* 63:251-259.

Udonsi, J.K., and Anya, A.O. (1981): Studies on the larval bionomics of *N. americanus* in relation to soil moisture suctions, *Nigerian Journal of parasitology*. 24:4-14.

W.H.O (2008) Public health significance of Intestinal parasitic infections. *Bulletin of W.H.O* 65 (5) 575-588.