PRINT: ISSN 0970-9274 ONLINE: 2456-6608
J Hum Ecol, 30(2): 123-130 (2010)
DOI: 10.31901/24566608.2010/30.02.07

Tropical City Milieux and Disease Infection: The Case of Douala, Cameroon

Zephania Nji Fogwe* and Fombutio Christopher Ndifor**

**Department of Geography, F. L. S S, Box 3132, Douala, University of Douala, Telephone: +237 77 61 00 39, E-mail: nfogwez@yahoo.co.uk*
***Department of Biochemistry, Faculty of Science P.O. Box 17491 Douala, University of Douala*

KEYWORDS Contamination. Flood Water. City Milieu. Nematodes. Patients

ABSTRACT Analyses of defects emanating from industrial and urban development have often neglected health hazards. The risks related to commonly cited problems – waste disposal, pollution and congestion – are a function of the level of exposure to such flaws. Douala city combined sustainable growth and development portrays trait-specific features at its Central Business District (CBD), middle belt, and margins reflecting varied levels of exposure to health hazards. One of these hazards is that of parasite infection and particularly intestinal nematodes (worms) that this paper addresses. The health risk of intestinal nematode infections was sampled in 1999 on faecal. Specimens were collected from 1800 patients of different ages, visiting three hospitals within each sector of the city. The most central city hospital was considered to be most exposed to infection while the one at the periphery was least exposed, assuming that patients visit the nearest hospitals. The results reveal a high (48%) infection prevalence for patients of the city centre, tending to reduce (44%) towards the middle belt but being abnormally high (64) at the city periphery, which is a situation identified to be typical of humid tropical cities. Results also revealed that 64.7% of the patients presented 5 intestinal nematodes. Mono parasites involving *Ascaris lumbricoides* and *Trichuris trichuria* (22.5%) were the most frequent as opposed to pluri-like *Ankylostoma specie* and *Enterobius vermicularis* (13%) were least. There was also a variation in the association of species of nematodes. Children aged 5 to 9 years were most affected (88.9%) as opposed to adults.

INTRODUCTION

Inevitable but capital challenges of civilization and the strive of human societies for food, shelter and clothing, stem from how to sustainably manage the spillover of this progress. In the towns and cities of the developing world, south of the Sahara, slums, congestion, high crime wave, flooding and pollution epitomize this challenge that is both human and natural in origin. Whereas the former have been widely investigated and so could be quickly checked by various national governments and local councils, the latter remains an up-hill task like war in, which only battles are won and not the war itself.

City management and development planners are facing this multi-faceted problem with unsuccessful approaches and strategies. The problem therefore does not only persist but takes new spatial dimensions. The alarm raised thereof, has been mostly about the exponential net accumulation and hardly on the health repercussions on the urban population of Douala, which has a peculiar hydrogeology. Its quasi-flat topography and poor drainage makes it a habitat par excellence for the breading of vectors of water-borne diseases. Some of such diseases like malaria and typhoid have been studied unfortunately, its vectors (mosquitoes) are of high mobility and so do not have a localized effect. They are not perfect indicators of the spatial variation of the relationship between pollution and the incidence of water borne diseases.

Intestinal infection by nematodes of the urban population is considered in this case study to be omnipresent or point specific. It can be considered to be a good indicator of the contamination of the active population by polluted water at any point and time. This disease is linked to an appropriate feeding hygiene with a high prevalence of this infection in rural areas even though coastal areas have a greater prevalence than continental.

The city of Douala has food processing and other industries, and the level of urbanization of the different zones is varied in history, morphology, function, and type of population. This thereby reflects varied degree of pollution from its city centre (Akwa) middle zone (Deido), to the suburbs (Bonaberi).

The Douala city milieu is that in which disease infection reflects both the urban environmental quality and the abundance of the water vector. The city centre is where big and small streets are well-developed. On both sides of the streets are

houses, shops, schools, clinics, hotels, and informal sector activities. The streetside big buildings hide behind them several other low quality houses that are made up of makeshift materials like opposite the Akwa cemetery in Ngodi. This gives a slum urban morphology of plank houses, broken walls, make shift huts along road sides, with uncleared grass, scrap cars though some undergo renewals.

The outstanding problems in this area are pollution and flooding. Waste dumps are scattered on streets in this quarter. The waste absorbs and stores water in the rainy season. The gutters are gradually filled and almost never cleared of its organic and non-organic waste. This waste is deposited directly by senseless urbanites and also indirectly through sewage network from poorly constructed houses so that faecal and other toilet materials are accumulated in gutters and depressed surfaces. This produces a dangerous, dark, black, smelling solution on the surface. Such stagnating water pollutes and is a vector of harmful urban diseases.

The dumps are not only in the streets but also in the behind-the-street quarters that built mostly of makeshift material, so are perfectly inaccessible to waste collection companies. The waste decomposes, *in situ* releasing an organic acid leachete, which meanders downstream between the houses into the nearest stream tributary. Polluting the surface over which it moves and the stream that it joins, this leachete attracts flies and forms a good mosquito-breeding habitat. At times some inhabitants engage in gutter and stream channel cleaning activities, so that the dirt from inside the gutters is dug out and deposited at the edge of the road or edge of the gutter. Unfortunately, the garbage collection ser-vices do not come to their rescue either because of inaccessibility, and such removed dirt gra-dually finds itself back into the gutters through gravitational drifting or when the rains return, they are quickly washed back into the gutters and by so block water flow so that flood responses are immediate.

The problem of flooding in Akwa is also rife because of the flat nature of the surface. This causes water to have a tendency of always stagnating in the rain season because there is no good gradient to drain the surface. At times, water may attain such surface heights that traffic could be temporarily halted like at Carrefour Arnod. This situation is worsened by the small nature of the gutters, which are often filled with dirt.

The middle city belt at Deido, is where the first occupants got established along the Wouri River, so they are bounded in the north by the Wouri mangroves, south by Bepanda, west by Bessengue and Bonantone, east by Akwa Nord. The site of Diedo is a plateau with a good road network made up of boulevards and streets. The route network and house outlay gives the idea of a check-square urban morphology. The Douala indigenes here for the most part have constructed houses with a permanent material (cement) thereby the village aspect has almost completely disappeared. However, some zones of this quarter have an anarchical outlay of plank houses.

In this area, flooding, mass movement and pollution are recurrent. Many streams from the town flow in several valleys across this quarter to empty their waters into the Wouri. For this reason Boateki, Bonamouti, Bonatene, Bonajinje Bonamoudouro, New Diedo, Grand Moulin, Bonatene Diedo, and Moulin suffer from frequent floods. Low altitude areas below Bonateki have been termed *Pays bas (low country),* indicating the frequency of flooding in this area. The edges of this area are of micro cliffs, which frequently yield to mass wasting phenomena, which at times carries along the buildings, which have been constructed on its edges.

In the other sectors of this quarter, like Bonamoundouro and Grand Moulin, severe pollution is associated with informal sector activities. Much of the wastewater is channelled through the surface into drains and then into the Mbanya stream, which enters the Wouri River. Household solid waste and scrap cars are thrown into this stream, which becomes polluted, and choked so that when it rains, flooding occurs. This is the cause of the type of flooding that occurred following the 6 hours rain of the night of 26 February 2002, though it was just still the first rains of the rainy season. This unexpected phenomenon took many people unaware just as the neighbouring population of the streams who are unaware of the rivers of emptying their waste into streams.

The peripheral or suburb area of the city does not reveal the same urbanisation traits like the city centre as several transformations have taken place in this area with the management of industrial zones, opening of roads, installation of electricity. Bonaberi is made up of Bonassama, which is industrial, Nkomba, Bonambape and Bona-

mikano, which disorderly urban morphology. This relatively recent area developed rapidly in the 1970s and 80s, spreading from extreme south-east towards the north west. This spread has continued to gain grounds and new territory even at Bojongo. The rapid demographic increase of Bonaberi started in 1976 just same as the expansion of industrial activities. In 1974, the Mission d'Aménagement et de Gestion des Zones Industrielle (MAGZI) was created with the goal of decentralizing the industrial activities, which had hitherto been concentrated in the Bassa zone. The inhabitants of this quarter are mostly indigenes from Centre, South, West, North and the Anglophone provinces of North-West and South-West. These developed on a marshy swampy surface extending to the mangroves. This poor drainage therefore largely explains why there is this exceptionally high infection prevalence.

Even though the quality of the houses has improved within the past years, Bonaberi still shows signs of old zinc, planks and makeshift material. In some cases, good buildings have taken the place of the old huts. In some old huts, there have been profound modifications in these recent days. In the newly acquired plots, there has been the construction of modern houses and this process is still going on and thus spreading the area spatially. In old quarters as Bonassama, Besseke, Nkomba, Bonambappe, and Bonamikano have observed transformations, which have touched on their form, their finishing and their surrounding space. At the margins of the old houses are high-class buildings in fences for people of higher standards of living. Industrialists, civil servants, office staff, business-persons and even foreigners occupy these areas.

Studies in Guinea on children of school age have shown that the prevalence is higher in males than in females (Gyorkos et al. 1995). On the contrary, the works of Same et al. (1986) done in several localities in Cameroon show that females are more infected than males and that the age groups 5-14 years are those who are most touched. The objective of this paper is to determine the different types of intestinal nematode infections and the distribution of this parasitic infection of Douala city due to pollution. This study determines the distribution and prevalence of different types of intestinal nematodes infection of Douala city.

METHODOLOGY

a) Choice of Sample Centres

Douala is a cosmopolitan town, situated on the coastal littoral plain, has about 2.5 million inhabitants. The climate is equatorial coastal climate with an average annual temperature of about 27°C. The rainfall ranges from 1500 to 9895mm per year. The climate is characterized by two seasons: one long rain season from April to October and a short dry season from November to March the following year. In order to have an average situation of the intestinal infection within the three urbanized sectors (city centre, middle sector and suburbs), the major hospitals in each of these sectors were chosen. This is with the consideration that the patients who visited each of these hospitals were resident in the sector and so exposed to the same risk of pollution. It is also assumed that all the chosen hospitals were best in their sectors, so offered maximum services that attracts the population discourages them to go to hospitals in the other zone. The population is thus assumed to be rational and obey the principle of proximity as concerns the hospitals visited. This sectorisation of Douala city is based on the fact that each sector has a sample hospital in each urban zone with its own peculiarities.

Laquintinie Hospital in Douala 1st District is found in the city centre of Douala precisely at Akwa, on the east bank of the Wouri River. This area is limited on the south by the Bisseke stream and the Bessoussokou affluent. The Mbopi stream limits it on the east side passing through Camp Yabassi to join the Wouri River at the level of the Sandaga food market. It stretches on about 16km along the Wouri up to Bonangando with about 20 sub villages that make up the Bonambela people of Akwa. The Mudongo-ridge land that was settlement area, and Koto-country ridge meant for farms. Past administrative decisions imposed that houses along the main streets be built with hard material forced some indigenes to give over their land to the richer Europeans. Some withdrew to Koto while some went to the resettlement area of present day Ngodi. With the construction of the provincial hospital of Laquintinie (1930), schools, shops, churches and government offices, this became a major zone of population confluence. Diedo District Hospital in Diedo in Douala 2nd District was chosen because Diedo, also called Bonebela, is one of

the oldest quarters of Douala, it was started with the arrival of German colonialists. Bonaberi CEBEC Hospital In Douala 5th District within the sub urban area linked to the main town by a bridge/rail route of 1840m over the River Wouri. Bonaberi is bordered on the south and north by industrial zones between, which is an elongated extension of sub urban houses, infrastructure and services.

b) Sample Collection

In order to collect faecal samples from the 1800 patients, the patients were distributed into 10 age groups at a 4-year interval. For each age group, a total of 180 faecal samples were taken in a random sampling and conserved in plastic bottles with corks. The presence of eggs of *Ascaris lumbricoides*, *Ankylostoma specie, Trichuris trichiura*, and larva of *Strongyloides stercoralis* were determined immediately in the laboratory. This was done by the method of fecal concen-tration characterized by the use of formol ether according to the method of Cheesbough (1987) and Nozais et al. (1984). The presence of eggs of *Enterobius vermicularis* was done by the method of an adhesive clear cellophane, such that the cellophane pieces were placed on the skin at the perianal zone of each sampled person and the pad revelation or outcome was observed by a microscope according to the method of Nozais et al. (1984).

c) Data Treatment

The results obtained were statistically expressed in terms of percentages and the comparisons were done using Fisher tests using the statistical 2.03 version program. For multiple comparisons, appropriate probabilities were corrected in function of the number of simultaneous comparisons, by using the sequential procedures of Bonferroni according to Rice (1989). As thus, the threshold α=0.05, the risk probability "p" determined for "k" comparisons were arranged from the smallest "p" to the biggest "pk". For the independent samples, which is our case, the tests that correspond to "pi" would be considered to be significant if $pi \leq (1 - [1-\alpha]1/(1+k-2)]$.

The attraction or repulsion behaviour between the different species of nematodes is evaluated with the help of a correlation coefficient of the tetrachoric point "r α" ($r \alpha > 0$) indicates an attraction between the species; $r \alpha < 0$ indicates a repulsion between the species the significance of the coefficient of correlationship is evaluated to the Fisher Test according to Zar (1996).

RESULTS AND DISCUSSION

a) City Milieu Traits and Spatial Infection Dimensions

Table 1 shows the relative occurrence of nematodes in Douala

Table 1: Comparison of the rate of intestinal nematodes observed in three city hospitals

Disease	*Hospital Laquintinie*	*Die-do*	*CE-BEC*	*Total*
Ascaris lumbricoides	94	88	117	299
Ankylostomes	61	58	69	188
Trichuris trichiura	24	21	33	78
Enterobius vermucularis	24	21	21	66
Total infected	203	188	240	631
Percentage infected	33	28	39	

b) City Age-Sex Infection Differences

On the whole, males were more infested than females (males: 560 on 900 being 62.2% and females: 386 on 900 being 42.9%. The exact Fisher test was $p = 2.6 \times 10^{-16}$). For each intestinal nematode, a study of the rate of prevalence in function of the age of the sampled persons showed that *Enterobius vermicularis* and *Strongyloides stercoralis* presented rates of infection less than 1% contrary to the prevalence of the other parasites. More over, children aged 0 to 9 years are more infested than persons of higher ages. No matter the parasite, the rate of infection tended to reduce with increase in age.

The difference of the rates of prevalence observed in the age group of 0-4 years, which are babies and the age group of 5-9 years being infants is not significant, p = 0.524 (Table 2).

In the adolescents, the persons aged 10-14 years being pre-puberty age has an infection rate that is comparable to that observed in the age group 15-19 years being puberty period, p=0.457 (Table 3).

In sum, the prevalence rate observed in adolescents is lower to that observed in children aged less than 10 years ($\alpha^1 = 0{,}002$ respectively for 1 versus III: $p=4.6 \times 10^{-9}$; I versus IV: $p=2.4 \times 10^{-11}$; II versus III: $p=3.9 \times 10^{-11}$; and II versus IV

Table 2: Distribution of different species of intestinal nematodes by age groups.

Age	*Percentage of disease infection*				
	Ankylostomes n = 188	*Ascarislumbri coides n = 299*	*Enterobius vermucularis n = 66*	*Trichuris trichiura n= 78*	*Strogyloides stericoralis n = 315*
0 - 4	2.2	2.9	0.7	0.3	2.6
5 - 9	1.8	2.8	0.8	1	2.8
10 - 14	1.3	1.9	0.2	0.2	2.5
15 - 19	1	1.2	0.3	0.7	2.4
20 - 24	1	1.3	0.2	0.5	1.5
25 - 29	1	1.2	0.2	0.5	1.5
30 - 34	0.8	1.8	0.4	0.3	1.4
35 - 39	0.9	1.5	0.2	0.4	1.1
40 - 44	0.8	1	0.2	0.3	1.5
> 45	0.8	1.1	0.3	0.2	1

Table 3: Age group variation in the prevalence of intestinal nematode infections

Age in years	*Number examined*	*Infected*	
		Number	*Percentage*
A. Infants			
I. 0 - 4	180	155	43.1
II. 5 - 9	180	160	44.4
Total	360	315	87.5
B. Adolescents			
III. 10 - 14	180	105	29.2
IV. 15 - 19	180	97	26.9
Total	360	202	56.1
C. Adults			
V. 20 - 24	180	80	7.4
VI. 25 - 29	180	77	7.1
VII. 30 - 34	180	78	7.2
VIII. 35 - 39	180	70	6.5
IX. 40 - 44	180	65	6.0
X. 45 and more	180	59	5.5
Total	1080	429	39.7

:p=1.2 x 10^{-13}) (Table 4). In general, the persons of more than 20 years age (adults) had infection rates that are significantly lower than in infants and adolescents (Table 2 and 3).

Of the 1800 persons sampled, 35.3% were not infected by the parasites. Of the persons infected, situations where only one-nematode specie was observed constituted 42% of the cases (Table 5). Those who had two-nematode specie infection (17.5%) concerned the association of *Ascaris lumbri-coides* and *Ankylostoma* specie 5.7% or with *Trichuris trichiura* (7.1%). Also, the association between the last two species of parasites was rarely observed (4.7%). In some of the samples, there was the combination of *Ascaris lumbri-coides*, *Ankylostoma* specie and *Trichuris trichiura* being 5.2% of the cases. These three species tolerate themselves very well in the same patient ($r\varphi>0$) whereas the presence of *Enterobius vermicularis* or *Strogyloides stercoralis* rejects the other parasite species ($r\varphi<0$) as on table 3.

α'=Corrected significance level using the sequential Bonferroni procedure. Significant probabilities ($P_1<\alpha'$) are compared data are in table 2.

(Correlation coefficient $r\varphi>0$ indicate tolerance between the compared parasites; $r\varphi< 0$ indicate repulsion between the two nematode species).

Spatially, the rate of disease infection (using the example of this nematode case study) shows that there is a significant variation between the various sectors of the city. The infection trend shows that there is a high prevalence in the city centre (33%) and this reduces significantly to 28% in the city middle belt. For the case of Douala the suburbs, revealed an exceptionally high infection rate. This is because the rapid growth in the population of Douala has clearly imposed remarkable limits on the management of urban solid waste in general and domestic waste in particular. A close look reveals that the urban population and industries have grown rapidly but waste management has remained a problem such that there has rather been a waste transfer from one urban area to another. This transfer has unfortunately been to the detriment of the swamps, which together with their streams have become receptacles, which have been rendered dead. This is largely because the problem of waste accumulation, collection, evacuation and management of the city waste is handicapped by a number of entangling bottlenecks.

In terms of urban technical constraints, the rapid expansion of the urban perimeter has not been proportionate with quality communication infrastructure. This extension obligatorily results in collection distances of household waste and

consequently the cost of their collection for those concerned. In this light, the costs rose from 50 million in 1968 to 2.5 billion in 1992 because of the bad state of the roads, choking roadside markets, road surface potholes and the lack of urban feeder roads. The heavy garbage collection vehicles of the garbage company (Hygiène et Salubrité du Cameroun) HYSACAM can reach only some of the areas of the town so that about 40–50% of the inhabitants are not reached. As a consequence, the percentage of waste collection is also limited only to this percentage. Equally, the method of waste treatment where there is no sorting of the waste results in much use of space.

With regards to the financial and economic bottlenecks, the budget handicap of the Douala Urban councils has not permitted them to be able to cope with the problem of waste handling. For example, for the 1992-93 the cost of waste collection was 5.5 billion, which was the equivalent of 50% of her income. It can therefore not permit the urban council to do a good job.

This is coupled with the fact that several ministries and institutions play a part in the management of urban waste. The Ministries involved are Mines, Water Resources and Energy; Territorial Administration; Urban Planning and Housing; Environment and Forestry; Town Affairs. The most evident of these flaws regards the law N° 87/015 of 15th July, concerning the creation of the Douala City Council that rather gave the responsibility of the management of city waste to the subdivisional urban councils whereas these other councils directly depend on the Douala City Council for their functioning. This same law leaves the exclusive responsibility of city hygiene and sanitation in the hands of the City Council, which equally implies solid waste management.

The victims of the lack of waste collection are the urban under privileged population occupying the valley areas and other slum areas. They are thus exposed to the health risk of germs, disease, and pests, which are even better propagated by the recurrent floods that are becoming moribund in the areas of low-income population.

Generally, rainwater and polluted water are discharged from the Douala city through a network. The primary network is constituted of the urban depressions or broad valley natural flow ways. Most of these systems are funnel shaped that open up or broaden out towards the downstream while narrowing towards its upstream. The broad inter plateau valleys have varied levels of transformation, which is a function of its humanisation history and population density. The secondary network assures a connection between the primary network and the tertiary network. Tertiary network made up of channels, gutters, roadside depressions, which are open in some places, half open, and closed in others. This explains why the young population is most exposed to the waste and thus contamination.

The consequences of this complex waste-hydrographic relationship are medical and socio-economic. From a medical perspective, stagnant water favours the propagation of water-borne

Table 4: Comparison of the prevalence of intestinal nematode infections.

Comparisons	±	*Fisher exact probability*
A. Adults		
V vs. VI	0.673	0.017
V vs. VII	0.05	0.915
V vs. VIII	0.005	0.336
V vs. IX	0.004	0.132
V vs. X	0.003	0.030
VI vs. VII	0.025	0.832
VI vs. VIII	0.010	0.593
VI vs. IX	0.005	0.282
VI vs. X	0.003	0.083
VII vs. VIII	0.006	0.453
VII vs. IX	0.004	0.196
VII vs. X	0.003	0.051
VIII vs. IX	0.013	0.663
VIII vs. X	0.004	0.272
IX vs. X	0.009	0.579
B. Children versus Adults		
I vs. V	0.002	4.7×10^{-17}
I vs. VI	0.001	8.2×10^{-19}
I vs. VII	0.001	8.3×10^{-18}
I vs. VIII	0.001	5.4×10^{-21}
I vs. IX	0.001	3.8×10^{-23}
I vs. X	0.001	6.7×10^{-26}
II vs. V	0.001	8.0×10^{-20}
II vs. VI	0.001	5.8×10^{-22}
II vs. VII	0.001	1.3×10^{-20}
II vs. VIII	0.001	5.1×10^{-24}
II vs. IX	0.001	2.7×10^{-26}
II vs. X	0.001	3.3×10^{-29}
C. Adolescents versus Adults		
III vs. V	0.002	0.011
III vs. VI	0.002	0.002
III vs. VII	0.002	0.006
III vs. VIII	0.002	3.2×10^{-4}
III vs. IX	0.002	3.6×10^{-5}
III vs. X	0.002	1.7×10^{-6}
IV vs. V	0.003	0.092
IV vs. VI	0.003	0.027
IV vs. VII	0.003	0.058
IV vs. VIII	0.002	0.006
IV vs. IX	0.002	0.001
IV vs. X	0.002	7.8×10^{-5}

Table 5: Attraction or repulsion between nematode species in infected patients

Nematodes	*Ascaris lumbricoides*	*Ankylostoma species*	*Trichuris triciura*	*Strogyloides stercoralis*
Ankylostoma sp.	+0.229***			
Trichuris trichiura	+0.195***	+0.173***		
Strongyloides stercoralis	-0.159***	-0.137***	-0.160***	
Enterobius vermicularis	-0.164	-0.141***	-0.165***	-0.065**

** =p<0.01; *** = p<0.001.

Table 6: The main illnesses of Douala in 1994

Name of illness	*Reported in health units*	*Percentage*
Malaria	42 730	33
Catarrh and cough	17 099	13
Skin infections	17 047	13
Intestinal worm infections	14 209	11
Pneumonia	9 385	8
Rheumatism	9 095	7
Diarrhoea	5 495	4
Mouth cavity	4 923	4
Conjunctivitis	4 547	4
Gonococci	3 254	3
Total	127 784	100

Source: DPSPL, Douala

diseases. Urban standing water is at the origin of four categories of diseases:

- Where water harbours a pathogen that enters the human body through the digestive tract to produce illnesses like cholera, typhoid, cysts, and amoebas.
- Where water harbours a pathogen that enters the human body through the skin to produce larva, which is at the origin of several intestinal infections. (Table 6).
- The water could also give refuge to intermediary hosts that would provoke filarial, bilharzias.
- The water may favour the development of the larva of insects that are vectors, which are at the origin of illnesses such as yellow fever, and above all malaria.

It stems from the above table that water borne diseases provoke illnesses such as malaria, yellow fever, intestinal infections, which are produced by the poor and complex relationship between urbanisation and the stagnating overland flow and polluted waters that contaminate the water tables therefore infecting people at various degrees according to the urban sectors where they bare found. Wastewater and rejected organic waste from industries and households thrown into streams are sources of infection. This results in the propagation of water-borne diseases such as cholera. In 1991, the population density was only estimated at 176 inhabitants/km² but today the density is more than 1000 inhabitants/km^2 in most of the flood prone areas. This increases the risk of contamination as shown by the number of infections in Douala.

During our inquiry, the coexistence between *Trichuris trichiura* and *Ascaris lumbricoides* was frequently observed. This association is frequently observed in patients (Forrester et al. 1988; Appleton et al. 1999; and Scolari 2000), but the association of *Ascaris lumbricoides*, *Ankylostomes* and *Trichuris trichiura* seem not to be common.

CONCLUSION

Investigations in the main hospitals of Douala have also permitted us to establish that there is a non-negligible variation in the prevalence of helminthic infection in function of their age and sex. Our results are close to those observed in Guinea and could be considered as a characteristic of the humid tropical region. However, the works of Same et al. (1986) show that *Ascaris lumbricoides* were more frequently found in Cameroonians than *Trichuris trichiura, Enterobius vermicularis* and *Strongyloides steroralis,* which is the reverse in our humid, swampy coastal city of Douala as shown by this research where it is *Trichuris trichiura* that dominates.

Due to the topographic milieu imposed contrasts, urban infrastructure (quantity, quality, stability and resistance to environmental hazards, shows marked difference between the swamp valleys where the infrastructure qualities are poorer and the raised surfaces or plateau where they are better. In the latter, the population, which is moderately dense is affluent and thus possess the means of creating and maintaining the infrastructure. Some of the infrastructure (particularly industrial) is located on the plateau that act like watersheds (Bassa plateau) from where industrial

solid and liquid waste are channelled or partially deadened streams carry along with them through the slums the industrial pollutants, which do not hesitate in the event of a flash flood to spread into the neighbourhood surfaces and wells.

RECOMMENDATIONS

The high prevalence observed in youths is related to the bad hygienic conditions in the different urban sectors of the city. Considering the nutritional and hygiene problems on our urban health, a fight against the proliferation of intestinal nematodes should be carried out through a good education of the population as well as frequent diagnosis of the infection in order to identify the various forms of infection. This entails the adoption of a strategic health plan that is in compliance with the city development plan all of with should be targeted on the milieu traits of this humanised coastal zone.

REFERENCES

Appleton, CC 1999. The Distribution of Helminth Infections Along the Coastal Plain of Kwazulu-Natal province, South Africa. *Annals of Tropical Medecine and Parasitology*, 93: 859-868.

Bulu BG 1990. Les Nématodoses Intestinales chez le Nourrisson de Moins de 2 ans à Douala, Cameroun 2éme Conference, Yaoundé : Médecine Nationale.

Cheesbough M 1987. *Medical Laboratory Manual for Tropical Countries.* Cambridgeshire: Butterworth-Heinemann, P. 605.

Coulaud JP 1990. L'Anguillulose en Afrique en Afrique 1990. Problèmes Epidémioloque et Chimiques. *Méd Afr Noire*, 37: 466-469.

Deniau M 1984. L'Anguillulose en Milieu Scolaire à Douala. *Tempo Med Afr*, 50: 23-25.

Foba-Pagou R, Kegoum E, Same-Ekobo A, Eben-Moussi E, Faucher P, Carrie J, Ripert C 1980. Etude Epidémioloque des Helminthiases Intestinales (Ascaridiose, Necatorose, Téniase, Bilharziose) dans la Ville de Maroua (Nord Cameroun). Résultats du Traitement des Populations par le Mébendazole. *Bull Soc Parasitol Exot*, 73: 171-178.

Foba-Pagou R 1978. Le Mébendazole, Medicament de Choix pour le Traitement des Verminoses Intestinales au Cameroun. Thèse de Médecine, CUSS, Yaoundé,

Forester JE. Scott ME, DAP Bundy, Golden MHN 1988. Clustering of *Ascaris lumbricoides* and Trichiura Infections within Households. *Transaction of the Royal Society of Tropical Medecine and Hygiene*, 82 : 282-284.

Granier H., Granier-Filloux F, Granier-Guionie M, Couprie B, Same-Ekobo A, Appriou M, Tribouley J, Ripert C 1983. Epidémiologie des Helminthiases Intestinales et de la Bilharziose Urinaire dans la Region de Tala-Mokolo (Nord Cameroun). Comm. II *Journ Méd* Yaoundé.

Gyorkos TW 1996. Enquête de Prevalence Parasitaire chez les Enfants d'Age Scolaire en Guinée (1995). *Cahiers Santé*, 6: 377-381.

Kengne Foduoup 1977. Bonaberi dans Douala. Autonomie et Interdependence. Université de Bordeaux 111, Institut de Géographie, Thèse de Doctorat de 3e cycle, P. 299.

Kengne Foduoup 1978. Expansion Recente, Modernization de l'Habitat et Speculation Fonciere dans le Secteur de Bonaberi à Douala. Department of Geography, University of Yaounde, P. 25.

Mely J 1976. Etude Epidémiologique de l'Ankylostomiase à Bomoco ba Jedu à Dibombari. Thèse de Médecine, CUSS, Yaoundé.

Moyou, SR, Same-Ekobo A, Ripert C, Carrie J 1986. Anguillulose dans l'Quest du Cameroun: Etudes Cliniques, Diagnostique et épidémioloque. *Tempo Méd Afr*, 50 : 18.

Nozais JP, Doucet J, Dunand J, Le Bras M 1984. L'Examen Coprologique en Parasitologie Courante. Paris: CHU, Pitie – Salpêtrière Laboratoire de Parasitologie, P. 36.

Rice WR 1989. Analysing tables of statistical tests. *Evolution*, 43: 223-225.

Ripert C 1976. Etude Epidémioloque des Verminoses Humaines dans la Vallée de la Sanaga (Cameroun). *Rapp. Fin. Xième Conference* OCEAC, Yaoundé.

Ripert C, Durand B**,** Carrie J, Riedel D, Bray-Zoua D 1978. Etude Epidémiologique des Nématodoses Intestinales dans la Vallée de la Sanaga (Cameroun). *Bull Soc Parasitol Exot*, 71: 361-369.

Same E 1997. *Santé, Climat et Environnement au Cameroun.* Ed. Justey Sciences: Yaoundé.

Same E, Darie H, Barabe P, Teyssier J, Imbert P, Peghini 1986. Aspects Epidémioloque des Nématodoses Intestinales au Cameroun. *Population et Santé Tropicale*, 19:1-6.

Zar JH 1996. *Biostatistical Analysis.* New Jersey: Prentice-Hall.