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Presence of *Cryptosporidium* and *Giardia* in the water sources of indigenous peoples in Boliwong, Philippines

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ABSTRACT

The study investigated the presence of *Cryptosporidium* and *Giardia* in the water system from an untapped indigenous community inhabited by the Tuwali ethno-linguistic group of the Philippines. These protozoa parasites were detected from river, creek and water pumps using direct fluorescence antibody (DFA) test and immunomagnetic separation (IMS) technique. *In situ* measurement of physico-chemical parameters such as pH, temperature, and total dissolved solids of the water samples were done. From the 24 samples collected during the month of April 2017, seven samples were positive for *Cryptosporidium* (29%) and one sample was positive for *Giardia* (4.2%). The concentration of parasites were typically one to two (oo)cysts per 10 liters of water. The quality of water was generally acceptable for primary contact recreation, irrigation and livestock watering based on the standards set by the Department of Environment and Natural Resources of the Philippines. The occurrence of *Cryptosporidium* and *Giardia* in the community is an important indicator of the occurring zoonosis in the community. This calls for a wider scale of the detection for waterborne protozoan parasites within the region before a possible outbreak could happen.

Keywords: Cryptosporidium, Giardia, indigenous community, river, Tuwali, zoonosis

Introduction

The waterborne parasites, Cryptosporidium and Giardia, emerged as major etiologic agents of documented waterborne disease outbreaks across the globe in the past few decades.[1-3] Both are considered pertinent threats to the public health due to their wide range of human and animal hosts that extensively disperse their infective (oo)cysts to the environment.[4] These parasites are transmitted through oral-fecal route, with the consumption of contaminated drinking water, and with fortuitous intake of contaminated water from recreational waterways. Some of their health implications include diarrhea, nutritional disorder, weight loss, and even death.[5]Cryptosporidium and Giardia are not well studied in the Philippines and their public health implications are undervalued and ignored.

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The recent accessible data on Cryptosporidium and Giardia from Philippine waters detected these parasites both in treated and untreated water systems.[6] Cryptosporidium was also detected from public swimming pools in Laguna (Occurrence Rate =100%)[7] and Metropolitan Waterworks and Sewage System (Occurrence Rate = 77.3%), a major water source of the majority of Filipinos in Metro Manila and neighboring provinces.[8] The reported high occurrence of these parasites in various water sources poses a need to uncover their possible involvement to the increasing waterborne disease outbreaks in the different regions of the country.[9]In order to estimate its risks to the Filipinos, a study was conducted in a community where water system is in direct contact with the human inhabitants. Boliwong is an indigenous community in Ifugao inhabited by Tuwali ethno-linguistic group of the Philippines. More than half of the total number of households in the community use an open pit for defecation. There were also no improved water sources for the 25.43% of them. A river streaming in the community called Muntabyong River, which traverses through other nearby

communities: Dukligan, Banaao, Tungngod, is accessible for a large portion of the community. There is also one long stretch of creek that arbitrarily channels the water to the rice fields in the community. A water pumps, on the other hand, are intended for primary contact recreation like bathing and swimming. The poor sanitation in the community, the issue on inaccessible improved water sources, and the constant direct contact between water system and the people, puts Boliwong at a potential risk of waterborne outbreaks of Cryptosporidiosis and Giardiasis. These facts induced the researchers to carry out the present study. Evaluating the occurrence of these parasites from the water systems in Boliwong is only a small portion of the study but it needs to be highlighted in this short communication.The study was conducted in April 2017 in Boliwong, Ifugao, Philippines (Geographical coordinates: 16o48'00"N 121o07'00"E). It is covered by high mountains and has a total land area of 956.4726 hectares. A total of 24 surface water samples were collected using 10-litres sterile bottles from the different water sources. Three points i.e. upstream, midstream and downstream were considered in collecting water samples from river and creek with triplicates each point for a total of nine samples from the river and another nine samples from the creek. There was a total of 11 water pumps scattered in the community but only six samples were obtained. Three water pumps were privately owned and the owners either did not allow providing water samples or were not around during the collection period to give access to the water pumps. One water pump was not working and another one was inaccessible due to the condition of pathway. Processing of water samples such as filtration, elution, concentration, purification, staining, examination and (oo)cyst enumeration formula were based on the protocol conducted by Onichandran et al.[6] using a commercial kit (Dynabeads GC-Combo, Invitrogen, USA). In addition, physico-chemical parameters such as electrical conductivity (EC), pH, temperature (°C), and total dissolved solids (TDS) were measured in-situ at each station using multi-probe meter, Thermo Orion Model A920.[10] All statistical recordings and analyses were done using IBM Statistical Package for the Social Sciences (SPSS) version 20.From the total of 24 water samples, seven (29%) were positive for Cryptosporidium spp. and one (4.2%) was positive for Giardia spp. Figure 1 depicts their occurrence and the physico-chemical parameters of the water sources.

Table 1: Occurrence of Cryptosporidium and Giardia with the assessed physico-chemical qualities of the water samples per sampling station

Sampling Station	**No.**	**Cryptosporidium** (oocyst/L)	**Giardia** (cyst/L)	**pH**	**Temp.** (℃)	**EC¶** (µS/cm)	**TDSΔ** (ppm)
Acceptable Range* Class B1 Class C2				6.5-8.5 6.5-9.0	26-30 25-31		
River (Upstream)1	1	0	0	8.4	27.7	236	155
	2	0	0	8.2	28	237	156
	3	0	0	8.2	26.9	237	156
River (Midstream)1	1	0.2	0	8.4	31.6†	251	163
	2	0	0	8.2	31 †	239	158
	3	0.2	0	8	30.7 †	240	159
River (Downstream)1	1	0	0	8.2	32 †	255	168
	2	0	0	8.2	31.9 †	253	168
	3	0	0.1	8.2	31.7 †	256	169
Creek (Upstream)2	1	0.1	0	8.2	27.8	399	269
	2	0	0	8.2	27.8	402	268
	3	0	0	8.4	28.1	400	264
Creek (Midstream)2	1	0	0	8	28.2	394	265
	2	0	0	8	27.2	400	268
	3	0.1	0	8.2	27	398	267
(Creek Downstream)2	1	0	0	8	26	406	279
	2	0.3	0	8.2	26.6	411	272

	3	0.3	0	7.6	26.4	402	268
Water Pumps1	1	0	0	7.2	30.1 †	599	400
	2	0.1	0	7.6	32.8 †	352	235
	3	0	0	8	28.8	349	231
	4	0	0	7.6	29.4	394	552
	5	0	0	7.6	26.5	597	406
	6	0	0	7.6	26.2	623	421

* Based on the Water Quality Guidelines of DENR to maintain its intended beneficial use
† Out-of-acceptable range based on DENR Guidelines
¶ Electrical Conductivity; Acceptable Range = 1000 µS/cm (US EPA)
Δ Total Dissolved Solids; Acceptable Range = 500 ppm (US EPA)

It was found that the highest concentration of Cryptosporidium was detected from the creek with a total concentration of 0.8 oocyst/L. It was followed by the river with a total concentration of 0.4 oocyst/L and pump (1) with 0.1 oocyst/L. Giardia was only detected in river with a low concentration of 0.1 cyst/L. The results of physico-chemical characteristics were compared to the acceptable range based on the water body classifications set by the Department of Environment and Natural Resources (DENR) of the Philippines. The river and water pump in the community are intended for primary contact recreation like bathing and swimming (Class B). Creek, on the other hand, is for agriculture, irrigation and livestock watering (Class C).[11]

From four assessed parameters, the temperature in river-midstream, river-downstream, pumps 1 and 2 were observed out-of-range but can still be accepted as naturally occurring, depending on the natural background, if the increase is only up to 10%.[11] The time of collection was at around 1000H–1200H, a reflection for the slight increase of water temperature. The water from the river and creek was slightly alkaline but it was still within the maximum permissible limit for both Class B and C bodies of water. DENR did not include EC and TDS either as the primary or secondary parameters to monitor but US Environmental Protection Agency (US EPA) considered 1000 µS/cm as recommended limit value for conductivity and 500 ppm for TDS.[12] As per US EPA guidelines, the EC and TDS of the water samples were acceptable except for the water pump (4) with a slight increase in TDS. Generally, the quality of water from all the water sources of Boliwong community is acceptable based on the standards of DENR (pH and temperature) and US EPA (EC and TDS).The results of this study confirm the presence of Cryptosporidium and Giardia even in water sources with acceptable quality based on various water regulations. In the case of Boliwong, the water system in the community should be monitored because it plays an important role in their daily subsistence. River and water pumps serve as the daily water sources for bathing, washing clothes, washing dishes and leisure among the people in the community. Fortuitous taking of water while swimming is associated to Cryptosporidium and Giardia infections. The infectious dose of these parasites are estimated as low as 10 oo(cysts),[13,14] which poses great risks to people who has constant contact with water contaminated by parasites.No study has been found about the presence of Cryptosporidium and Giardia in agricultural produce in the Philippines but the high occurrence of Cryptosporidium in creek of Boliwong, which is used for crop irrigation, suspects the presence of the parasites in vegetables, rice crops, and fruits from this and other neighboring communities. The use of contaminated wastewater for irrigation has been reported in various studies promoting foodborne transmission of Cryptosporidium and Giardia.[15]On the other aspect, feces coming from dogs, cats, chickens and goats were seen pooling on the surroundings grounds just a meter away from river and creek. These animals were free-roamers in the community, which have an access to the river and creek to drink and to take a bath. It promotes zoonotic transmission of Cryptosporidium and Giardia that can intensify the rate of infections in the community.[4]There are several potential gateways for Cryptosporidium and Giardia to infect humans in Boliwong. A study on the epidemiology of these protozoa within an indigenous community can give light to the condition of public health among the marginalized members of the society. It is deemed vital for national development. The threats they are facing as well as their practices and strategies in coping with problems besetting their ecosystem has a potential impact in the whole system of the country.[16] This study calls for in-depth surveillance in the community (and other indigenous communities) in regard with Cryptosporidium and Giardia contamination and infection before a possible outbreak could happen.

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