

## Water-borne pathogens in urban areas of Shillong, India

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To ascertain the risk of health hazards, if any, due to enteric water-borne pathogens in Shillong, India, an investigation was carried out in two streams, namely the Umkhrah and Umshyrpi streams, from April to September 1991. A total of 96 water samples examined revealed 84 (87.5%), 60 (62.5%), 35 (36.45%) and 39 (40.62%) samples positive for coliform (bacteria), *Escherichia coli*, protozoan cysts and helminth eggs and/or larvae, respectively. Both the streams were found to be positive for three species of pathogenic protozoa, i.e. *Balantidium coli*, *Giardia lamblia* and *Entamoeba histolytica*, and the eggs/larvae of two helminths, i.e. *Ascaris* spp. and *Schistosoma* spp. Among these the most dominant contaminant was the cercaria larvae of *Schistosoma* spp. (28.12%) followed by cysts of *Giardia lamblia*.

### Introduction

The general agents of water pollution are animal and plant wastes, municipal discharges, industrial wastes and agricultural chemicals. However, pollution in terms of parasites is restricted to faeces of warm-blooded animals (i.e. faecal pollution). About half of the world's population has suffered from diseases due to drinking polluted water,<sup>1</sup> resulting in more than five million deaths due to gastro-enteritis each year. The mortality rate due to water-borne diarrhoea, particularly among children aged under five years in different parts of the tropics has been well demonstrated by Snyder and Merson<sup>2</sup> and Bockemühl.<sup>3</sup> However, studies on the occurrence of pathogens in water in India are scarce,<sup>4-6</sup> and in respect of North-East India, there is at present no report exclusively on parasitic contaminants of water due to faecal discharges in streams. The continuing formation and utilisation of unhygienic low-cost latrines and slaughter houses draining to open streams facilitate the contamination of water and open up a man-made cause of concern to human health.

Therefore, to evaluate the risk, if any, of health hazards due to polluted waters in Shillong, a humid sub-tropical mountainous zone in India, an investigation of the water quality of Umshyrpi and Umkhrah streams was carried out. Both of these streams provide a ready source of water for recreation and various domestic purposes to the inhabitants of several localities in the city.

### Materials and methods

#### Water sampling

Water samples used in the present study were collected from eight different stations of the two streams Umkhrah and Umshyrpi in Shillong city. Of these, four stations were upstream and four downstream. The study area experiences an alarming level of pollution by domestic (stations 2, 3, 4, 6 and 8) and industrial effluents (station 7). Stations 1 and 5 are in the extreme upstream of the two streams respectively, having clean water with no inhabitants in the surrounding area.

A total of 96 samples comprising 16 from each station were collected fortnightly from April to September 1991 in sterile bottles of 2 litre capacity. All the samples were tested within six hours of collection.

#### Coliform bacteria detection and enumeration

Total coliforms were enumerated by standard five-tube, most probable number (MPN) procedures, using lauryl tryptose broth and brilliant green lactose bile broth with faecal coliform confirmation in EC broth. Confirmation of *Escherichia coli* of faecal origin was carried out using the membrane filter technique using M-FC broth, as described in standard methods.<sup>7</sup>

#### Protozoal and helminthological tests

Parasitic protozoan cysts were detected and

identified by iodine-stained preparation using the concentration method.<sup>7,8</sup> Helminth eggs and/or larvae were detected using salt flotation technique<sup>9</sup> and were identified using morphological criteria.<sup>10,11</sup>

### Results

Bacteriological studies indicated the occurrence of coliforms in most of the stations of the two streams; five stations possessed *Escherichia coli* (Table 1). Of the total 96 samples examined, 87.5%, 36.45% and 40.62% were positive for pathogenic bacteria, protozoan cysts and helminth eggs and/or larvae, respectively. Six samples were positive for more than one type of protozoan and seven samples had both *Ascaris* eggs and *Schistosoma* eggs and/or fork-tailed cercariae.

Besides coliform bacteria (which showed the highest prevalence), the most predominant contaminants (in descending order of prevalence) were cercariae of *Schistosoma* spp., cysts of *Giardia lamblia*, eggs of *Ascaris* spp. and cysts of *Entamoeba histolytica* and *Balantidium coli* (Table 2).

The overall rate of contamination due to protozoan and helminth parasites was found to be higher (41.67%) in the Umkhrach stream than the Umshyrpi stream (35.41%). Local distribution of different pathogens in the two streams is shown in Table 1.

### Discussion

This study was probably the first survey of water-borne pathogens carried out in the hills of North-East India. The findings (Table 2) are not different from other tropical countries where water-borne pathogens are still considered alarming agents taking millions of lives each year.<sup>2,3</sup> This high rate of mortality in the tropics is mainly due to utilisation of surface water.<sup>12</sup>

Similar to our observations in the upstream of Umshyrpi, a high count (100 000 colony forming units/100 ml of water) of coliform was recorded by Oluwande *et al.*<sup>13</sup> in the upstream of a Nigerian river having a known source of contamination. However, comparative data provided by Evison and James<sup>14</sup> on tropical waters in India, Ceylon, Singapore and Egypt revealed that *Escherichia coli* in water did not seem to coincide with the known source of faecal contamination. Coliform densities may be more closely correlated with the number of

Table 1. Prevalence of bacteria, protozoan cysts and helminth eggs/larvae of public health significance in the Umkhrach and Umshyrpi streams in Shillong.

\* Station number and localities; \*\* Colony forming units

Pathogens	Range/no. (%) positive in stream							
	Umkhrach				Umshyrpi			
	1* Nongrah	2 Umpling	3 Wahingdoh	4 Jaiaw	5 Crenolane	6 Laban	7 Kench's trace	8 Mawprem
Total coliform/100 ml of water	9-17**	50-170	60-300	90-170	—	350-900	26-110	17-60
<i>Escherichia coli</i> /100 ml of water	—	17-80	34-220	80-170	—	240-500	12-70	—
<i>Balantidium coli</i> (cyst)	—	2 (16.67)	—	1 (8.33)	—	5 (41.67)	—	1 (8.83)
<i>Giardia lamblia</i> (cyst)	—	6 (50.0)	3 (25.0)	—	—	7 (58.33)	4 (33.33)	2 (16.67)
<i>Entamoeba histolytica</i> (cyst)	—	4 (33.33)	1 (8.33)	3 (25.0)	—	3 (25.0)	1 (8.83)	1 (8.83)
<i>Ascaris</i> spp. (eggs)	2 (16.66)	4 (33.33)	—	5 (41.67)	—	5 (41.67)	2 (16.22)	3 (25.0)
<i>Schistosoma</i> spp. (eggs/cercaria)	1 (8.33)	4 (33.33)	7 (58.33)	8 (66.67)	—	5 (41.67)	2 (16.22)	—

**Table 2.** Different types of pathogens recovered from water samples in Shillong and their intensity

Type of organism	Pathogens	No. (%) of positive samples	Intensity (per 100 ml)
Bacteria	Coliform	84 (87.5)	9-900 CFU*
	<i>Escherichia coli</i>	60 (62.5)	26-500 CFU*
Protozoa	<i>Balantidium coli</i>	9 (9.37)	1-5 cysts
	<i>Giardia lamblia</i>	22 (22.92)	1-3 cysts
	<i>Entamoeba histolytica</i>	13 (13.54)	1-8 cysts
Helminths	<i>Ascaris</i> spp.	21 (21.87)	1-85 eggs
	<i>Schistosoma</i> spp.	27 (28.12)	5-42 eggs/larvae

\* Colony forming units.

domestic animals in the watershed than with the number of people.<sup>15</sup> Compared with other tropical countries, namely Nigeria (8-100 000),<sup>13</sup> New Guinea (10-10 000),<sup>15</sup> West Africa (11-421),<sup>16</sup> Sierra Leone (40-240 000),<sup>17</sup> and Hawaii (100-10 000),<sup>18</sup> *E. coli* of faecal origin were found to be much lower in density (per 100 ml volume) than in the present study area.

The higher prevalence of protozoans and helminth eggs/larvae in the Umpling and Laban stations may be significantly related to the presence of numerous unhygienic latrines draining to the streams in these areas. Pranavakshari *et al.*<sup>6</sup> in Hyderabad (South India) found drinking water to be contaminated with different types of protozoan cysts only, while the soil samples from the same region had both pathogenic protozoan cysts and helminth eggs/larvae. The streams in Shillong are found to be contaminated with both protozoan and helminthic contaminants. The density of cysts/100 ml in the present study should be regarded as alarming to public health in the city.

Among helminths a considerably high rate of *Schistosoma* eggs and/or cercariae and *Ascaris* eggs in the water bodies may be related to the high rate of schistosomiasis and ascariasis among cattle and pigs, respectively, in the region.<sup>19,20</sup> A high rate of ascariasis<sup>20</sup> and giardiasis (7%) among human subjects in the region (information gathered from several health centres) may also indicate the involvement of water in health hazards in the region. Nama and Chauhan<sup>5</sup> found as many as 130 *Ascaris* eggs/100 ml water and a high intensity of *Schistosoma* cercariae in a water reservoir in Rajasthan. In peninsular India, where untreated, raw surface water is the main source of drinking water, up to 70% of the

rural population suffer from ascariasis.<sup>21</sup>

A high rate of water-borne pathogens in the area reflects inadequate sewage treatment and poor sanitary conditions. Stool examination of local inhabitants of the area for these infections seems a pre-requisite to drawing a correlation between the habitation around the two streams and contamination.

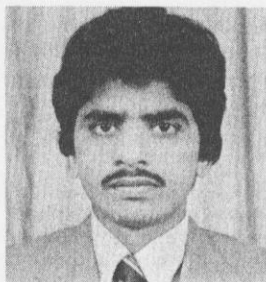
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