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Research Article

LEVEL OF PARASITE RISKS RELATED TO THE USE OF WATER FROM ARTIFICIAL LAKES BY THE POPULATIONS OF THE CITY OF DALOA (CENTRAL WEST OF COTE D'IVOIRE)

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ABSTRACT

In regions with limited water resources, the use of surface water such as that of lakes for different purposes can be an interesting alternative. It is clear that this use poses the problem of health risks for humans or animals. The objective of this work is to raise awareness among populations and authorities of the risks of pollution and reuse of lake water in the city of Daloa through the parasitological characterization of the lakes. Through the studies analyzed, 7 parasitic taxa were found using the modified Bailenger method, which is a method for concentrating parasites in wastewater. In this study, the parasites identified belong to the group of helminths and protozoa whose abundance differs from one lake to another. And among these three lakes, the most contaminated lakes are Lakes Bra Kanon1 and Gbokora. Lakes Bra Kanon1 and Gbokora present a similarity in terms of their parasitic community. And these data far exceed the standards recommended by the WHO in terms of wastewater reuse. Thus, this strong parasitic contamination of the raw water of the Daloa lakes testifies to the level of health risks incurred by the city's populations as well as the animals following their uses.

Keywords: Parasite risks, Artificial lakes, Populations, Daloa, Côte d'ivoire.

INTRODUCTION

Watercourses are among the most complex and dynamic ecosystems, playing a vital role in the conservation and evolution of biodiversity (Dynesius & Nilsson, 1994). One of the most pressing environmental issues concerns sanitation in general, and wastewater management in particular (Akpo *et al*., 2013). Human activity generates wastewater daily, which is then discharged into the environment. The release of untreated wastewater into natural environments is a widespread practice in most developing countries, and this situation is exacerbated in urban centers due to their rapid population growth. The significant changes observed, resulting from both human activities (rapid industrialization and urbanization) and natural factors, have potentially significant health and environmental repercussions (Strobl & Robillard, 2008). Urban wastewater constitutes a major source of pollutants and parasitic contaminants in water. Water, essential for life and used for numerous needs, can also pose a danger to human and animal health. Indeed, its quality has a direct impact on health, morbidity, and mortality, in both humans and animals (Kazi *et al*., 2009). According to data from the World Health Organization (WHO), approximately 1.8 million people, 90% of whom are children under five years of age living primarily in developing countries, die each year from diarrheal diseases (WHO, 2004). It is important to note that 88% of these diarrheal diseases worldwide are attributable to poor drinking water quality and inadequate wastewater treatment (Attab, 2011). However, in most developing countries, the monitoring and control of the quality of reused wastewater are not systematically carried out due to a lack of resources (Sadat *et al*., 2011). In Africa, the practice of controlling and treating wastewater before reuse is more widespread in arid areas, such as the Sahel, due to the scarcity of water resources. Conversely, in humid tropical areas, where rainfall is relatively abundant, wastewater treatment is not a priority and receives less attention in studies (Amy *et al*., 1996).

This is the case in Daloa, where most residents use lake water for various purposes without prior treatment, thus

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creating a risk factor for parasites. Consequently, its main lakes, which provide important socio-cultural and socio-economic services to the population, are subject to pollution. Indeed, a study assessing the parasitological contamination of domestic wastewater at the Cambérène wastewater treatment plant (Dakar) by Akpo *et al*. (2013) revealed that wastewater from tropical regions contains a significant quantity of intestinal parasite eggs and cysts. The consequences for public health can be disastrous, with an increased prevalence of parasitic diseases and a negative impact on the well-being and socio-economic development of the community.

However, there is no specific study on the parasitological aspects of the water in Daloa's artificial lakes. All wastewater reuse projects must undergo specific parasitological characterization according to the WHO (1997). This study, focusing on the level of parasitic risks associated with the use of water from artificial lakes by the population of Daloa (central-western Côte d'Ivoire), falls within this framework. Its objective is to raise awareness among the population and authorities regarding the risks of pollution and reuse of lake water in Daloa through parasitological characterization of the lakes.

MATERIALS AND METHODS

Study environment

Daloa is a department in the Centre-West region of Côte d'Ivoire, with latitudes ranging from 6°40' to 7°20' North and longitudes from 6°40' to 6°00' West. The capital of the Haut-Sassandra administrative region in Côte d'Ivoire, Daloa was founded in 1873 by the ancestor Dalo, hence its name, which means "the descendants of Dalo" (Zébri, 1949). It is located 141 km from the political capital Yamoussoukro and 383 km from the economic capital Abidjan. Its northern border is the Vavoua department, its southern border the Issia department, its eastern border the Bouaflé department, and its western border the Duékoué department (Figure 1). It is the third most populous city in Côte d'Ivoire after Abidjan and Bouaké. The population recorded in 2021 was 705,378 inhabitants, including 366,165 men and 339,212 women, with an estimated number of households of 124,239.

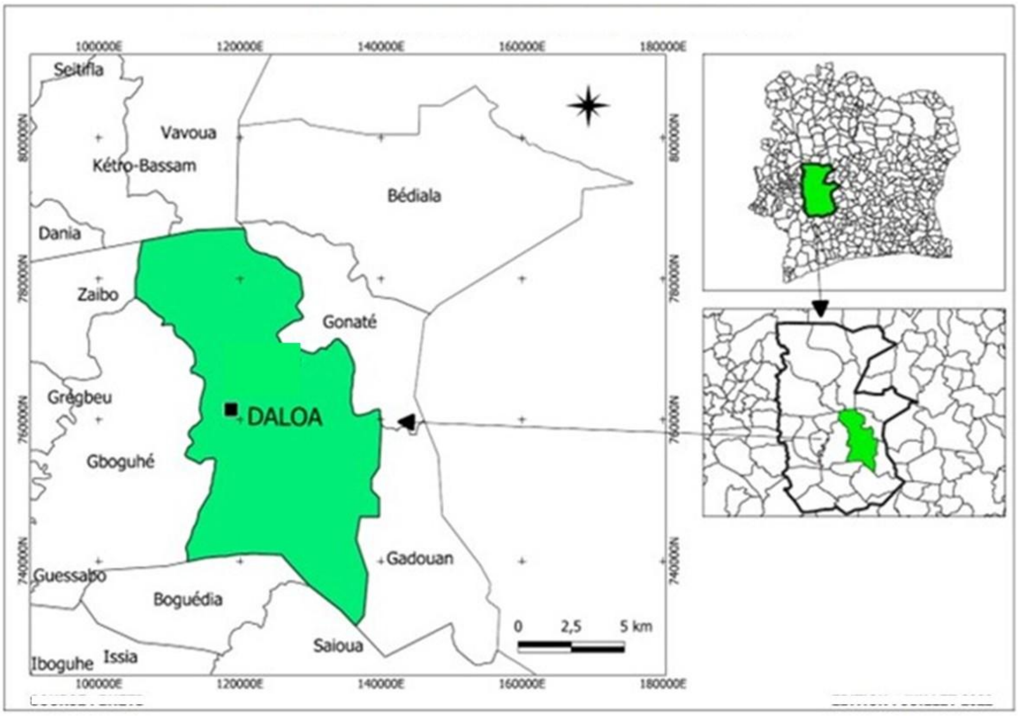

Figure 1. Presentation of the study area.

Table 1. Description of sampling lakes.

Lakes	Description et activités anthropiques
Lake Gbedji	Lake Gbedji is an artificial lake located just north of the city of Daloa (06°54'30.7" N and 6°27'26.9" W). This body of water has an estimated surface area of approximately 1.5 hectares with a gentle slope (0.38%). It is covered with herbaceous vegetation consisting mainly of grasses and ferns. On the left bank, food crops such as corn, cassava, and vegetables, as well as a cocoa plantation, can be seen. There is also a house with a toilet whose drainage system empties directly into the lake, and a shed where an alcoholic beverage, commonly called koutoukou, is produced.
lake Gbokora	Lake Gbokora is also located at the northern exit of the city of Daloa (06°54'54.2" N and 6°27'10.4" W). It is separated from Lake Gbedji by the paved road connecting the cities of Daloa and Vavoua. The slope at the station is gentle (0.33%), with a surface area of approximately 0.9 hectares. The lake, which constitutes this station, is bordered on its left bank by vegetation consisting of shrubs and several herbaceous plants, including Chromolaena odorata. The right bank of this body of water is occupied not only by the same vegetation as the left bank but also by food crops (maize, cassava), rubber tree nurseries, and a small-scale distillery.
Lake Bra Kanon 1	Station Bra Kanon 1 (LA2) is an artificial lake located in the heart of the urban area of Daloa (06°53'02.6" N and 6°26'03.8" W). This lake has a gentle slope (0.44%) and a surface area of approximately 2.3 hectares. On the right bank, there are herbaceous plants dominated by grasses and ferns, coconut palms, and waste produced by cattle that regularly come to drink there. This bank is also used for laundry and vehicle washing. On the opposite bank, there is a church, occupied and unoccupied houses, and some herbaceous vegetation.

Selection of sampling lakes

The preliminary study was conducted over one (1) month. It allowed us, firstly, to select the sampling stations and, secondly, to gather all the necessary equipment for carrying out this study. The sampling stations were chosen based on their accessibility, their ecological and socio-economic value, human activities, and proximity to dwellings. A total of three (3) lakes were selected: Lake Gbedji, Lake Gbokora, and Lake Bra Kanon 1.

Water sampling of lakes and laboratory analysis techniques

Water samples were collected manually from the various sites and placed in coded 1-liter polyethylene bottles. For this purpose, one site was designated for each lake (the site where the population has the most contact). Two samples were taken from each site, one in the morning (between 7 :00 and 9 :00 AM) and the other in the evening (between 4:00 and 6:00 PM). After sampling, 5 ml of 70% alcohol was added to each sample to fix microorganisms (Sylla *et al*., 2019). In total, four (4) sampling sessions were conducted over four (4) weeks, with one sample taken per week, resulting in 24 samples for our study period. The samples were transported to the laboratory in coolers for parasitological analysis. At the laboratory, the lake water samples collected from May to June 2024 were analyzed using the modified Bailenger method (WHO, 1996). This method was used for the parasitological characterization of the samples because it is the most recommended by the WHO due to its numerous advantages. The parasites identified in the morning and those identified in the evening at each site were combined to determine the daily parasite load of each lake. The three morning samples were analyzed upon my return from the laboratory, and the three evening samples the following morning. The Bailenger method was carried out as follows: First, I allowed the 1-liter wastewater samples to settle for 1-2 hours. Depending on the size of the container, I removed 90% of the supernatant using a siphon pump. Subsequently, I carefully transferred the sediment into four centrifuge tubes, according to the volume, making sure to thoroughly rinse the settling container with a detergent solution. I added the rinsing solution to the previously collected sediment while centrifuging at 1000 g for 15 min. After discarding the supernatant, and knowing that I had used several centrifuge tubes, I combined all the pellets into two tubes before centrifuging again at 1000 g for 15 min. Next, I suspended the centrifuged pellet in its volume of acetoacetic buffer at pH 4.5 (in other words, if the pellet volume was 2 ml, I added 2 ml of buffer). I then added two volumes of ether and thoroughly mixed the solution using a vortex mixer. After centrifugation at 1000 g for 15 min, the sample consisted of three distinct phases. I recorded the volume of the centrifuged pellet containing the eggs and then discarded the remaining supernatant all at once by carefully tilting the tube. I resuspended the pellet in five times its volume of zinc sulfate solution (for example, for a 1 ml pellet, I added 5 ml of $ZnSO_4$). I then quickly pipetted a small amount onto a slide, covering it with a coverslip (since I didn't have a McMaster slide for final examination). Finally, I left the covered slide on a flat surface for a few minutes before examining it under the microscope. This allowed me to identify the different parasites present in the various lake samples studied.

Identification of parasites

Helminth eggs were observed at 400x magnification, while protozoan cysts, due to their small size, were observed at 1000x magnification. Identification was performed using identification keys. Parasitological examination was carried out by dissection according to standard methods used in the study of fish parasites (Tavares-Dias & Martins, 2017). Various organs, such as the skin, fins, gills, abdominal cavity, and internal organs (intestine, stomach, liver), were inspected to detect the presence of parasites. Collected parasites were isolated, counted, and preserved in appropriate solutions for identification. The parasites were observed under a light microscope and identified based on their morphological and morphometric characteristics. Taxonomic keys and descriptions available in the scientific literature were used to identify parasites down to the genus or species level where possible (Woo, 2007). Only parasites known to infect humans were included (Chai *et al*., 2005 ; Robertson *et al*., 2014).

Data analysis

Species richness corresponds to the total number of zoonotic parasite species recorded across all sampled lakes. The taxonomic similarities between the parasite communities of the different lakes were highlighted using the Sorensen index. The Sorensen index is given by the following formula :

$$C = \frac{2j}{a+b}$$

Where: j = number of taxa common to the two groups being compared, a and b = number of taxa absent in one group but present in the other. This index ranges from 0 (no similarity) to 1 (identical environments) (Dajoz, 2000). There is no available statistical method to test the significance of the similarity index. The Percentage of Occurrence provides information on the habitat preferences of a given species. It consists of counting the number of times species i appears in the samples (Dajoz, 2000). It is the ratio, expressed as a percentage, between the number of samples (Fi) in which species i appears and the total number of samples (Ft) of the biocenotic unit considered. It is obtained using the following formula:

$$F = \frac{Fi \times 100}{Ft}$$

Based on the F value, the following classification is adopted (Dajoz, 2000): - Constant species: present in more than 50% of samples - Accessory species: present in 25% to 50% of samples - Accidental species: present in less than 25% of samples.

The taxonomic richness of parasitic communities was used to estimate the total number of taxa recorded in the different lakes (Aliaume *et al*., 1990). This composite index is a good indicator of an environment's carrying capacity. Statistical data analysis was performed using Excel 2016 software. The assessment of the level of parasitic risk was carried out through a literature review that considered parameters such as the percentage of occurrence, which indicates the frequency with which parasites are present or distributed in lake waters ; the severity of symptoms caused by parasites, identifying those that cause serious or mild illnesses; and the hygiene and lake water use practices of the inhabitants in relation to WHO standards for wastewater reuse.

RESULTS AND DISCUSSION

The taxonomic compositions of the parasitic communities in the lakes of Daloa are presented in Table V. Across all the lakes visited, seven (7) taxa belonging to four (4) families and two (2) orders were collected (Table II). The recorded orders are Helminths and Protozoa. Within the order Helminths, the parasites encountered are divided into two families: the Nematoda family, which has three (3) taxa, including *Ascaris* sp., *Strongyloides* sp., and *Trichuris* sp.; and the Cestoda family, which contains only one taxon, *Hymenolepis* sp. The order Protozoa is also divided into two families: the Rhizopoda family, which includes two (2) taxa, such as Entamoeba histolytica and *Entamoeba coli*; and the Flagellata family, which contains only one taxon, *Giardia* sp. Indeed, Lake Bra Kanon 1 and Lake Gbokora stand out for their taxonomic richness, containing seven (7) and six (6) parasitic taxa respectively out of the seven recorded. Lake Gbedji, on the other hand, exhibits low taxonomic richness (Figure 2). Eggs of *Ascaris* sp., *Strongyloides* sp., and *Entamoeba histolytica* were found in all sampled lakes, while taxa such as *Entamoeba coli*, *Giardia* sp., and *Trichuris* sp. were found in only two lakes, with *Hymenolepis nana* in only one lake (Table II).

Table 2. List of parasitic communities inventoried in the different lakes of Daloa.

Orders	Families	Taxa	Sampling lake		
			Lake Gbedji	Lake Gbokora	Lake Bra Kanon 1
Helminthes	Cestodes	*Hymenolepis* sp.	-	-	+
	Nematodes	*Strongyloides* sp.	+	+	+
		Trichuris sp.	-	+	+
		Ascaris sp.	+	+	+
Protozoa	Rhizopodes	*Entamoeba histolytica*	+	+	+
		Entamoeba coli	-	+	+
	Flagellates	*Giardia* sp.	-	+	+
Total		7	3	6	7

- = absence of species, + = presence of species

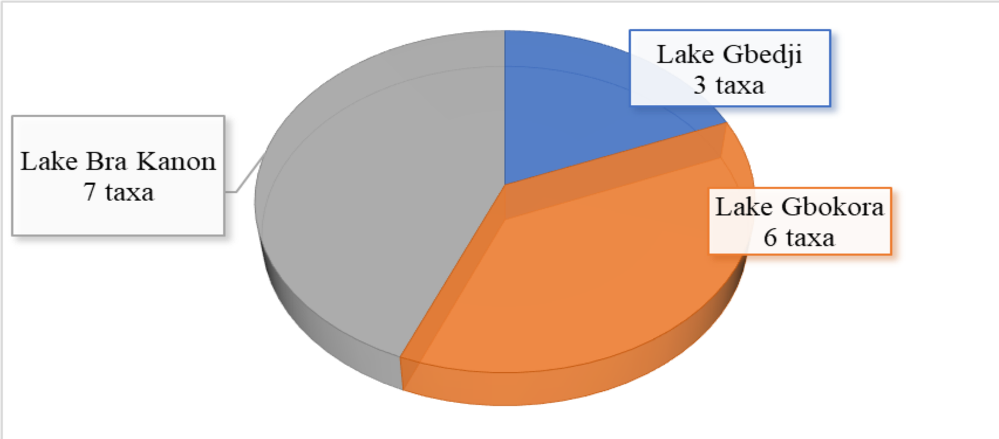

Figure 2. Taxonomic richness of the different sampling lakes.

Table 3. Percentage of occurrence of parasitic taxa isolated from the lakes of Daloa.

Taxa	Number of infested lakes	Percentage of occurrence (%)
Ascaris sp.***	3	100
Strongyloides sp. ***	3	100
Trichuris sp. ***	2	66,6
Hymenolepis nana **	1	33,3
Entamoeba histolytica. ***	3	100
Entamoeba coli. ***	2	66,6
Giardia sp. ***	2	66,6

* = Accidental species ; ** = Accessory species ; *** = Constant species ; OC (%) = Percentage of occurrence.

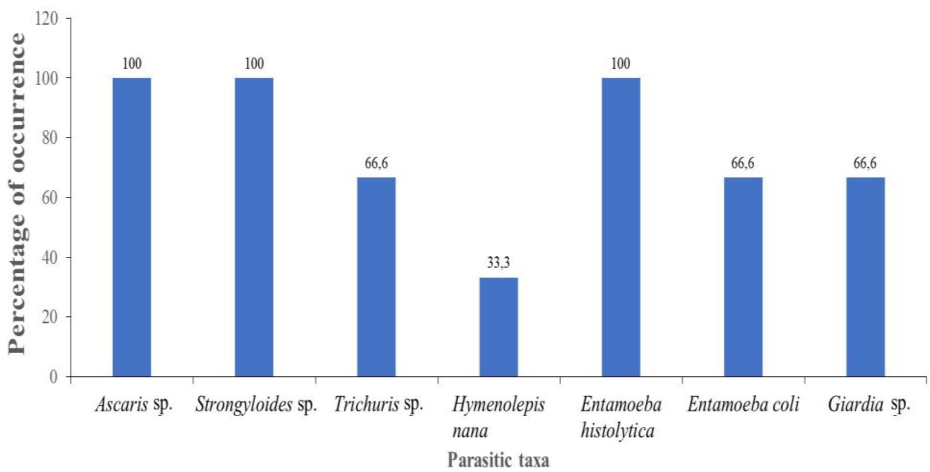

Figure 3. Percentage of occurrence of parasitic taxa identified in the lakes of Daloa.

The different taxa identified in the lakes exhibit varying percentages of occurrence. Indeed, taxa such as *Ascaris* sp., *Strongyloides* sp., *Entamoeba histolytica*, *Entamoeba coli*, *Giardia* sp., and *Trichuris* sp. are present in more than 50% of the lakes studied, making them consistent species. *Hymenolepis nana*, on the other hand, is present in less than 50% of the lakes studied, making it an accessory species. These different parasites are listed in Table III and also presented in Figure 3. The Sorensen similarity index values used to assess the taxonomic similarity between the parasitic communities of the different lakes, taken two at a time, indicate low similarities between the parasitic communities of Lakes Gbedji & Gbokora and Lake Gbedji & Bra Kanon 1, with values ranging from 60% to 66% (Table IV). However, it reveals a high similarity of parasitic communities between Lakes Bra Kanon 1 and Lake Gbokora, with a score of 92% (Figure 4).

Table 4. Sorensen Index of the different lakes in the city of Daloa from April to May 2024.

Lakes compared	Sorensen index
Lake Gbedji & Lake Gbokora	0,66
Lake Gbokora & Lac Bra Kanon 1	0,92
Lac Gbedji & Lac Bra Kanon 1	0,6

Close to zero = absence of similarity; close to 1 = similarity.

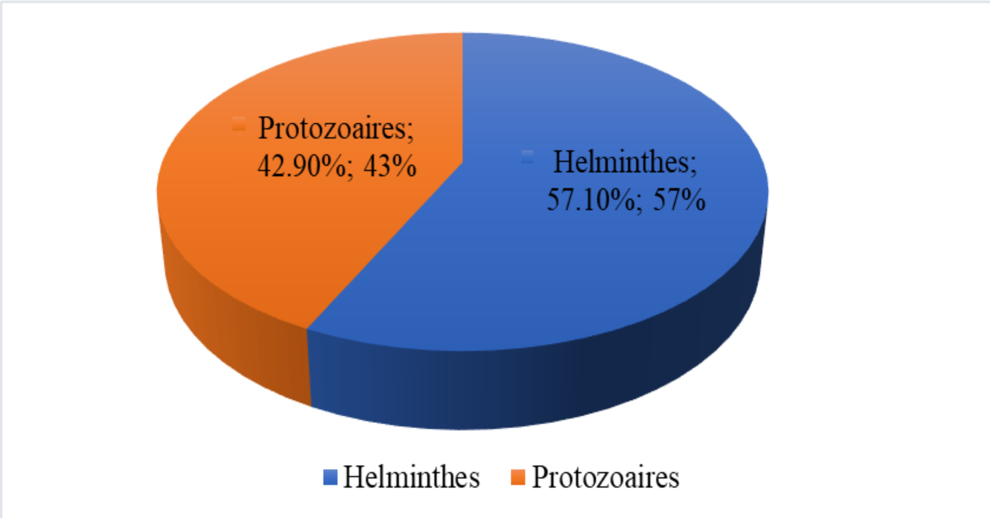

Figure 5. Distribution of parasite orders across the different sampling lakes

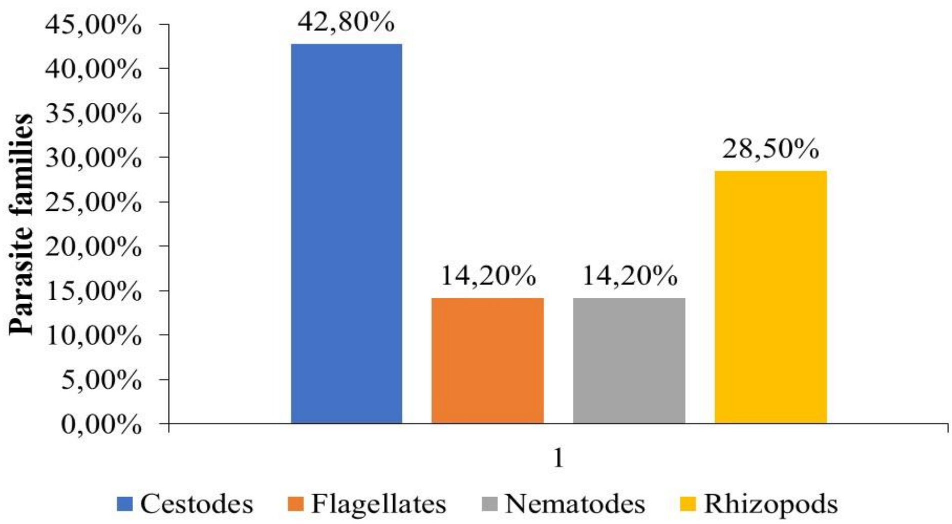

Figure 6. Relative abundance of parasite families across the different sampling lakes

The overall abundances by order and family of parasitic taxa collected from all the lakes are shown in Figures 5 and 6. Of the two orders encountered, the order Helminths is the most abundant with four (4) taxa collected (57.1% of the taxa), compared to the order Protozoa, which contains 42.9% (3 taxa). At the family level, the most abundant is the Nematoda family with three (3) taxa, representing 42.8% of the taxa. It is followed by the Rhizopoda family, which accounts for two (28.5%) of the taxa. Finally, the Cestoda and Flagellata families each contain only one parasite (14.2%). By examining the different parasites, we observe that their risk level varies according to their percentage of occurrence and the severity of their symptoms (Table V). Thus, parasitic risk levels have been divided into three risk classes. Parasitic taxa such as *Entamoeba histolytica*, *Ascaris lumbricoides*, and *Strongyloides stercoralis* present the highest risk level. Next come *Giardia intestinalis* and *Trichuris trichiura*, which present a medium risk level, and finally, *Hymenolepis nana* and *Entamoeba coli* present the lowest risk level (Figure 7).

Table 5. Level of parasitic risk according to species.

Parasites	Percentage of occurrence	Severity of Symptoms	Associated Diseases	Level of Risks
Entamoeba histolytica	100%	High	Amoebiasis	High
Ascaris lumbricoides	100%	Moderate / High	Ascariasis	High
Strongyloides Stercoralis	100%	High	Strongyloidiasis	High
Giardia intestinalis	66,6%	Moderate	Giardiasis	Medium
Trichuris trichiura	66,6%	Moderate	Trichocephalosis	Medium
Hymenolepis nana	33,3%	Bénigne	Hymenolepiosis	Weak
Entamoeba coli	66,6%	Bénigne	Not specifically associated with a disease	Weak

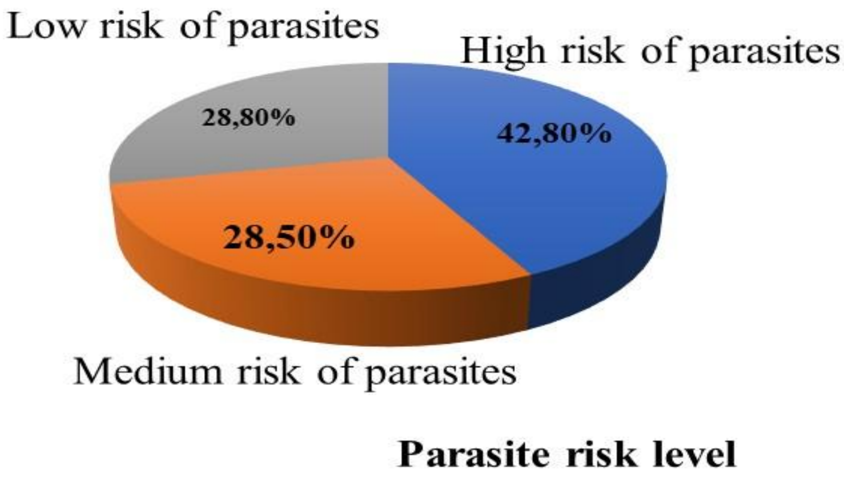

Figure 7. Parasite risk levels according to habitats.

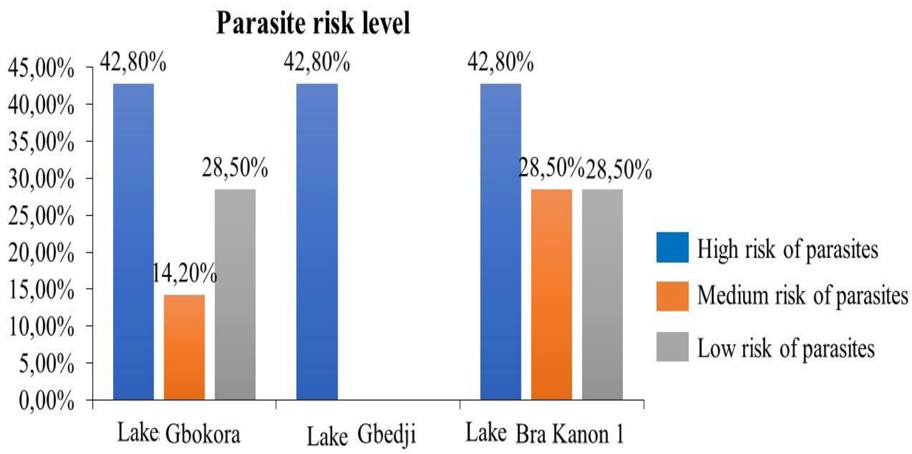

Figure 8. Level of parasite risk according to habitat.

The level of parasite risk varies from one lake to another. Indeed, all three lakes harbor certain parasites that pose a high risk. However, Lake Bra Kanon 1 presents the highest overall risk of parasitic infections, containing all parasites that cause high, medium, and low risk Figure 8). Following Lake Bra Kanon is Lake Gbokora, which also has a relatively high parasite risk. Lake Gbokora, on the other hand, has a relatively low overall parasite risk.

The waters of the artificial lakes in the city of Daloa exhibit a taxonomic richness of seven taxa. This taxonomic richness is similar to that recorded in a study of domestic wastewater discharged into the Sebou River basin in the city of Kenitra, Morocco (7 taxa) (Raweh *et al*., 2010). However, it is relatively lower than that revealed by Sylla *et al*. (2019) in their study on the Evaluation of the Diversity and Parasite Load of Lakes in the city of Yamoussoukro, Côte d'Ivoire, where they found 13 taxa. This observed difference could be related to the health status of the connected populations, certain dietary habits of the local residents, and also to the easy access of animals to collection points from one region to another (Nsom-Zamo, 1999; Lahlou, 1992). This difference in parasitic species could also be explained by the sampling period, which was carried out only during the month of May, a month dominated by low rainfall, and also by the region's climatic conditions.

Qualitative analysis identified seven (7) different parasite taxa in the form of eggs and cysts belonging to two orders of intestinal parasites: Within the order Helminths, the parasites encountered are divided into two families: the Nematoda family, which includes the taxa *Ascaris* sp., *Strongyloides* sp., and *Trichuris* sp.; and the Cestoda family, which includes the taxon *Hymenolepis* sp. The identified protozoa are also divided into two families: the Rhizopoda family, which includes the taxa *Entamoeba histolytica* and *Entamoeba coli* ; and the Flagellata family, which includes *Giardia* sp. These data reveal fecal pollution of human and animal origin carried by raw effluents. Helminths are the most frequently identified, with an occurrence rate of 57.1%, or 4/7 (42.8% nematodes and 14.3% cestodes), compared to protozoa, which account for only 42.8% of all parasites identified. This abundance of helminths was also revealed in the work of Cissé *et al*. (2011) in the wastewater of the "Gouro" collector (Abidjan District), and this is attributed to population growth, which increases the amount of raw effluent discharged into wastewater (Bouhoum, 1996). The distribution of identified helminth eggs shows a predominance of nematode eggs (42.8%), evidence of their easy transmission and high contaminating potential, including their high resistance in wastewater. This predominance of nematode eggs was also reported by Dssouli *et al*. (2001). Cestode eggs, on the other hand, represent only 14.3%, which explains their low resistance compared to nematodes, which exhibit greater resistance in wastewater (Guessab *et al*., 1993; Alouini *et al*., 1995).

Trematode eggs were not found. These results are in perfect agreement with those of (Lahlou, 1992; El Guamri & Belghyti, 2007), whose study focused on wastewater from El Jadida (Morocco), and those of (Akpo *et al*., 2013), on wastewater from the Cambérène treatment plant (Dakar). The absence of trematode eggs is thought to be linked to their density, specifically their rapid sedimentation and deformation, reflecting the limited performance of Bailenger's method for eggs of this class. Regarding the protozoan group, three taxa were identified as cysts: *Entamoeba histolytica*, *Entamoeba coli*, and *Giardia* sp., with occurrence rates of 100% and 66.6% for *Entamoeba coli* and *Giardia* sp., respectively. Among these three protozoa, two species (*Entamoeba histolytica* and *Entamoeba coli*) were also identified by Sylla *et al*. (2019) at somewhat similar rates. Indeed, within the helminth group, the various taxa identified during our parasitological analyses, such as *Ascaris* sp. and *Strongyloides* sp., were also present. are present in all the different sampling sites with an occurrence rate of 100%. These data are consistent with those of (Cissé *et al*., 2011) who found the same percentages for these two taxa. However, a major difference between their work and ours should be highlighted. Indeed, in our study, the *Hymenolepis* sp. taxon was the least abundant among all the other taxa, with an occurrence rate of 33.3% across all the lakes, in contrast to the study which found an abundant presence of *Hymenolepis* sp. at 100%. This difference could be explained by the organic composition of the effluents, which may vary due to dietary habits or pollution related to the lifestyles of the local populations (El Guamri & Belghyti, 2007).

Quantitatively, the level of parasitic contamination varies considerably from one lake to another; some have a high parasitic presence compared to others. This is the case of Lake Bra Kanon1 which contains within it all the seven (7) identified taxa, i.e. 100% parasitic presence, therefore the most contaminated, followed by Lake Gbokora which contains 85.7% of the identified taxa and finally Lake Gbedji, the least contaminated with a percentage of occurrence of 42.8% in terms of parasitic presence. The Sorensen index applied to the different parasitic communities of the lakes shows a low similarity between the parasitic communities of Lakes Gbedji & Bra Kanon 1 and Lake Gbedji & Gbokora, but reveals a significant similarity between the parasitic communities of Lake Bra Kanon 1 & Lake Gbokora. These differences may be due to the size and socioeconomic level of the urban populations connected to each lake (Raweh *et al*., 2010). Indeed, Lakes Bra Kanon 1 and Gbokora are located in the heart of the city, and their surroundings are home to various economic activities such as informal eateries, hotels, restaurants, kiosks, a plastic water production plant, and a school. Wastewater, food scraps, and other waste from these establishments are dumped into the lakes daily. Lake Bra Kanon 1, in particular, is a large lake connected to a large population. In addition to the established businesses, some areas have become dumping grounds for household waste. According to some residents, it is also the site for the discharge of wastewater from the regional hospital (CHR) and the morgue, and it is also used as a rinsing point for tanker trucks carrying sewage.

The level of parasitic risk varies depending on the percentage of occurrence and the severity of symptoms. First, Entamoeba histolytica presents a high risk level, with a 100% occurrence rate and severe symptoms. This high risk level for *Entamoeba histolytica* is consistent with previous studies that also highlighted the severity of *Entamoeba histolytica* infections (Haque *et al*., 2010). Similarly, *Ascaris lumbricoides* is also classified as high risk for the same reasons, which is in agreement with previous research highlighting the severity of *Ascaris lumbricoides* infections (Bethony *et al*., 2006). However, *Strongyloides stercoralis*, although with a 100% occurrence rate, is associated with high symptom severity, which also places it in the high-risk category. This finding is supported by previous studies highlighting the significant morbidity associated with this infection (Olsen *et al*., 2008). In contrast, *Giardia intestinalis* has a relatively high occurrence rate, but the average severity of its symptoms leads to a moderate risk level. It is possible that, despite its notable frequency of infection, the symptoms are not as severe as those of other parasites. For *Trichuris trichiura*, the combination of a moderate occurrence rate and average symptom severity classifies it at a medium risk level. This assessment is consistent with previous studies on the morbidity associated with this infection (Pullan *et al*., 2012). Finally, *Hymenolepis nana*, although less prevalent, presents with mild symptoms, placing it at a low risk level. Its low risk level is consistent with previous studies highlighting the generally benign nature of Hymenolepis nana infections (Moro & MClean., 2017). Similarly, *Entamoeba coli*, despite a prevalence similar to *Giardia intestinalis*, is also considered to be at a low risk level due to the mild severity of its symptoms. This finding is supported by studies that have emphasized the generally benign nature of *Entamoeba coli* infections (Fotedar *et al*., 2007).

CONCLUSION

Our study on the level of parasitic risks associated with the use of water from artificial lakes by the population of Daloa revealed, through the samples taken, a diversity of parasites in the three lakes studied. In this study, the parasites identified belong to the group of helminths and protozoa, whose abundance differs from one lake to another. Among these three lakes, the most contaminated are Bra Kanon 1 and Gbokora, with parasite occurrence rates of 100% and 85.7%, respectively. These figures far exceed the standards recommended by the World Health Organization. This data indicates a high level of infestation in the human and animal populations of the lakes in question. Despite this high level of parasitic contamination, the raw water from the lakes continues to be reused for market gardening by gardeners and by some city residents for various purposes. Thus, this high level of parasitic contamination in the waters of Daloa's lakes reveals a health risk linked to the various practices of using the water from these artificial lakes, exposing both the city's population and animals. Indeed, the various parasites identified are all pathogenic to humans. Furthermore, the presence of certain pathogenic species, such as intestinal nematodes, and particularly *Ascaris* sp., *Trichuris* sp., and *Strongyloides* sp., in wastewater is considered a major risk for the reuse of this water in agriculture, according to the WHO in 1989.

Limiting the risks attributable to wastewater requires not only abandoning current practices of water reuse but also adhering to hygiene rules regarding raw produce. As recommendations, we encourage : - raising public awareness of the risks associated with using lake water and consuming produce from gardens in the studied lakes. - ensuring the functionality and operational readiness of existing wastewater treatment plants to prevent lake contamination and the associated health risks to the population. - urging city authorities to incorporate lake maintenance into their urban development plans to reduce pollution levels in existing lakes and meet WHO recommendations. Looking ahead, the study should be extended over a longé period to account for the influence of seasonal variations on the lake parasitic community, taking into account other surrounding lakes.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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