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RESEARCH ARTICLE

ECOLOGY OF SNAIL PARASITES IN THE CENTRAL PLATEAU REGION OF BURKINA FASO, WEST AFRICA

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ABSTRACT

Snail was invertebrate host of many parasites including trematode, nematode and annelid. Trematode are endoparasites that present a complex life cycle, generally involving an intermediate invertebrate host and a vertebrate host. Many studies have focused on the diversity of trematodes in molluscs in several countries of the world. But research on mollusc parasites is little addressed in Africa, especially in West Africa. The aim of this study was to conduct a freshwater snail survey to assess the diversity and the relation with a focus on habitat types and their parasites infections. Snails were collected in different areas of central plateau region and examined. A total of 936 individuals' snail was collected and classified into four families, 6 genera, and 8 species. Snail diversity was higher in soil. The most abundant species was *Melanoides tuberculata*, representing 23.08% of the sample and the reservoir of Loumbila records the abundant and diversity of snail species. Three species of snail were free of parasites. They are *Biomphalaria Pfeifferi*, *Bulinus joussemei* and *Melanoides tuberculata.* The harvested parasites are divided into two groups that are the trematodes (12 species) and Annelids (1 specie) with an overall rate of 6.60%. The Shannon diversity index showed that parasitic diversity varied between the two sites based on infected hosts, micro-habitats and seasonal periods. *Cleopatra*sp presented the highest diversity of parasite among the species of gastropods collected. The infection rate varied according to the collection months and according to the micro-habitats. *Lecithodendrium*sp only had an aggregated distribution during this study.

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INTRODUCTION

Freshwater gastropods are important components of aquatic food webs. They serve to balance the ecological niche by providing nutrients to terrestrial and aquatic ecosystems. Some species are of great commercial importance for human beings in breeding or for ornamental purposes, whereas others are used as bio indicators to monitor the level of contamination of aquatic environments by pollutants such as heavy metals and pesticides (Tietze and Francesco, 2010). Freshwater gastropods are best known as vectors of transmission of parasites to humans and animals. Many species of Trematodes such as schistosomes and flukes, which are of medical and veterinary importance also use these freshwater gastropods for their life cycle (Martin and Cabrera, 2018). Various types of habitats such as river minor beds, floodplains, tributaries, ponds and irrigation channels are prone to host molluscs (Thiam and Anis, 2010). The presence, distribution and abundance of freshwater molluscs depend on the characteristics of the environment. Species that act as intermediate hosts of parasitosis generally prefer warm, shaded, stagnant or moderately flowing waters with abundant vegetation (rivers, marshes, ponds, natural and artificial lakes, dams, ponds or irrigation systems) (Thiam and Anis, 2010). Their habitat is really polymorphic and they generally live at a depth of 20 to 30 cm beneath water on plant stems, dead leaves or in the mud at the bottom. The burial of certain species during the dry period allows certain molluscs like *Bulinus* to resume their activity when water returns (Dreyfuss *et al.*, 2011). Molluscs are particularly present in the digeneans cycle, as they are always the first and often the second intermediate host (Bryant, 1998). Previous studies have focused on the distribution of intermediate host molluscs of schistosomiasis and the diversity of trematodes (Kpoda *et al.*, 2022). However, most studies on trematodes and other mollusc parasites are poorly explored despite their influence in the physiology of gastropods (Morley, 2006). In addition to that, data on the relationships between molluscs, their parasites and their environment are scarce. The aim of this study is then to analyze the relationship between parasites and snails along with the characteristics of the environment in order to control effectively parasitosis.

MATERIAL AND METHODS

Study area: The present study was carried out in the reservoirs of Loumbila and Ziga (Figure 1). The reservoir of Loumbila (12°29' N, 01°24' W) is located about 20 km north of the city of Ouagadougou, built in 1947, then restored several times. This reservoir has a capacity of about 42 million cubic meters (m^3). The average depth of this lake is 2.15 m and the surface area in full water is 16.80 km². The reservoir of Ziga is located 50 km from Ouagadougou, the Ziga dam lake (12°37'03.22" N and 0°49'23.43" W) has a capacity of 200 million m^3 and covers 70 Km². It was built between May 1998 and July 2000. These two reservoirs are located on the Nakambé River in the Sudano-Sahelian zone. These reservoirs supply the capital city of Ouagadougou with water and fishery products. These reservoirs have the highest diversity of gastropod species in Burkina Faso (Ouédraogo, 2018), hence their choice as research sites.

Physico-chemical characterisation of reservoirs: The characterisationof snail habitats consisted in measuring the physico-chemical parameters of the water in the reservoirs. The parameters of interest were temperature (°C), pH, conductivity, salinity and transparency, which play an important role in the emergence of trematodes. In fact, temperature plays an important role in the pre-patent period of trematodes; the Hydrogen potential (pH) is an important to define whether a given water is aggressive or incrusting; the electrical conductivity (µS. cm-1) allows aquick but approximate assessment ofwater mineralization and to follow its evolution; salinity determines and monitors the total concentration of dissolved substances in the water; as for transparency (cm), it allows to measure the depth of light penetration; this also impact the positive phototropism of miracidia. Transparency was measured using a Secchi disk. With a HANNA multi-parameter probe (model HI 98129), temperature, pH, electrical conductivity and salinity were determined *in situ*. These measurements were made at each sampling time.

Collection and identification of gastropods: Snails were collected once a month from September 2019 to March 2020. Sampling was carried out earlier in the mornings when low temperatures and low light conditions were observed. Three complementary methods were used to collect gastropods in order to take into account the diversity of microhabitats over a 20 m stretch. For the nearshore and pelagic zones, gastropods were collected with a dip net made of a 500 µm mesh net mounted on a metal frame with a 50 cm square opening. For the deep benthic zones, the collection was carried out in a dugout in a place where the water is shallow with an Eckman grab. Manual collection was also carried out for shoreline gastropods. During the sampling, we wore gloves and waders for our own protection. The collected gastropods were kept alive in wide-mouthed, aerated jars containing water from each site. The jars were labelled with the name of the site, the date, the micro-habitat of collection and then carried to the laboratory. For the identification of gastropods, morpho-metric parameters such as height for conical shells and shell diameter for discoid shells were measured witha caliper (precision = 0.1 mm). They were all identified in the laboratory up to species level using the identification keys provided by Lévêque (1980) and Brown (1994).

Collection and identification of parasites

Harvesting of parasites: Each individual gastropod was first observed under a binocular loupe looking for any ectoparasites and then examined using cercarial excretion methods. Emerged cercariae were collected using a stretched Pasteur pipette for identification. Dissection of the gastropods was also carried out to look for parasites. This method not only established the distribution of the parasites obtained and their abundance according to the sites of infection in the host, but also allowed the observation of other developmental stages of trematodes and other parasites.

Measurement and identification of parasites: Measurements were made with a calibrated eye piece micrometer. The length of the body, esophagus, tail, furcae and diameter of the suckers were measured. Parasites were mounted between slide and coverslip and observed under a Carl ZEISS light microscope. Identification was made by observing the following anatomical and morphological characteristics. Thus, live cercariae were first mounted between slide and coverslip with a drop of water to observe their swimming behavior and then stained with a drop of 1% iodine. They were identified using the identification keys of Frandsen and Christensen (1984) and Hechinger (2012). As for the Annelids, they were observed directly without any prior staining and identified according to the identification keys of Brinkhurst and Jamieson (1971).

Statistical analysis: The data were analyzed by the statistical programs R.4.0 and the software PAST Version 3.0. The physicochemical characteristics of the research environments were compared using a Student's parametric test. The diversity of the parasitic fauna of the collected gastropods was analyzed by listing the parasites encountered on the captured gastropods according to the sites, microhabitats and capture period. Diversity parameters such as absolute abundance, species richness and Shannon & Weaver's H' index were estimated. Absolute abundance reflects the number of individuals of a given parasite species within the total number of parasites collected. Species richness refers to the total number of parasite species collected. Shannon's H' index expresses the specific diversity of parasite infections.For each mollusc population, the overall parasitic diversity based on the presence of different parasitic species was estimated from the Shannon-Weaver diversity index (H). All these indices were calculated using the PAST software. In order to analyze the parasite distribution, the prevalence **(P)** according to hosts, microhabitats, sites and periods was determined. The non-parametric chi-square test was used to compare infection frequencies between sites, hosts, microhabitats and collection periods. A probability of less than 5% was considered significant for statistical analysis. The distribution of parasites was done by drawing up comparison tables.

RESULTS

Host populations: During this study, 939 gastropods were collected at the research sites. The molluscs collected belonged to 4 families: the family Thiaridae with three species (Table 1): *Cleopatra bulimoides* (Olivier, 1804), *Cleopatra sp*, *Melanoides tuberculata* (Müller, 1774); the family Planorbidae with two species: *Biomphalaria pfeifferi* (Krauss, 1848), *Bulinus jousseaumei* (Dautzenberg, 1890); the family Ampullariidae with two species: *Lanistes ovum* (Troschel, 1845), *Lanistes lybicus* (Morelet, 1848); the family Viviparidae with a single species: *Bellamya unicolor* (Olivier, 1804).

Table 1. Distribution of host species in the study area

Sites/Snail number		Loumbila	Ziga	Total
Thiaridae	*Cleopatra bulimoides*	130	69	199
	Cleopatra sp	20	0	20
	Melanoides tuberculata	95	121	216
Planorbidae	*Biomphalaria pfeifferi*	90	0	90
	Bulinus jousseaumei	31	0	31
Ampullariidae	*Lanites ovum*	170	19	189
	Lanites lybicus	73	4	77
Viviparidae	*Bellamya unicolor*	87	30	117
DI	SR	8	5	8
	H'	1,93	1,23	1,87

All species of prosobranch (Ampullaridae, Thiaridae, Viviparidae) were found in Loumbila and Ziga while the species of pulmonates (Planorbidae) were only found in the Loumbila site (Table 1). In general, snail diversity and abundance were high in the reservoir ofLoumbila (H'=1.93) compared to the reservoir of Ziga site (H'=1.23).

Prevalence and Abundance of harvested parasites: Of the 939 snails examined, 62 were parasitized, *i.e.* an infection rate of 6.60% with a total abundance of 705 parasites, including 568 trematodes and 137 annelids.

Table 2. Prevalence and abundance of the parasite species

Parasite species	Prevalence %	Abundance	Mean intensity
Lecithodendrium sp	0,43	344	86
Haematoloechus sp	0,11	12	12
Apatemon sp1	0,11	10	10
Apatemon sp2	0,32	114	38
Apatemon sp3	0,32	8	3
Acaudate xiphidiocercaria sp1	0,11	20	20
Acaudate xiphidiocercaria sp2	0,11	7	7
Aporocotyld sp1	0,11	25	25
Aporocotyld sp2	0,11	2	2
Plagirchioid sp	0,21	21	10
Tubifex sp	5,54	137	3
Furcocercaire1	0,11	2	2
cercaire1	0,11	2	2
Total	6,6	705	11

An analysis of the infection rates according to the hosts showed a significant difference ($P \leq 0.05$). Indeed, the highest rate (25%) was observed in *Cleopatra* sp and the highest abundance of parasites in *Lanistes ovum*. Table 2 shows the prevalence and abundance of the parasite species. *Tubifex* sp was the most frequently encountered species and *Lecithodendrium* sp was the most abundant with an average density of 86 parasites per infected host. The infection rate of annelids was 5.54% and the infection rate of trematodes was 1.17%. Trematode species were collected from five different snail species, namely *Cleopatra bulimoides* (1%); *Cleopatra* sp (10%); *Lanistes lybicus* (1.29%); *Bellamya unicolor* (1.7%) and *Lanistes ovum* (2.11%).

Diversity analysis: An analysis of the parasites identified reveals a strong predominance of *Lecithodendrium*sp 48.79%.

In terms of parasitic diversity into host, *Cleopatra* sp showed the highest diversity index (H'=1.585) with ten species mentioned and a total abundance of 255 parasites. In contrast, *Lanistes ovum* showed the lowest parasite diversity (H'=0.147), with two parasite species and a total abundance of 355 (Table 3). Analyze of parasite diversity according to the collection period showed that the month of March contained the highest diversity of parasite species with an H' of 1.399 (Table 4). In fact, during this period, ten parasite species were collected with a total abundance of 187. The diversity of parasite infestations also varied between sites. Indeed, the Loumbila site is the most diversity with 13 morphologically different species and a diversity index of 1.549 (Table 5). However, the comparison of the average values of physicochemical parameters showed that there was no significant difference in these parameters between the sites.

Parasite distribution according to biotic parameters

Parasite distribution according to hosts: Distribution of infection frequencies between gastropod species showed a significant difference (p-value ≤ 0.05). This means that the infection rates of the different host species are different. The parasite species are heterogeneously distributed among the host species with a very strict specificity. The host species (*Cleopatra bulimoides, Cleopatra* sp, *Lanistes lybicus, Bellamya unicolor* and *Lanistes ovum*) were infected by at least two parasite species (Table 6). Trematode infection rate shows that there is a significant difference within hosts (p-value $\leq$ 0.05). This shows that the rate of trematode infections varies according to the host. In fact, trematode infections were more observed in the genera *Cleopatra, Lanites* and *Bellamnya*. Parasitic relationships according to host species reveal parasitic specificities of the oioxene, stenoxene and even euryxene types (Table 6). In fact, *Haematoloechus* sp and *Lecithodendrium* sp collected from *L. ovum*, *Aporocotylid* sp, *Acaudate xiphidiocercaria* sp as well as cercariae 1 collected from *Cleopatra* sp have an oioxene specificity. *Apatemon* sp collected from the genera *Cleopatra* and *Bellamya* have stenoxene specificity. *Tubifex* sp which parasitized all infected host species have euryxene specificity. *Aporocotylid* sp, *Acaudate xiphidiocercaria* sp and *Apatemon* sp have been found in mixed infections in host individuals. *Haematoloechus* sp and *Lecithodendrium* were only observed in single infection. Tubifex sp was the most widespread parasite, *i.e.* observed in most of the snail population examined (Table 6).

Parasite distribution according to host organs: The distribution of parasites in the different host organs shows that the muscular tissues of the foot and the hepatopancreas contained high parasite abundance and are infected by several parasite species. These organs contain the bulk of the parasites with 10 and 3 species collected respectively. Each parasite had a specific location except for *Lecithodendrium* sp and *Apatemon* sp2 which were collected from the hepatopancreas and foot muscle tissue. *Lecithodendrium* sp, *Apatemon* sp1, *Apatemon* sp2, *Acaudate xiphidiocercaria* sp1 and 2, *Aporocotyld* sp1 and 2 were found in the foot muscle. Annelids were found in the digestive tract. Only *Lecithodendrium* sp, *Haematoloechus* sp and *Apatemon* sp2 were found in the hepatopancreas, the other parasites are naturally freed by their host. The majority of the species identified were found in the foot muscle tissue. Only *Lecithodendrium* sp, and *Apatemon* sp2 were found in both organs.

Parasite distribution according to microhabitats: The distribution of infection frequencies of gastropods showed a significant difference with respect to microhabitats (p-value $=2.765e^{-10}$). Actually, only gastropods from microhabitats such as soil, pebbles, grass and floating plants were infected by the parasites. The highest infection rate was observed in floating plants followed by grass (Table 7). The distribution of parasite species according to microhabitats showed that the soil microhabitat had the most parasite species (10 species) followed by floating plants and pebbles with four species each. Grass was the least diverse microhabitat in terms of parasites (only two species) (Table 7). However, the microhabitat with the highest parasite population is grass. We also noticed a high abundance of parasites in the shoreline grass. The hosts collected within the microhabitats cement channel; irrigation channel; sediment and dead wood were not infected by any parasite species (Table 7).

Parasite distribution according to the Months: The variations in parasite infections are influenced by the period of collection. In reality, the infection rate varied according to the months (p-value =0.002981). We observed infections throughout the study period. However, the month of October had the highest infection rate (13.93%). An analysis of the distribution of parasites according to months shows that *Tubifex* sp was found all along the data collection period, but inabundance in the dry season; whereas Trematodes were only observed during the months of September and October (rainy season) and March (the hot and dry season). Trematode infection was higher in September. The highest number of species was collected during the month of March (10 species). Analysis of the parasite distribution according to the binomial distribution rule reveals that the parasite species are collected on a few host individuals. As a consequence, they have an aggregated distribution overall. This results in a value of V(M)/M equal to 1.509 (Table 8). *Lecithodendrium* sp presents an aggregated distribution (V(M)/M=3.06) and cases of under-dispersed distribution were observed with the others species (V(M)/M<1).

DISCUSSION

This study confirmed the existence of numerous species of freshwater gastropods in the Loumbila and Ziga reservoirs in Burkina Faso. There are *Cleopatra bulimoides*, *Cleopatra* sp, *Melanoides tuberculata, Biomphalari apfeifferi; Bulinus jousseaumei, Lanites ovum, Lanites lybicus, Bellamya unicolor*. All these species have already been mentioned in previous studies (Ouédraogo, 2018). An analysis of the parasite infection rate according to the hosts revealed a prevalence of 6.60%. This prevalence is lower than the one found by Abdulkadir *et al.* (2018) in Nigeria that is to say10.55% during the period of January to December. Our results could be explained by the sampling season which probably contributed to the low prevalence of cercariae excretion among the examined snails. The low prevalence of parasite infestation in this study could also be explained by parasite-induced host mortality.

Table 3. Parasite diversity indexaccording to the hosts

Snail host	Snail		Infestation rate(%)	ID		
	Examined	Infected		A	SR	H'
Biomphalariapfeifferi	90	0	0	0	-	-
Bulinusjousseaumei	31	0	0	0	-	-
Cleopatra bulimoides	199	5	2.51	27	2	0.158
Cleopatra sp	20	5	25	255	10	1.585
Laniteslybicus	77	13	16.88	16	3	0.463
Bellamya unicolor	117	8	6.83	52	4	0.951
Lanites ovum	189	31	16.4	355	2	0.147
Melanoidestuberculata	216	0	0	0	-	-
Total	939	62	6.6	705	12	1.57

DI: Diversity index; A: Total abundance; SR: Specific richness; H': Shannon diversity index

Table 4. Infection rate and parasite diversity index according to month

Mois	Host		Prevalence	DI		
	Examined snail	Infected snail		A	RS	H'
September	159	13	8.18	27	5	0,903
October	122	17	13.93	355	2	0,147
November	117	9	7.69	12	1	0
December	139	7	5.04	21	1	0
January	124	3	2.42	26	2	0.690
February	158	10	6.33	77	1	0
March	130	3	2.31	187	10	1.399
Total	939	62	6.6	705	13	1.570

DI: Diversity index; A: Total abundance; SR: Specific richness; H': Shannon diversity index

Table 5: Parasite index according to study area

Sites	Host		Prevalence	DI		
	Examined snail	Infected snail		A	SR	H'
Loumbila	696	52	7,47	680	13	1.549
Ziga	243	10	4,11	25	1	0
Total	939	62	6.6	705	13	1.549

DI: Diversity index; A: Total abundance; SR: Specific richness; H': Shannon diversity index

Table 6: Distribution of parasite in host species

Hostspecies	Parasitespecies	Abundance
Biomphalariapfeifferi	-	-
Melanoidestuberculata	-	-
Bulinusjoussemei	-	-
Cleopatra bulimoides	*Apatemon*sp2	1
	Tubifex sp	26
Cleopatra sp	*Aporocotyld*sp1	25
	*Aporocotyld*sp2	3
	*Apatemon*sp1	10
	*Apatemon*sp2	111
	*Apatemon*sp3	6
	Acaudate xiphidiocercaria sp1	20
	Acaudate xiphidiocercaria sp2	7
	Furcocercaria1	2
	Cercaria 1	2
	Tubifex sp	69
Laniteslybicus	*Lecithodendrium*sp	58
	*Plagiorchioid*sp	1
	Tubifex sp	14
Bellamya unicolor	*Apatemon*sp3	2
	*Plagiorchioid*sp	20
	Tubifex sp	28
	*Apatemon*sp2	2
Lanites ovum	*Lecithodendrium*sp	286
	*Haematoloechus*sp	12

According to Anderson and May (1979), the low prevalence of cercariae excretion among the natural snail population in Nigeria is related to direct host mortality induced by parasites. The low prevalence of parasite infestation could be due to high mortality in infested individuals at the juvenile stage of life (Théron and Gérard, 1994). The results of this study revealed thirteen different species of parasites hosted by the natural population of gastropods studied, among which twelve species of Trematodes and one species of Annelid.

The genera *Cleopatra* and *Lanistes* were infected by xiphidiocercaria species such as Leucithodendridae, Haematoloechidae, Zoogonidae and Microphallidae. The outpouring of Xiphidiocercariae, by the genus *Cleopatra* collected at the reservoir ofLoumbila, may suggest that humans and livestock using this freshwater are more at risk of contracting infections carried by these freshwater snails than those of the Ziga site. The number of parasitic trematode species observed could indicate a high parasite pressure in these snails' population. In fact, parasites generally cause a reduction in the selective value of

Table 7. Distribution of infection according to the microhabitats

Microhabitats	EN	IN	P%	Parasite species richness	Parasite abundance
Soil	211	10	4,74	10	233
floating plants	165	27	16.36	4	30
Irrigation channel	64	0	0	0	0
Ciment channel	127	0	0	0	0
pebbles	128	9	7.03	4	61
Grass	111	16	14.41	2	381
Sediment	128	0	0	0	0
Deadwood	6	0	0	0	0
Total	939	62	6.60	13	
P- Value			2.765e-10		

EN: examined number, IN: infected number, P: infection rate

infested hosts (Miller *etal*., 2007). Next to that, trematodes usually induce an inhibition of female reproductive function in molluscs by castration (Théron and Gérard, 1994; Rupp, 1996). This could contribute to reduce the effective size and consequently the genetic diversity of molluscs host population. An assessment of parasite diversity in relation to hosts showed that Thiaridae of the genus *Cleopatra* had a high susceptibility to cercarial infections (H'=1.585), thus containing the highest diversity of infection in the different species collected. Our results are similar to that of Veeravechsukij *et al.* (2018) who also showed that Thiaridae gastropods were parasitized by many species of Trematodes in Thailand. As a result, these snail species were found to be infected by many species of Trematodes which have a very low level of specificity and are known to be susceptible to Trematodes infections. According to Ismail et al. (2021), the ecological characteristics associated with the absence of snails are: high turbidity, deep water, near absence of vegetation coverage, high water temperature, and high current speed. The spatio-temporal variations of larval digenean assemblages parasitizing *H. parchappii* seem to be mainly influenced by the diversity and vagility of definitive hosts, the types of digenean life cycles and habitat characteristics (Parietti et al., 2020). Environmental disturbances derived from anthropogenic activities are highlighted as the probable main factors that may affect the composition and dynamic of these parasite assemblages (Parietti et al., 2020). The variation in infection between the genus *Cleopatra* and other gastropod species could be due to the fact that trematodes are very specific to their snail hosts (Frandsen and Christensen, 1984). This could also be due to the abundance of *Cleopatra* in the study area where this species represented up to 219 individuals collected out of 939 in total. Regarding diversity according to sites and microhabitats, our results also showed that gastropods from the soil microhabitats of the Loumbila site are the most diverse with an H' index of 1.549 of total infections and containing all kind of trematodes infection. This high diversity is explained by the fact that truck farming is important in this water body. It takes place mainly in the dry season which corresponds to the period of maximum transmission. In this reservoir, the plantations are less than 100 meters far from the water body. The truck farming area extends along the artificial lake and almost the entire population of the village practices this activity. Contacts with the infested water are significant as men, women and children are all involved in truck farming, resulting in a change in the chemical composition of the water. The attraction of miracidia toa specific snail is influenced by physico-chemical factors in the environment (Upatham, 1972). The nature of the environment determines whether the relationship between snail and miracidium can be productive.

An assessment of parasitic diversity by month reveals a higher diversity in the month of March (H'=1, 399). This could be explained by a concentration of parasites around the hosts at this period due to evaporation, resulting in a decrease in the volume of water at the sites, thus favoring host-parasite contact. Furthermore, this period precedes the end of the rainy season when snail reproduction takes place, leading to a high number of juveniles in the population at the beginning of the dry season. However, young snails are generally vulnerable to parasites than adults (Anderson and Crombie, 1984). Analysis of the distribution of infection frequencies showed a significant difference between hosts.

This means that the parasites have host specificity. Indeed, the Leucithodendridae which were collected on *L. ovum* and *L. lybicus*, as well as the Plagiorchioid which parasitized *B. unicolor* and *L. lybicus*, show stenoxene specificity; the Haematoloechidae which only parasitized *L. ovum* as well as the Acaudate xiphidiocercaria and the Aporocotylidae have an oioxene specificity. The Naididae that parasitize *Cleopatra*, *Lanistes* and *Bellamya* have euryxene specificity. Overall, cases of co-infections were rare in the study areas. This suggested that antagonistic interactions could occur between different parasites within the snail, limiting or excluding the establishment of certain species. This was demonstrated by Sousa (1993). MacLeod *et al.* (2018) in their work had shown that the absence of co-infecting Trematodes could be regulated by the redia through their antagonistic and interspecific interactions against other parasites which try to infect the same snail intermediate host. This is consistent with the fact that interspecific competition for resources and space represent a potentially strong selection pressure for trematode infecting snail intermediate hosts (Combes, 1982). The results of the present study also showed that some freshwater snails namely *Biomphalaria pfeifferi* and *Bulinus jousseaumei* were not infected by any parasite. This could be explained by the fact that the gastropods *Biomphalariapfeifferi* are particularly known to be intermediate hosts of *Schistosoma mansoni* (Brown, 1994; Tian-Bi *etal*., 2013). The prevalence rate of infection in Burkina Faso is varying and particularly hypo endemic as it is the case in central plateau region (Zongo *et al.,* 2017). Oguoma *et al.* (2010) also observed the absence of cercariae release by three species of freshwater snails (*Lymnea natalensis*, *Pila ovata and Anisus stagnicola*) in their studies conducted in Nigeria. This lack of infection was also observed by Opisa *et al.* (2011) in Kenya where some species of freshwater gastropods collected were not infected by a species of parasites. An analysis of the relationships between host and parasite over the collection period showed cases of aggregated distribution within the parasitized hosts across the collected parasites with sites of predilection such as the hepatopancreas and foot muscle tissue; as demonstrated by Anderson and Gordon (1982). James (1969) also found cases of double or even triple infections. Parasite aggregation could be explained by heterogeneity of the host immune response, direct reproduction of the parasite in the host or an aggregate distribution of the infecting stages. This could lead to a lot of damage to the host as demonstrated by Anderson and May (1978) in their work. They think aggregation is a key parameter of host-parasite population dynamics; the main parameters of this host-parasite population regulation are direct mortality, indirect mortality and reduced fertilization or parasite castration (Combescot-Lang, 1976). *Tubifex*sp infections were frequent throughout the study period but of higher abundance during the month of February. This parasite species was always found in mono-infestation. This could also be explained by the lower abundance of Trematodes during this period, with which an antagonistic reaction could occur.

CONCLUSION

Through this study we have discovered two major groups of parasites in molluscs, namely trematodes and annelids. Annelids of the genus *Tubifex* were frequent throughout the study period, but the frequency of trematodes was influenced by the season. Snail infection was influenced by the type of their microhabitat.

Conflict of Interest: No conflict interest

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