INTERNAL PARASITES OF FRESHWATER GASTROPODS AROUND THE BOUMERZOUG SUB-BASIN (NORTH-EAST ALGERIA)

BEKHOUCHE, N.[1] – KHAMMAR, H.[2*] – OULDJAOUI, A.[3] – MARNICHE, F.[4]

[1]*Laboratory of Natural Resources and Management of Sensitive Environments (RNAMS), University of Oum El Bouaghi, B.P. 10 Oum El Bouaghi 04000, Algeria*

[2]*Laboratory of Functional Ecology and Environment (LFEE), University of Oum El Bouaghi, B.P. 10 Oum El Bouaghi 04000, Algeria*

[3]*Laboratory of Animal Ecobiology and Physiology, Department of Life Sciences and Nature, Faculty of Exact Sciences and Life Sciences and Nature, University of Oum El Bouaghi, B.P. 10 Oum El Bouaghi 04000, Algeria*

[4]*National Veterinary School of El Alia Preclinical Zoology, Algiers 016000, Algeria*

**Corresponding author*
e-mail: hichem.khammar@univ-oeb.dz; phone: +213-661-221-833; fax: +213-32-563-185

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Abstract. Freshwater gastropods are intermediate hosts that disperse infection by carrying pathogens from one host to another. Our study was conducted on freshwater gastropods. No study was undertaken on internal parasites in this study station. The study was conducted on freshwater gastropods during the period from December 2014 to November 2015 in the vicinity of Boumerzoug sub-basin (Algeria). For the inventory of gastropods, only one technique is subject to validation: the use of a Surber net. Concerning the parasitological analysis of these freshwater gastropods we have opted for the method of flotation. Thanks to the Surber net, we determined the presence of 4586 individuals of gastropods in the sub-basin of Boumerzoug (Algeria). The family Viviparidae dominates with 2423 individuals with 52.83%. It is followed by the family Physidae with 2036 individuals with 44.40% and Sphincterochilidae with 1.66% (76 individuals). The other species are poorly represented. The parasites found in the stomach contents of both families show that the Physidae (*Physella (Physa) acuta*) are infected by plathelminths such as Cestodes, with the species *Hymenolepis* ssp. (eggs) dominating at 38%, followed by Trematode *Fasciola* spp. (eggs) at 29%. Viviparidae (*Viviparus fasciatus*) are also infested by plathelminths such as trematodes, with the species *Echonostoma* spp. (eggs) (A.R.% = 40%) in first place, followed by the nematode *Strongyloides* spp. with a percentage of 22%.
Keywords: *freshwater biology, inventories, flotation, checklist parasites, sub-basin of Boumerzoug, Algeria*

Introduction

Identification of the malacological fauna and knowledge of the species' behavior are necessary to ensure effective parasite control for both humans and animals. Given the ecological requirements of molluscs, especially the presence of water, the focal points of disease transmitted by these invertebrates can be easily detected and monitored over time, depending on the seasons (Dreyfuss et al., 2011). They are important from a parasitological perspective since some are edible, and many are agricultural pests or hosts to parasitic organisms (Şeşen and Yıldırım, 1993). According to Pizarro et al. (2010), the discharge of a large volume of pollutant resulting from human activity has had an impact on aquatic ecosystems. Vectors, or intermediate hosts, are organisms that disperse infection by carrying pathogens from one host to another (OMS, 2016). Some of them are essential to complete the cycle of pathogens and are, therefore, of medico-veterinary interest. Because

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of their interest, several authors have been interested in various intermediate hosts, as well as in their different aspects, such as their distribution and biology. Improved knowledge of these organisms increases the chances of achieving more effective control of them and the diseases they transmit. For example, Dreyfuss et al. (2011) have studied the interest of gastropods in the transmission of helminthoses. They cited that a very low parasite prevalence (1%) in molluscs is sufficient to maintain the endemicity of parasitosis in focus. Gérard (1997) was interested in parasitism in a community of gastropods in his study station. Almost a little information is known about the parasitic of freshwater gastropods in semi-arid regions. In this study we surveyed and recorded the diversity and different communities of terrestrial and freshwater gastropods, to establish an initial database of malacofauna in the Boumerzoug sub-basin (Oum El Bouaghi-Constantine) region of Algeria. In the present work, we were interested in intermediate hosts, such as freshwater gastropods in semi-arid regions. The search for parasites in freshwater gastropods in Algeria was fragmentary, so we were interested in the intermediate hosts consumed by domestic animals, such as the ruminants that circulate in this region.

Materials and methods

Study area

The Boumerzoug sub-basin is located in north-east Algeria and is one of the sub-basins of the Kabir El Remel (Constantine) catchment area, which covers a total surface area of 1,832 km^2. Its geographical coordinates are 35.53° to 36.25° North altitude and 6.28° to 7.4° East longitude. This sub-basin is bounded to the north by El Khroub, to the south-east by the Ain Kirche tell, to the east by Ain Abid and the Sigus tell, to the west by El Guerah, and to the south-west by the Ain M'lila tell (Sahli et al., 2014). The minimum temperature recorded in February 2015 was 9.8°C, and the maximum in July 2015 was 29.7°C. The lowest rainfall, 0.15 mm, was recorded in July 2015, while the highest, 138.15 mm, was recorded in January 2015. It should be noted that the average reported humidity is 62.95% (Tutiempo, 2016). The average temperature, precipitation, and humidity during the December 2014 section sampled were 7.5°C, 72.14 mm, and 78.4%, respectively (Keddari et al., 2020) (*Fig. 1*).

Study methodology

In this research region, the five permanent streams of the Boumerzoug sub-basin—Oued Sigus, Oued El Guareh, Oued El Berda, Oued Boumerzoug, and Oued El Hamime—were sampled for fauna at eighteen sites. From December 2014 through November 2015, the sampling was done once a month. These stations were selected based on factors like height, slope, biotope variety, and the upstream and downstream locations of populated areas. In this study area, the sampling of gastropods was carried out on eighteen stations belonging to five permanent streams of the Boumerzoug sub-basin, which are Oued Sigus, Oued El Guareh, Oued El Berda, Oued Boumerzoug, and Oued El Hamime. The choice of these stations was made taking into account some parameters such as altitude, diversity of biotopes, and upstream and downstream settlements (*Table 1; Fig. 1*).

After collection with the Surber net with a porosity of 100 μm, the samples collected from the Boumerzoug sub-basin were placed in containers or pillboxes labelled with the place of collection, the date, and the characteristics of the site, and then preserved in 70% alcohol and potassium dichromate at 2.5%.

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Table 1. *The geographical coordinates and physico-chemical parameters of the various stations collecting freshwater and terrestrial gastropods are available in Boumerzoug sub-basin (Alegria)*

Oued	Station	Lat (°N)	Long (°E)	pH	Sal g/l	EC µS/cm	TDS Mg/l	NO_3^- Mg/l	NH_4^+ Mg/l	$S0_4^{2-}$ Mg/l	Cl^- Mg/l
Oued El Guareh	G1	36.158	6.676	8.07	1.38	2663.69	1260.5	66.45	2.56	504.5	296.42
	G2	36.160	6.678	8.2	1.57	4157.43	1087	35.44	2.68	379	289.68
	G3	36.162	6.680	8.13	0.69	1080.08	183	54.42	0.78	366	189.37
Oued Sigus	S1	36.095	6.536	8.1	1.44	2884.28	1620	41.13	0.38	857.5	158.33
	S2	36.097	6.538	8.1	1.13	2245.12	1373.5	90.49	0.60	422	222.23
	S3	36.099	6.540	8.09	1.21	2914.75	1260.5	67.39	0.45	458.5	325.53
	S4	36.101	6.542	8.3	0.75	1521.62	1087	40.50	0.35	318	217.97
Oued Boumerzoug	B1	36.261	6.646	7.96	0.60	1153.07	608.97	22.46	0.67	360	160.46
	B2	36.263	6.648	8.01	0.72	1427.34	729.17	39.87	0.36	558.5	240.33
	B3	36.265	6.650	8.01	0.48	899.17	414.37	30.69	0.69	796	100.46
	B4	36.261	6.646	8.12	0.51	1273.51	303.72	34.49	0.72	338	208.38
Oued El Berda	A1	36.247	7.421	7.86	0.66	1149.90	693.99	31.64	0.28	608.5	167.20
	A2	36.249	7.423	8.07	0.44	1246.14	667.19	46.52	0.31	447.5	142.00
	A3	36.251	7.425	8.80	0.61	1130.58	725.39	32.90	0.39	376.5	145.90
	A4	36.253	7.427	8.49	0.64	1231.48	681.98	41.76	0.31	391.5	148.03
Oued El Hamime	H1	36.156	7.304	7.85	0.34	678.98	259.48	50.28	0.17	176	127.8
	H2	36.158	7.306	8.14	0.40	831.43	364.23	24.68	0.27	454.5	89.46
	H3	36.160	7.308	7.98	0.39	794.58	292.48	38.60	0.40	338	125.67

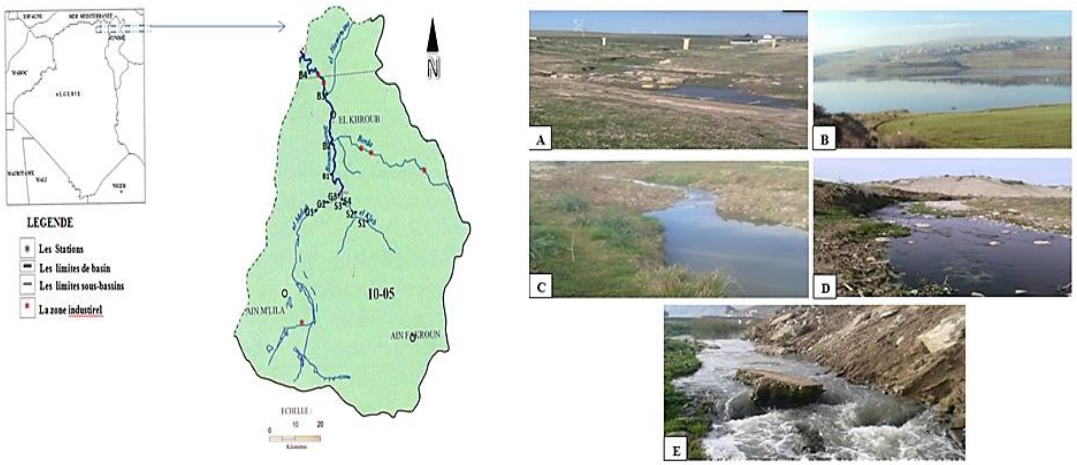

Figure 1. *Study site (A.B.H., 2002, modified) and sample collection. (a) Oued El Berda; (b) Oued Boumerzoug; (c) Oued El Gareh; (d) Oued El Hmime; (e) Oued Sigus, Original*

Parasite research method by the flotation method

We took two families of freshwater gastropods, *Physidae* and *Viviparidae*, for the parasite analysis. The analysis of the stomach contents of the latter was done by the flotation method. This is a qualitative, simple, and rapid technique, and it is the most used in veterinary medicine for the examination of stomach contents. This procedure concentrates the parasitic elements from one stomach content to another and brings to the surface those

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that are of low density. This technique is called post-enrichment examination and consists of concentrating the worm eggs or larvae in the stomach contents so that they can be detected Thienpont et al. (1979) (*Fig. 2*). C- Conservation in potassium dichromate dichromate (2.5%).

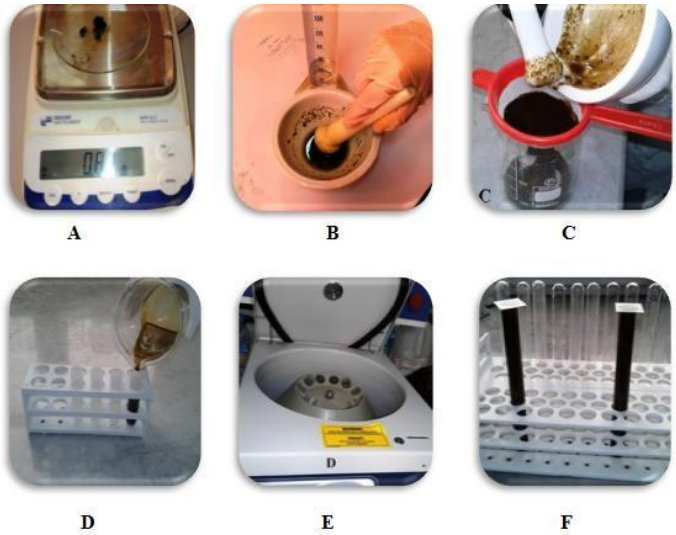

Figure 2. *Flotation technique (original). (A) Weighing; (B) Bryoge; (C) Filtration; (D, E) Centrifugation (1500 rpm); (F) Lamella deposition*

Determinations and counting of the specimens collected were carried out with the assistance of Professor Marniche Faiza at the zoology laboratory of the Ecole Nationale Supérieure Vétérinaire (ENSV, Algiers) and using the works, guides and determination keys of Tachet et al. (2000). The taxonomic unit used was the family for both faunal groups.

Data analysis

The Ecological composition metrics such as total specific richness (S), relative abundance (AR%), and frequency of occurrence (FO%) are used to analyze the data (Blondel et al., 1984; Vuilleumier, 1981). Ecological metrics of structure, such as Shannon's diversity index (H'), equi-repartition or equitability (J), and Simpson's diversity index (D), are then used to measure structure (Müller, 1985; Schlaepfer and Büter, 2004), and finalized using statistical techniques. We utilized the Surber net data to gauge the variety and number of gastropods present in the sampled streams. Version 2.17 of the PAST (PA-leontological Statistics) program was used to examine these data **(**Hammer et al., 2001). One statistical method—the Parasite Index (I.Q.)—is used for parasite analysis (Rózsa et al., 2000).

Results

Inventory of freshwater and pulmonate gastropods

The list of families captured is obtained from the trips made from December 2014 to November 2015 in the 18 stations, knowing that these stations are grouped into a single station is the sub-basin of Boumerzoug (Algeria) thanks to the Surber type net

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is represented in *Table 2* and *Figure 3*. Thanks to the Surber net shows the presence of 4586 individuals in the sub-basin Boumerzoug. The family Viviparidae dominates with 2423 individuals. It is followed by the family Physidae with 2036 individuals. The others are weakly represented, with numbers varying from 9 to 76 individuals. *Figure 4* shows that the two families of freshwater gastropods, Physidae and Viviparidae, are dominant compared to the other families. Indeed, the high number was recorded for July with 831 individuals for the Physidae, and in March, with 812 individuals for the family Viviparidae. The other families have less frequent numbers during the months.

Table 2. *Freshwater and pulmonate gastropod inventories from the 2014/2015 year*

Categories	**Freshwater gastropods**			**Pulmonary gastropods**	
Month	**Physidae**	**Viviparidae**	**Limnae**	**Helicidae**	**Sphincterochilidae**
Dec-14	146	0	0	1	0
Jan -15	6	132	3	4	3
Feb -15	53	452	1	1	1
Mar -15	38	812	1	6	4
Apr -15	1	75	0	1	4
May -15	27	67	1	1	12
Jun -15	335	162	0	4	5
Jul -15	831	366	0	4	12
Aug -15	428	165	0	5	10
Sept-15	38	63	1	11	9
Oct-15	79	89	0	0	4
Nov-15	54	40	2	4	12
Total (N)	2036	2423	9	42	76

Figure 3. *Freshwater and lung gastropod inventories (original photos). (a) Family Sphincterochilidae Sphincterochila candidissima (Draparnaud, 1801) (Lunged Gastropods); (b) Family Helicidae Eobania vermiculata (O.F.Müller, 1774) (Lunged Gastropods); (c) Family Limnae Lymnaea (Galba) truncatula (O.F.Müller, 1774) (Freshwater Gastropods); (d) Family Physidae Physella (Physa) acuta (Draparnaud, 1805) (Freshwater Gastropods); (e) Family Viviparidae Viviparus fasciatus (O.F.Müller, 1774) (freshwater gastropods)*

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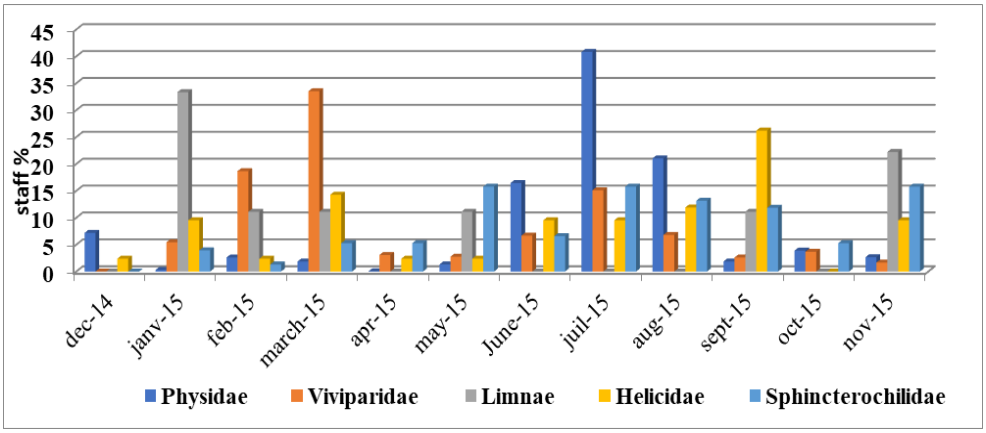

Figure 4. *Monthly relative abundances (AR%) of freshwater and pulmonate gastropods from the 2014/2015 year*

Analysis of results by ecological indices of freshwater and pulmonate gastropod families total and average richness

The total annual richness of freshwater and pulmonate gastropods is 5 families in the Boumerzoug sub-basin with a total of 52 individuals with an average richness equal to 4.33 (*Table 2*). We note an essential richness during the year for the two families Physidae and Sphincterochilidae (S = 12). We were followed by Helicidae and Viviparidae (S = 11). It is also to note a low richness in Limnae (S = 6). The average richness is variable between families. Indeed, the highest average richness is recorded for two families of Physidae and Sphincterochilidae with 1.00, followed by Helicidae and Viviparidae with 0.92. Finally, the average richness of the family Limnae is equal to 0.5 (*Table 3*).

Table 3. *Annual total, mean, relative abundances (A.R.%), and frequencies of occurrence (F.O.%) of captured gastropods*

Station	**Boumerzoug Sub-basin (2014 - 2015)**					
Families	**ni**	**A.R. (%)**	**S**	**sm**	**F.O. (%)**	**Categories**
Physidae	2036	44.40	12	1.00	100	Omni-present
Helicidae	42	0.92	11	0.92	91.67	Highly consistent
Sphincterochilidae	76	1.66	11	0.92	91.67	Highly consistent
Viviparidae	2423	52.83	11	0.92	91.67	Highly consistent
Limnae	9	0.20	6	0.50	58.33	Very regular
Total (N)	4586	100	52	4.33		

S: total richness, sm: mean richness; ni: number; A.R. (%): relative abundance; F.O. (%): frequency of occurrence in %

Relative abundances (AR%)

4586 individuals were recorded in the Boumerzoug sub-basin (Algeria) from December 2014 to November 2015 (*Table 3*). It should be noted that the best-represented position is Viviparidae in this station with 52.83% (2423 individuals). The *Viviparus fasciatus* species, which dominates with 33.51% (812 individuals). Followed by the family Physidae with 44.40% (2036 individuals) dominated by the species *Physella (Physa) acuta* with 40.82% (831 individuals) and Sphincterochilidae with 1.66% (76 individuals). *Sphincterochila candidissima,* dominates with 15.79% (12

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individuals). The other species are poorly represented, with values varying from 9 individuals (A.R. % = 0.20%) to 42 individuals (A.R. % = 0.92%). From *Figure 4*, we notice that the relative abundance (A.R. %) of the gastropod families varies from month to month. The high number is recorded for July, with 831 individuals (A.R. % = 40.82%) in Physidae, and in March, with 812 individuals (A.R. % = 33.51%) for the family Viviparidae. In February, there were 452 individuals (A.R.% = 18.65%) for the Viviparidae; on the other hand, in August, the Physidae had 428 individuals (A.R. % = 21.02%). As for the pulmonate gastropods such as Helicidae are better represented in September with 26.19% and March with 14.29%. Then appear the family of Limnae (dulciquicole gastropod) during January with 33.33%, then in November with 22.22%, and finally, the 4 months that remain: February, March, May, and September with 11.11% each. Finally, the family Sphincterochilidae (pulmonate gastropod) have less frequent numbers in May, June, and July, with 15.79% each, in August with 13.16%, and in September, with 11.84%. Finally, the other months have frequencies varying from 0 to 1.32%. The ecology of gastropods is very varied, and species can be marine, freshwater, or terrestrial. The ecological preferences or requirements of terrestrial gastropods are very different from one species to another. Forests are generally vibrant habitats and many species can also be found in gardens, hedges, or wastelands. The low mobility of molluscs and their significant dependence on microclimate conditions make them good indicators of the history of an environment and its evolution. In general, their cycles are as follows: the individuals of the previous generation, having spent the winter, lay eggs in the summer and die shortly afterwards; during this time, the eggs hatch and give birth to a new generation. This one will develop rapidly until the fall and then spend the winter in a state of slow life, waiting for the following spring. This explains in our study station, the Viviparidae (La Paludine) with separated sexes, the fertilization of females can take place all year round except during the winter period. This explains the low frequency in December 2014 and January 2015, with relative abundances varying from 0 to 5.45%, respectively. However, some populations of Viviparidae would reach sexual maturity only during the second year; in this case, the cycle would be biennial. In addition, one finds some pulmonates like Limnae have, in specific environments a longevity of approximately two years. They reach sexual maturity at the end of the first year and can thus lay eggs twice during their life. This type of cycle is thus an intermediate between the annual cycle and a proper biennial cycle. However, in environments more favorable to growth, the life span of these families seems to be one year. They then present a classic annual cycle.

Frequency of occurrence (FO%) of different families of freshwater and pulmonate gastropods caught by the Surber net in the Boumerzoug sub-basin (Algeria)

In the Boumerzoug sub-basin station, the ubiquitous family constancy class is the best represented with 100% of the cases as Physidae (*Table 3*). It is followed by the class of strongly constant families corresponding to 91.67% of cases such as Helicidae, Sphincterochilidae and Viviparidae. Only the family Limnae (F.O. % = 58.33%) belongs to the class of very regular families.

Structure index

The diversity H' is close to 2 bits in the five gastropod families, which means that the individuals are equally distributed. Equitability also tends towards 1. This implies that

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the families have identical abundances in the stand (same number of individuals). It can also illustrate a weak interspecific competition. The Simpson index is also very close to 1). This indicates the maximum diversity (*Table 4*).

Table 4. *Composition and structure indices applied for freshwater and pulmonate gastropods from 2014/2015*

Parameters	Physidae	Viviparidae	Limnae	Helicidae	Sphincterochilidae
Taxa_S	12	11	6	11	11
Individuals	2036	2423	9	42	76
Dominance_D	0.2468	0.186	0.2099	0.1417	0.1205
Simpson_1-D	0.7532	0.814	0.7901	0.8583	0.8795
Shannon_H	1.724	1.978	1.677	2.134	2.222
Equitability_J	0.6937	0.825	0.9359	0.8899	0.9268

Results on freshwater gastropod parasites

In this station, we considered two families of freshwater gastropods, Physidae (*Physella (Physa) acuta* (Draparnaud, 1805) and Viviparidae *Viviparus fasciatus* (O.F.Müller, 1774). These two families were collected in the Boumerzoug Basin (Algeria) during our experimentation in 2015. The intestinal parasites were identified using the identification (Thienpont et al., 1979; Bussiéras et Chermette, 1991; Zajac et al., 2021) and under the assistance of Professor MARNICHE Faiza of the National Veterinary School of El Alia, Algiers. The results obtained are mentioned in *Table 4* and *Figure 5*. Nematodes and protozoa are poorly represented, with 1 to 4 individuals for the genus *Balathidium* sp. (Protozoa) and 1 to 2 for nematodes. As for the Viviparidae, they are also infested by plathelminthes such as trematodes with numbers ranging from 3 to 13 individuals and nematodes with 2 to 10 individuals. In addition, *Balanthidium* sp. are better represented than the Presidium family, with numbers varying from 1 to 9 individuals, and cestodes are less frequent in this family, with numbers varying from 1 to 6 individuals. We also notice that November in the Viviparidae is infested much more by trematodes and nematodes. On the other hand, the Physidae in January are infested much more by trematodes.

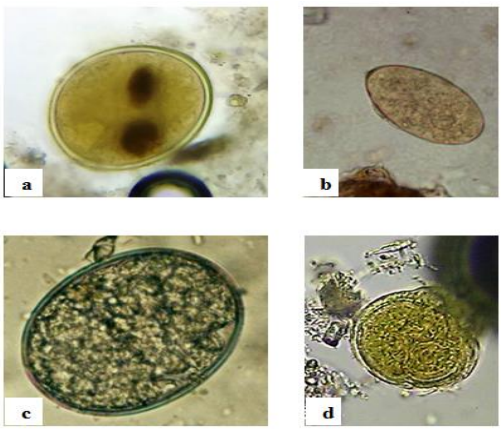

Figure 5. *Intestinal parasites found in the two families of freshwater gastropods from the Boumerzoug sub-basin by the flotation method flotation method (original photo). (a) Cyst form Balantidium sp. (Protozoa) (GX40); (b) Egg of Echonostoma spp. (Trematoda) (GX140); (c) Egg of Strongyloides spp. (Nematoda) (GX40); (d) Egg of Hymenolepis ssp. (Cestoda) (GX40)*

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Relative abundances (A.R.%)

The relative abundances (AR%) of intestinal parasites found in freshwater gastropods in the Boumerzoug sub-basin (Algeria) during 2015 are grouped in *Table 4*. From *Figure 6* we notice that the plathelminth class dominates for both families, with a relative abundance equal to 67% for Physidae and 58% for Viviparidae. In the second position, we find nemathelminths with a relative abundance equal to 22% in Viviparidae and protozoa in Physidae. In the third position, we find protozoa, with 20% in Viviparidae and 15% of nemathelminths in Phydidae. The values of relative abundance (A.R.%) obtained in *Table 5*, show us that Trematodes dominate in the family Viviparidae with 40.30% (54 individuals), while in Physidae, it is the Cestodes that are dominant with 37.70% (23 individuals). Followed by Nematodes with 21.64% (29 individuals) in Viviparidae; as for Physidae, Trematodes come in second position with 29.51% (18 individuals). In the third position in the Viviparidae come the Nematodes, with a total relative abundance of 21.64% (29 individuals), followed by a protozoan *Balanthidium* sp. With 20.15% (27 individuals) contrary to the Physidae, this last one comes in third position with 18.03% (11 individuals), then the Nematodes in later with a rate of 14.75% (9 individuals). Many helminth parasites live in the intestinal lumen. While trematodes, cestodes, and acanthocephalans are obligate parasites, i.e. they require two distinct intermediate hosts, most often an aquatic mollusk, a vast number of nematode species are not parasitic. Some species of nematodes have free-living and parasitic forms, i.e. they can have a parthenogenetic parasitic development cycle. The protozoan found in the feces of freshwater snails may be due to contamination that occurs by ingestion of water contaminated by parasites that are encysted. The cyst represents the form of resistance of protozoa in the external environment.

Table 5. *Monthly intestinal parasites found in the two freshwater gastropod families*

Families	Class	Station	Boumerzoug sub-basin 2015													
		Species months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ni	A.R. (%)
Physidae	Protozoa	*Balantidium* sp. (Cyst)	2	0	0	0	2	4	0	1	0	0	0	2	11	18.03
	Trematoda	*Fasciola* spp. (Eggs)	7	0	0	0	0	3	3	0	0	0	5	0	18	29.51
	Cestoda	*Hymenolepis* ssp. (Egg)	0	0	6	0	0	3	6	6	0	0	0	2	23	37.70
	Nematoda	*Strongyloides* spp. (Egg)	0	0	2	2	2	0	0	2	0	0	1	0	9	14.75
Viviparidae	Protozoa	*Balantidium* sp.	0	1	0	0	2	5	0	2	3	9	5	0	27	20.15
	Trematoda sp.	*Echonostoma* spp. (Egg)	5	3	0	0	7	7	0	0	6	6	13	7	54	40.30
	Cestoda sp.	*Hymenolepis* ssp. (Egg)	1	6	0	6	2	0	0	0	2	1	1	5	24	17.91
	Nematoda sp.	*Strongyloides* spp. (Egg)	2	0	0	3	0	4	0	0	0	2	10	8	29	21.64

ni: Number; A.R. (%): Relative abundance

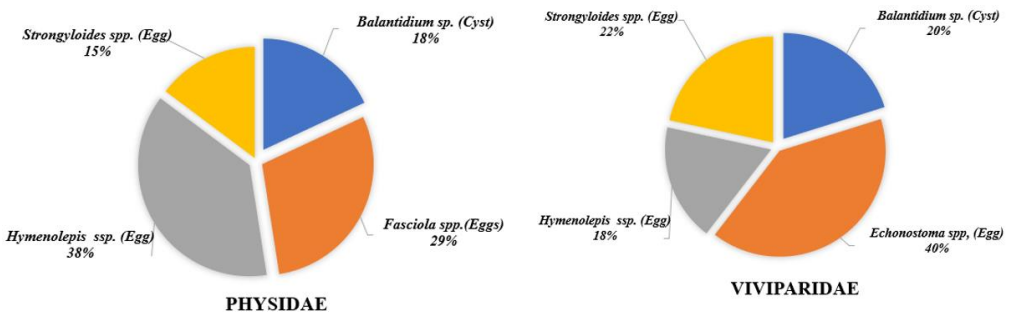

Figure 6. *Species found in the feces of freshwater gastropods from the Boumerzoug sub-basin (Algeria)*

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Results expressed by a statistical method: parasite indices (I.Q.)

From *Table 6*, we notice that out of a total of 61 individuals of Physidae, 5.7% (4 individuals) are parasitized by cestodes and nematodes, followed by Protozoa *Balantidium* sp. and trematodes with an infestation rate of 4.3% (3 individuals). These 4 classes belong to the rare parasitic species (*Fig. 7*). For the family Viviparidae, the infestation rate by *Balantidium* sp. and nematodes is 1.5% (2 individuals). Still, it is 2.2% and 3.00% for cestodes and trematodes, respectively, and therefore, is a rare species (*Fig. 8*). Regarding the average intensity, it is deficient for values between 2.00 and 6.00 in Physidae, so it is very low average intensity recorded for *Balantidium* sp., nematodes, cestodes and trematodes. Concerning the family of Viviparidae, we also noted an average intensity is fragile for the values situated between 1.00, which means that the average intensity is fragile recorded for *Balantidium* sp., nematodes, cestodes and trematodes.

Table 6. *Prevalence, intensities, and infestation rates of individuals for each parasite class*

Hosts	Class	Species	The state of the host		Prevalences	Intensities
			Total	Infested		Median
Physidae *Physella (Physa) acuta*	Protozoa	*Balantidium* sp. (Cyst)	61	3	4.3%	1.0
	Trematoda	*Fasciola* spp. (Eggs)	61	4	5.7%	1.0
	Cestoda	*Hymenolepis* ssp. (Egg)	61	4	5.7%	1.0
	Nematoda	*Strongyloides* spp. (Egg)	61	3	4.3%	1.0
Viviparidae *Viviparus fasciatus*	Protozoa	*Balantidium* sp. (Cyst)	134	2	1.5%	1.0
	Trematoda	*Echonostoma* spp. (Egg)	134	3	2.2%	1.0
	Cestoda	*Hymenolepis* ssp. (Egg)	134	2	1.5%	1.0
	Nematoda	*Strongyloides* spp. (Egg)	134	4	3.0%	1.0

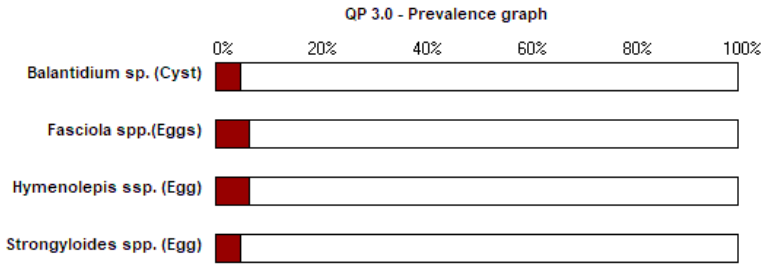

Figure 7. *Graph of prevalences of endoparasites found in Physidae Physella (Physa) acuta feces with the software (Quantitative Parasitology V 3.0.)*

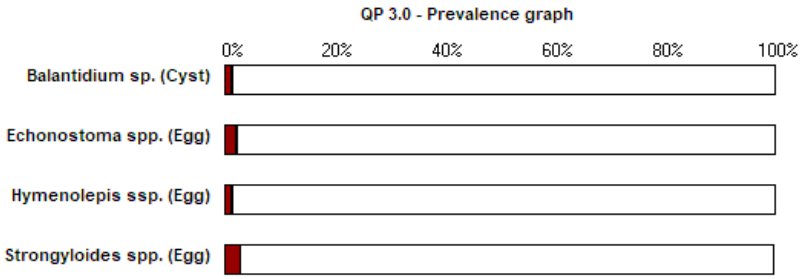

Figure 8. *Graph of prevalences of endoparasites found in Viviparidae feces with the software (Quantitative Parasitology V 3.0.)*

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Discussion

Our results show the presence of 4586 individuals in the Boumerzoug sub-basin. The family Viviparidae dominates with 2423 individuals. It is followed by the family Physidae with 2036 individuals. The others are weakly represented, with numbers varying from 9 to 76 individuals. In the Macta watershed (western Algeria), Khettar et al. (2013) reported the presence of Molluscs with 8 families with 963 individuals or 3.85%. The total annual richness of freshwater gastropods is 5 families in the sub-basin of Boumerzoug, with a total of 52 individuals with an average richness equal to 4.33. We notice a vital richness during the year for the two families, Physidae and Sphincterochilidae (S = 12). They were followed by Helicidae and Viviparidae (S = 11). It is also worth noting a low richness in Limnae (S = 6). The average richness is variable between families. Indeed the highest average richness is recorded for two families of Physidae and Sphincterochilidae with 1.00, followed by Helicidae and Viviparidae with 0.92. Finally, the average richness of the family Limnae is equal to 0.5. These results are similar to those found by Douafer (2010), had noted 6 families of Gastropods in North East Algeria, with a specific richness in Guelma reaching 10 species. On the other hand, Karas (2009) identified 40 taxa in the La Loire countries (France), including 3 species of the family Physidae and 2 species of the family Viviparidae. Five Physidae were found by Bousloukia and Yahiaoui (2014) in a study of physicochemical characteristics of aquatic and terrestrial invertebrates in the Oued El Guerah (Ain M'lila). 4586 individuals are recorded in the sub-basin of Boumerzoug (Constantine) from December 2014 to November 2015 (*Table 2*). It should be noted that the best-represented position is Viviparidae in this station, with 52.83% (2423 individuals). They were followed by the family Physidae with 44.40% (2036 individuals) and the Sphincterochilidae with 1.66% (76 individuals). The other species are poorly represented, with values ranging from 9 individuals (A.R. % = 0.20%) to 42 individuals (A.R. % = 0.92%). Two % of pulmonea were found by Bousloukia and Yahiaoui (2014) in a study of the physicochemical characteristics of aquatic and terrestrial invertebrates in 3 stations of the Oued El Guerah (Ain Mlila). As Zouggaghe et al. (2014) recorded in summer, a total of 31,619 individuals were collected in the Soummam valley (with an average of 2258 ind/station), of which the Physidae represents 3.17%. In Wadi Khoumane (Morocco), 2140 individuals (12.49% of the total fauna collected) belonging to 3 families and three genera were collected: Physidae (Physasp.), Planorbidae (*Planorbis* sp.) and Viviparidae (*Viviparus*). The Physidae are dominant and count 2138 individuals (99.9% of the molluscs) and are represented by a single genus Physa. The other families, Planorbidae (*Planorbis* sp.) and Viviparidae (*Viviparus* sp.) have very low numerical importance, with 0.05% each (Moussa et al., 2014). According to Karrouch (2010), vegetation, calcium content, the substrate's nature, and the water current's speed contribute considerably to the distribution and proliferation of molluscs in continental waters (Moussa et al., 2014; Bouzidi, 1989; Tachet et al., 2006). This section will focus on the parasitic analyses found in the study site's digestive tracts of freshwater snails. No studies have been undertaken regarding parasites at this station. In our research, we found different intestinal parasites in various families of freshwater gastropods. The family Physidae is infected by plathelminthes such as Trematodes, with an abundance of 30% (21 individuals), followed by Cestodes with 41.43% (29 individuals), then Nematodes with a rate of 12.86% (9 individuals), protozoa with a rate of 15.71% (11 individuals) represented by *Balantidium* sp. Viviparidae is also infested by plathelminthes, such as trematodes, with a frequency of 40.30% (54 individuals). On the other hand, Balantidium sp. are better represented compared to the previous family with 20.15% (27 individuals), and cestodes are less

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frequent in this family with 17.91% (24 individuals). According to Dreyfuss et al. (2011), most schistosomes and flukes belonging to the family Trematodes are transmitted by gastropods.

Conclusion

The inventory of freshwater and lunged gastropods during 12 months of experiments from December 2014 to November 2015 through the Surber type net. In its five sub-basin stations in Boumerzoug, Algeria, Viviparidae are more directly involved in the harboring of intestinal parasites in ruminants than Physidae are, and they are more commonly linked to these diseases. Viviparidae and Physidae species play a role in the transmission of internal parasites and are more often involved in the transmission of major ruminant parasites. Snail species such as Viviparus fasciatus and *Physa acuta* are among those that harbor trematodes that could potentially affect ruminants in the semi-arid ecosystems of this study region. These species can serve as intermediate hosts for parasites, particularly trematodes, responsible for infections in animals and sometimes in humans. *Physa acuta* and *Viviparus fasciatus* are among the molluscs found in Algeria that are likely to harbor intestinal parasites affecting ruminants and other animals. Their role as intermediate hosts for trematodes highlights the importance of these molluscs in the epidemiology of parasitic diseases. The stomach contents are the basis for parasite analysis. The results deduced that the Boumerzoug basin could be a hotbed of certain diseases, revealing the various parasites that gastropods can carry, enabling improved disease control.

Conflict of interests. The authors declare that they have no competing interests.

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