

Taxonomic diversity and structure of the benthic macrofauna of the waters of the source Aghbal (sector of Azrou) (Middle Atlas, Morocco)

Imane HINCHI ; Imane NECHAD , Zineb CHBIHI IDRISSE HAMZAOUI, Imane TLEMCANI, Kenza BOUAYAD & Fatima Fadil

Laboratory of functional ecology and environment, Faculty of sciences and technology, Université sidi Mohamed ben Abdallah, Fez Morocco

Corresponding author : imanehinchi@gmail.com

Abstract

Macroinvertebrates of the source Aghbal (sector of Azrou) were studied using samples taken seasonally between October 2015 and August 2016. The fauna listed in this work is made up of 2829 individuals corresponding to 15 species belonging to 13 faunistic families and to 5 classes (Gastropods, Oligochaetes, Turbellaries, Malacostraceae and Insects). These classes are divided into 12 orders. The size of the benthic population has shown that those are Malacostraceae which hold the front followed by the Turbellariés, Insects, Oligochetes and Gastropods. the taxon *Gammarus gauthieri* is numerically the most inventoried while the remaining species are represented in small percentage. The values of the specific diversity index H and the specific fairness index revealed that the specific diversity of macroinvertebrates populating this source is low. The results obtained in this study highlight an alarming state of the ecological state of the Aghbal source (Azrou sector).

keywords: Macroinvertebrates, The source Aghbal (Sector of Azrou), species, faunistic, the specific diversity index, the specific fairness index.

1. Introduction

The evaluation of water quality is often carried out using "classic" methods of measuring a series of physico-chemical parameters which are then compared to proven standards or quality criteria. This approach has shown their usefulness but also its limits [1]. In order to measure the effects of water pollution, This classic approach, physicochemical parameters, can be supplemented by biological monitoring which consists in using living organisms (biological indicators), for example microorganisms, plants or animals. Among these indicators, macroinvertebrates are the basis of various biotic indices (The Shannon-Wiener index, the fairness index, the jaccard index, etc.) and are the subject of several hydrobiological studies [2 ;3 ;4 ;5 ;6]. Indeed, the notion of ecosystem integrity or health requires that chemical, physical and biological parameters be taken into account

simultaneously [7]. Macroinvertebrates are hosts of running and / or stagnant waters where they contribute to the energy flow of food networks.

Therefore, they are one of the fundamental elements of the functioning of aquatic ecosystems and hold an important place in the biological equilibria and the trophic chains taking place there. Although macroinvertebrates allow the detection of dysfunctions caused by surrounding pressures, they are also used to assess the state of biodiversity of aquatic ecosystems.

Concerning the source Aghbal (sector of Azrou), one of the largest sources in the Moroccan Middle Atlas, these benthic Macroinvertebrates are unknown and have not been the subject of further study despite the work carried out in some sources belonging to the same geographic unit of this resurgence such as Source Regrag [8]. In order to fill this gap, we conducted this study which main objective is to establish a first complete fauna inventory and to assess the biodiversity of macroinvertebrates inhabiting this aquatic ecosystem.

2. Material and methods

2.1. Study site

La source Ag(Az) est située à 3 km à l'Ouest de la ville d'Azrou. Elle émerge des basaltes quaternaires du bassin de Tigrigra qui fait partie du Moyen Atlas tabulaire. Le débit moyen de la source est de 370 l/s. Les eaux de cette résurgence sont utilisées pour l'alimentation en eau potable, l'irrigation et la pisciculture.

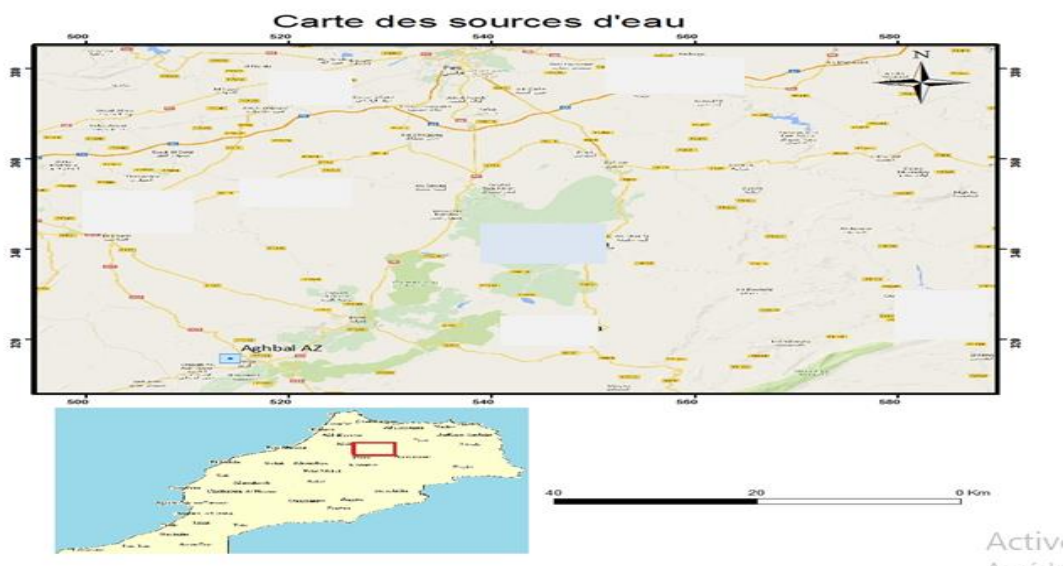


Figure 1: Location of the Aghbal(Az) source

2.2 Sampling of the macro invertebrate benthic

For a general sampling, we opted for a surber NET to a width of mesh 400µm. This technique can be used on rocky, Sandy, gravelly and muddy, good that it is difficult on the very organic substrates. In order to collect the maximum of Macroinvertebrates colonizing the site, we

should spend 30-45 minutes on the rocky beaches to return stones and search for invertebrates. On detached bodies of stones with pliers and keep them in a jar. The collected samples are fixed at 40% formalin, then stored in water from source to 10%. The sorting of samples is done using the loupe. Zoological groups are separated in vials containing 70% alcohol [9]. Species in each group are sorted, identified, counted, and classified among functional feeding groups according to [10].

2.3 calculation of statistical descriptors of data

2.3.1. Specific diversity index

The most used index and the Shannon-Weaver, it reflects the diversity of species that make up the stands in a medium and establishes the link between the number of species and the number of individuals of a same ecosystem or a community. Is calculated using the formula: $H' = -\sum (n_i / N) \cdot \log_2 (n_i / N)$ H': diversity specific N: total number of individuals n_i : number of species i Index of species diversity is high, when the taxon richness is important and the distribution of individuals among the taxa is balanced.

2.3.2. Fairness Index

Knowledge of species diversity index is used to determine the fairness, equity is a second fundamental dimension of diversity. It is the ratio between the maximum diversity (Hmax). It varies between 0 and 1, tends towards 0 when almost all of the staff is focused on a species; It is 1 when all species have same abundance. Index of fairness determines, either reconciliation or even the remoteness between H' and Hmax. It is expressed by the formula

$E = H' / H_{max}$ where : $H_{max} = \log_2 (S)$; $E = H' / H_{max}$; $H_{max} = \log_2 (S)$; S: Total number of species.

2.3.3 Relative abundance

Relative abundance of a species is the percentage of the number of it compared to the total number of individuals collected from a station. It is expressed by the formula $P_i = \frac{Ab(a)}{Ab(t)} * 100$ Where, Ab (a): total number of individuals of a species. Ab (t): total number of individual.

2.3.4. The frequency

The frequency of a species is the ratio, expressed as a percentage, between the total number of samples where this species is noted and the total number of all samples taken. $F_i = \frac{P_a}{P_t} * 100$ where : PA: number of samples where the species was collected ; Pt: total number of samples A species is ubiquitous if its F is 100%, constant if the F is strictly between 75% and 100%, regular if the F is between 50 and 75%, accessory if the F is between 25 and 50% Finally, a species is accidental if F is less than 25%.

3. Results and discussion

3.1. Inventory of the benthic community

The understanding of the structure and the overall functioning of benthic ecosystems through a fundamental first step: the description of the communities that constitute. This initial stage is often used as basis for the development of more complex curriculum, focused on the study of the interactions between the various benthic compartments (relations inter and intra specific, relations fauna - substrate,...). Table 1 is a detailed inventory showing the numbers of each species in the source Aghbal(Az) in the 4 seasons.

Table 3: Seasonal change in the abundance of benthic macrofauna in the year 2015-2016 of Aghbal(Az) station.

Especies	Oct	Nov	Janv	Mars	Avr	Mai	Juil	Aout
<i>Thiodoxus numidicus</i>	1	1	1	2	0	0	2	4
<i>Melanopsis praemorsa</i>	5	7	6	5	7	8	12	10
<i>Pseudomnicola sp.</i>	0	0	0	0	1	0	2	0
<i>Tubifex sp.</i>	6	4	7	9	12	14	12	11
<i>eisenilla sp.</i>	1	2	0	1	2	1	3	4
<i>Dugesia tigrina</i>	14	19	15	39	36	38	38	27
<i>Grenobia sp.</i>	20	23	22	24	26	28	30	32
<i>Gammarus gauthieri</i>	200	240	260	266	270	268	271	270
<i>Simulium pseudoquinum</i>	6	9	7	10	11	12	13	11
<i>Procleon sp.</i>	3	4	2	5	4	3	3	2
<i>Baetis rhodani</i>	2	1	3	6	5	3	4	2
<i>Potamophilus sp.</i>	1	2	0	1	0	0	0	0
<i>Glossosoma sp.</i>	0	1	0	1	2	1	0	0
<i>Apatania sp.</i>	1	2	1	3	2	1	0	0
<i>Hydrachnidia sp.</i>	5	7	3	2	4	6	5	8

Au niveau de cette source, la faune aquatique est représentée par 5 classes. Ce sont les Malacostracés qui détiennent le devant avec un total de 2045 individus suivis des Turbellariés (431individus), des Insectes (190individus), des Oligochètes (89individus) et des Gastéropodes (74individus)(**Figure2**).

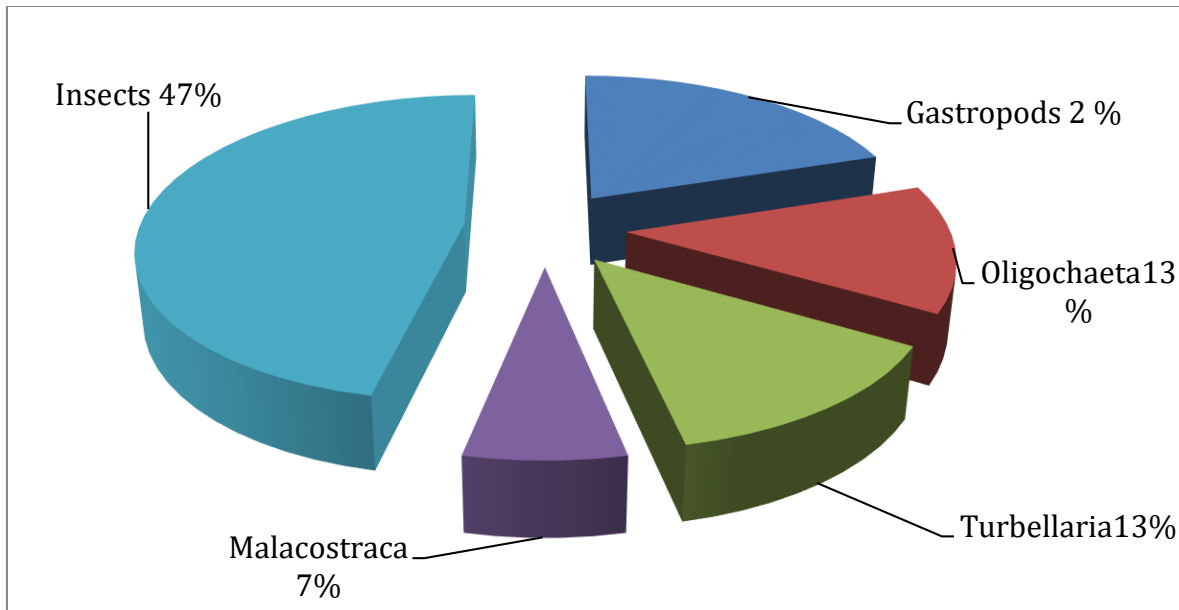


Figure 2: Number of taxonomic not classified species in station Aghbal(Az)

3.2.2 Total abundance

Analysis of all stands harvested during the study period, shows that in the source Aghbal(Az), there are 12 orders. The Amphipods are numerically the most inventoried and represent the highest abundance (72,28%) followed by Triclad (15,23%) While the remaining groups have a very low abundance (less than 3%)(Figure3).

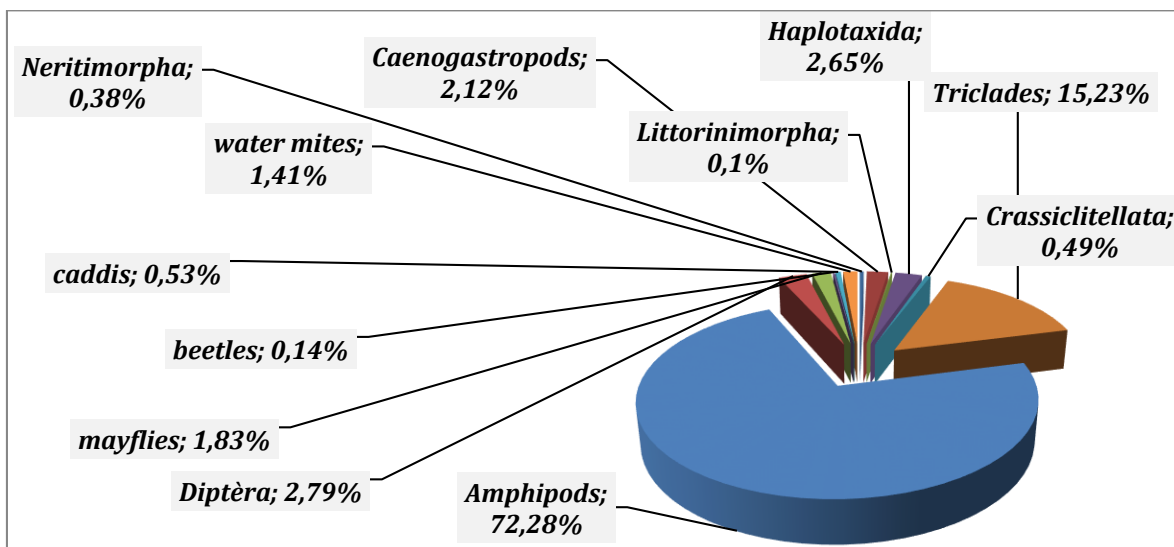


Figure3 : Abundance of different orders in Aghbal(Az) station

3.2.3 Specific diversity index

Specific diversity index provide complementary results as the stand structure and the way in which individuals are distributed among the different species. It is minimum when the sample contains only a single species. H is maximum (theoretically infinite) when each individual belongs to a different species. Maximum diversity is $\text{Log}_2(N)$. The results of the analysis

show that this index is very low in this station (0.03). This could be linked to the three main factors, namely: anthropogenic activity since this resort is seaside and attract the attention of many tourists, the low speed of the current which does not promote the survival of many species and the homogeneity of the substrate which is poor in vegetation and dominated by pebbles.

3.2.4 specific fairness index

Fairness is also called regularity or equidistribution, varies between 0 and 1, more a taxon is abundant, lower than we is fairness. L'analyse de la communauté macrobenthique peuplant cette source a révélé que cet indice est très faible . il est égal à 0,007. This is due to the fact that this ecosystem is dominated by the species *Gammarus gauthieri* to the detriment of the rest of the taxa.

3.2.5 Relative abundance

Analysis of all stands harvested during the study period, shows that in the source Aghbal(Az), *Gammarus gauthieri* species is the most inventoried and represents the largest percentage (72,28%) followed by the two species *Grenobia sp.* and *Dugesia tigrina* representing a percentage of 8% and finally the procession of the 12 remaining species, with a low dropout not exceeding 3%(Figure4).

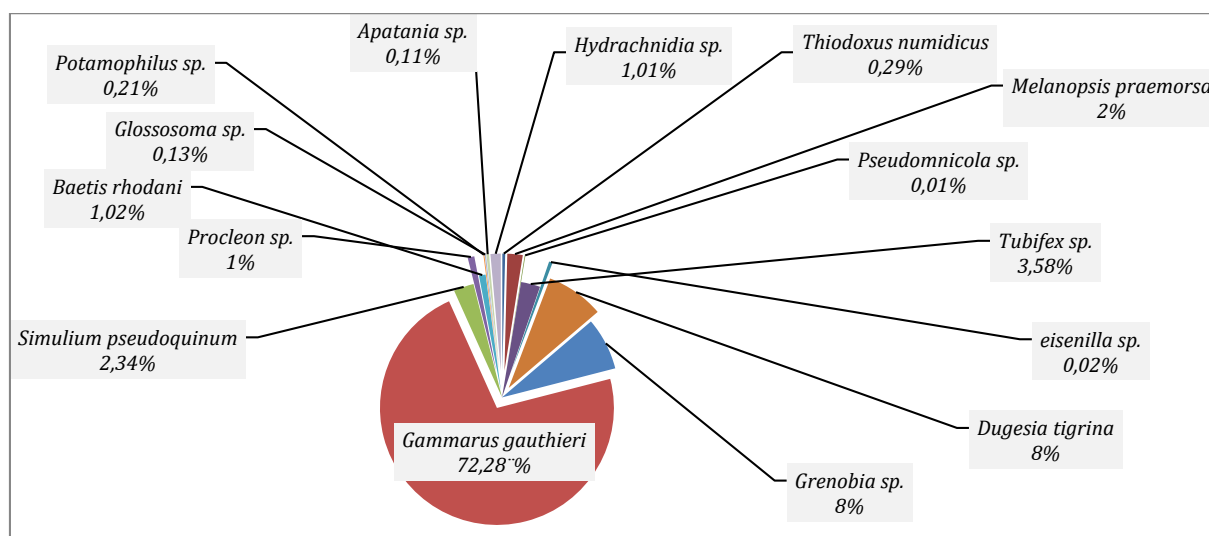


Figure 4: Relative abundance of various taxa in the source Aghbal(Az)

3.2.6 Frequency

At the Aghbal (Az) station, we noted the presence of 13 constant species out of a total of 15 taxa populating this aquatic environment, 1 accessory species and 1 accidental species

Table 4: frequency of occurrence of the species colonizing the source Aghbal(Az)

species (Source of	frequency (%)	Presence
--------------------	---------------	----------

Aghbal(Azrou))		
<i>Thiodoxus numidicus</i>	75	Constant ($\geq 50\%$)
<i>Melanopsis praemorsa</i>	100	
<i>Tubifex sp.</i>	100	
<i>eisenilla sp.</i>	87,5	
<i>Dugesia tigrina</i>	100	
<i>Grenobia sp.</i>	100	
<i>Gammarus gauthieri</i>	100	
<i>Simulium pseudoquinum</i>	100	
<i>Procleon sp.</i>	100	
<i>Baetis rhodani</i>	100	
<i>Glossosoma sp.</i>	50	
<i>Apatania sp.</i>	75	
<i>Hydrachnidia sp.</i>	100	
<i>Potamophilus sp.</i>	37,5	25 < accessory < 50
<i>Pseudomnicola sp.</i>	25	accidental ≤ 25

Conclusion

Biodiversity and freshwater habitats are recognized as particularly threatened at global level. Monitoring of freshwater basins is proving so be a necessary measure to prevent the loss of these ecosystems. a taxonomic inventory coupled with a synthesis of the biological/ecological knowledge of wildlife should be drawn up in the preamble to any methodological development in bio-indication. The results of analyzes of the structure of macroinvertebrates populating the Aghbal source (Az) using conventional descriptors (Abundance, diversity, etc.) have made it possible to reveal that the benthic fauna at the level of this aquatic ecosystem is represented by a low number of taxa per report to the work of (Nechad et al, 2016) which focused on a source belonging to the same geological entity as the source in question.

The analysis of all the species collected during the study year showed that it is the species *Gammarus gauthieri* which governs this station with a percentage value equal to 72.28% while the other taxa are represented by small percentages not exceeding 3%. This diagnosis should encourage the public authority to formulate recommendations to contribute to strategic thinking for the management of biodiversity and the integration of data in decision-making, develop a

biodiversity monitoring network and promote dialogue and communication between actors.

References

- [1] Thomas, J.D., *Journal of Natural History*, 27 (1993): 795-806.
- [2] Bouzidi, A. 1989. Recherches hydrobiologiques sur les cours d'eau des massifs du Haut-Atlas (Maroc). Bio-écologie des macroinvertébrés et distribution spatiale des peuplements. Thèse d'état, Fac.Sc. Tech. St. Jerome, Université d'Aix-Marseille III: 190pp.
- [3] Chahlaoui, A., Etude Hydrobiologique de l'Oued Boufekrane - Impact sur l'environnement et la santé, Thèse d'état en Biologie. Univ. Moulay Ismail Fac. Sci. Meknès. (1996) 256pp.
- [4] Maqboul A., Aoujdad R., Fekhaoui M., Fadli A. et Touhami A. (2001). *Riv. Idrobiol.*, 40,2-3:129-152.
- [5] Karrouch, L., Bio-évaluation de la qualité des eaux courantes de la région Meknès (Centre- Sud, Maroc) – Impact sur l'environnement et la sante. Thèse doctorat es sciences en biologie. Faculté des sciences. Meknès, (2010) 216pp
- [6] Haouchine, S., Recherche sur la faunistique et l'écologie des macroinvertébrés des cours d'eau de Kabylie. Mémoire de Magister, Faculté des Sciences Biologiques et Sciences Agronomiques, Université Mouloud Mammeri de Tizi ousou, Algérie. (2011) 157 pp.
- [7] Genin, B., Chauvin, C., Menard, F., Cours d'eau et indices biologiques: pollution et méthodes IBGN, Dijon, ENESA-CNERTA., (1997) 202pp.
- [8] Nechad, I., Slimani; M., Fadil, M., Fatima Fadil. Limnic and hydrochemical study Source AinRegrag (Middle Atlas, Morocco). *International Journal of Scientific & Engineering Research*, Volume 7, Issue 8, August-2016 962 ISSN 2229-5518.
- [9] Azeroual, A., Crivelli, A.J., Yahyaoui. A and Dakki, M « l'ichtyofaune des eaux continentales du maroc » *Cybium* 2000, 24(3) suppl.: 17-22

[10] Tachet,H., Richoux,P and Bournaud, M., P.Usseglio-Polatera. « Invertébrés d'eau douce: systématique, biologie, écologie ». CNRS 2emeEditions, 2006. Paris 588pp.