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Inventory of benthic macroinvertebrates as bio-indicators of Afenourirlake (Morocco)

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Keywords

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Abstract

Benthic macroinvertebrates of the Afenourirlake were studied from samples collected between June 2015 and June2016; the results of the benthic fauna identified in this study consist of 4945 individuals representing 17 families belonging to 4 faunistic groups: (arthropods (79%), annelids (15%), mollusks (5%), and Nemathelminthes (1%)). The number of benthic population showed a dominance of the crustaceans (44%) and, Diptera (Chironomidae larvae (32%)) followed by, Oligochaeta (9%), the Achaetes (6%), and gastropods (6%). whereas the Odonata (1%), Heteroptera (1%), Ephemeroptera (1%) and Coleoptera (0%) are only a small fraction of the total fauna. A comparison is made between pollu-tolerant and pollu-sensitive taxa in order to assess the quality of the water of the lake and the degree of degradation of the wetland. This comparison shows that at the level of 4 stations (upstream and downstream), there is a poor water quality due to a high proportion of pollu-tolerant taxa (ChironomidaeSp, and annelids). The results obtained in this study show a critical situation of water quality at the Afenourirlake and this may cause a degradation of the wetland. To address this problem, it is necessary to carry out a proper planning and management of human activities practiced at Afenourir.

1. Introduction

For a sustainable management of aquatic environments and wetlands, a water quality assessment is required [1], often using standard methods for measuring a range of physico-chemical parameters. We compare them to proven standards or quality criteria. [2,15] This approach has shown not only its usefulness but also its limitations as well.

In order to determine the effects of water pollution, the classical approach of physico-chemical parameters, can be complemented by a biological monitoring that involves the use of living organisms (biological indicators). Among these indicators, benthic macroinvertebrates were the subject of several hydrobiological studies [3, 4]. Indeed, the notion of integrity or health of ecosystems requires taking into account the chemical, physical and biological parameters [5, 15].

Benthic macroinvertebrates are animal organisms that are visible to the naked eye, present and abundant in all ecosystems, particularly wetlands. They are represented by larvae of aquatic insects, crustaceans, mollusks and worms. Benthic macroinvertebrates play an important role in the aquatic food chain, as they are the main food source for several fishes, insects and amphibians. They must therefore be present in sufficient quantity and with an important diversity to maintain the ecosystem of these wetlands in balance, function and health. Benthic macroinvertebrates are relatively sedentary, making them good indicators of local conditions because they include a large number of taxa, many of which have a known degree of tolerance, which reflects significantly the different sources of pollution and degradation of wetlands. [6]

Afenourirlake, a class RAMSAR site since 1990, is located at the level of the large catchment area of Sebou, in the region of Ifrane-Ain Leuh. The benthic macro-invertebrate fauna of the lake is unknown and has never been studied before despite the work carried out in some ecosystems belonging to the same watershed as *OuedKhoumane* [4], *Boufekrane*river [3] and *Ouislane* [7], these streams subject to an important organic

pollution due to their location in a highly urbanized zone. In order to fill this gap, our investigations focused on Afenourirlake, characterized by a high anthropogenic activity, to establish a first inventory of macro-invertebrates in order to assess the state of water quality in this region.

2. Experimental details

2.1.*Description of the study area and sampling stations*

Afenourirlake (Aguelmam) is located in the central Middle Atlas of Morocco, with geographical coordinates (33 ° 17'N - 5 ° 16'W), an altitude of 1790-1800 m, covering an area of 400 ha. This Aguelmam is located in the south of the province of Ifrane at 30 km south of Azrou and relevant to Ain Leuh rural community. The lake is included in the perimeter of the National Park of Ifrane, and is classified RAMSAR [8-10].

It is a mountain site consisting of an eutrophic lake of nearly 400 ha, shallow, less than 2 m, a wet lawn around it and a stream located at the lake spillway [10, 11]. To complete this study, four stations were chosen at the lake level, taking into account a number of criteria such as the direction of water flow, accessibility, and sources of pollution and dominance of aquatic vegetation. (Table 1, Figure 1).

Table 1: Characteristics of the study stations of the Afenourirlake.

Stations	GeographicalCoordinates		Substrate	Locality and others
	Latitude	Longitude		
S1	33°17'0,26" N	5°15'14,33" W	Muddy, stony	Downstream near the dike, high anthropogenic activity (washing, pasture)
S2	33°16'54,61" N	5°15'20,82" W	-------	Upstream near the bird observatory, washing, pasture, tourist waste.
S3	33°16'38,3" N	5°14'57,75" W	-------	Upstream, On the side of the Ain Kahla forest, washing, pasture, pumping and pollution by household waste.
S4	33°16'49,71" N	5°14'51,22" W	-------	Downstream, on the side of the Ain Kahla forest, washing, pasture, pumping and pollution by household waste.

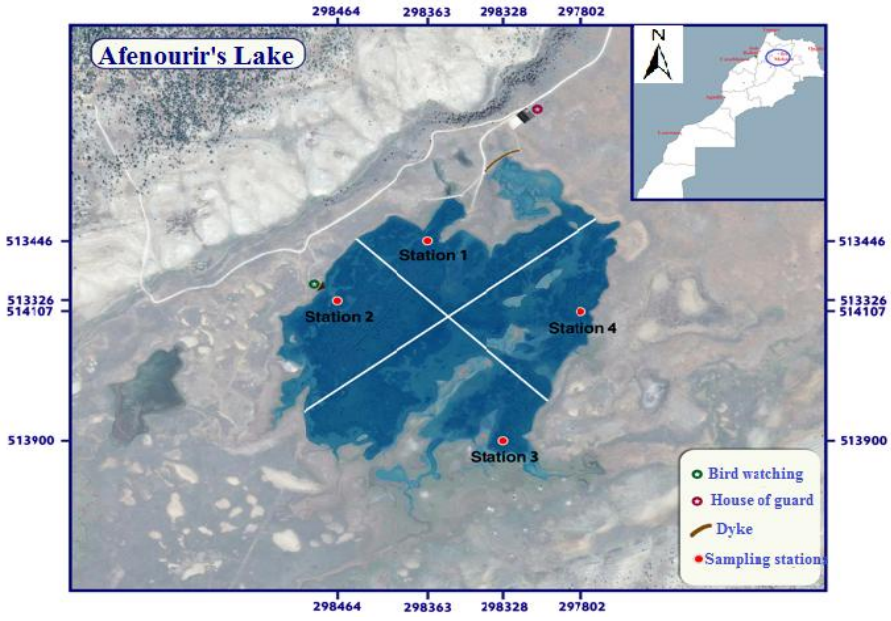

Figure 1: Location of sampling stations at Afenourirlake

2.2 *Sampling and analysis*

2.2.1 *Sampling technique*

32 benthic macroinvertebrate samples were collected from the 4 study stations (littoral zone), during 8 Campaigns between June 2015 and June 2016. The sampling was carried out in a surface of $1m^2$ with the aid of a net hand. It is a net of 19 cm diameter with a mesh of 300 µm. Each sample consisted of 4 shots of net. The samples are stored in formalin diluted to 10% [3, 6].

2.2.2 *Analysis technique*

In the laboratory, the invertebrates are separated from the sediment by sieving (mesh ranging between 200 µm and 500 µm). They are identified under a binocular lens and using the key to determine benthic macroinvertebrates of freshwater [3, 12, 15]. The number of individuals, per square meter of each taxon is determined. (Figure 2).

Figure 2: The different stages of identification of benthic macroinvertebrates

3. Results and Discussion

3.1.*Identification and inventory of benthic macroinvertebrates*

The faunistic determination for the 8 campaigns between June 2015 and June 2016, for the four sampling stations, consists of 4 branches, 6 classes, 11 orders and 17 families.

Table 2 summarizes the results of the taxonomic composition of benthic communities by families. A total of 4945 individuals were identified, corresponding to 17 families belonging to 4 faunistic groups (Arthropods (79%), Annelids (15%), Mollusks (5%) and Nemathelminthes (1%). In terms of total abundance at Afenourir lake, crustaceans (Limnadiidae, Daphniidae, Asellidae, and Cyclopidae) are numerically the most inventoried and represent the highest percentage (44%) followed by Diptera (Chironomidaesp) (32%), Annelids (15%) and Mollusks (5%). Ephemeroptera (Baetidae, Leptophlebiidae) and Nemathelminthes are the least represented groups (1%) (Figure 3).

3.2. *Comparison of pollu-tolerant and sensitive MIB's*

We have chosen to calculate the abundance of pollu-tolerant (Chironomidae, and Annelids) and pollu-sensitive (Ephemeroptera), In order to compare them, with the intention of doing assess the biological quality of the lake. This abundance fluctuates according to the station. It varies between 515 and 649 individuals for pollu-tolerant and 7 to 13 for pollu-sensitive.

The choice of the stations was done according to the following criteria: The anthropogenic activity, the hydrological situation and the distribution of aquatic vegetation at the lake, allows us to interpret the inventory of the recorded MIB's in order to monitor the evolution of the pollu-tolerant and pollu-sensitive MIB of the Afenourir lake at each station during the 8 campaigns (Figures 4, to 7).

Table 2: Total abundance of benthic macroinvertebrates harvested at different sampling stations at Afenourir lake (June 2015 – June 2016)

	Families	Station 1	Station 2	Station 3	Station 4	Total
ARTHROPODS	LIMNADIIDAE	121	134	200	184	639
	DAPHNIIDAE G : DAPHNIA	450	322	187	196	1155
	CHIRONOMIDAE Larve	378	380	410	422	1590
	CERATOPOGONIDAE	0	2	0	0	2
	HYDROPHILIDAE G : HYDROCHARA	2	6	3	1	12
	ASELLIDAE	0	25	0	0	25
	COENAGRIONIDAE	9	14	15	12	50
	BAETIDAE	1	0	0	1	2
	LEPTOPHLEBIIDAE	10	13	9	6	38
	CYCLOPIDAE	156	89	67	45	357
	CORIXIDAE G : MICRONECTA	0	2	16	33	51
Subtotal for Arthropods branches		1127	987	907	900	**3921**
ANNELIDS	GLOSSIPHONIIDAE G : GLOSSIPHONIA	73	98	121	100	392
	NAIDIDAE Species : STYLARIA LACUSTRIS	64	68	103	127	362
Subtotal for Annelids branches		137	166	224	227	**754**
MOLLUSKS	PLANORBIDAE	11	18	8	30	67
	LYMNAEIDAE	9	10	13	34	66
	PHYSIDAE	8	12	32	43	95
Subtotal for Arthropods branches		28	40	53	107	**228**
NEMATHELMINTHES	MERMITHOIDEA	6	12	16	8	**42**
	Total Abundance	1298	1205	1200	1242	4945
	Total of families	14	16	14	15	59

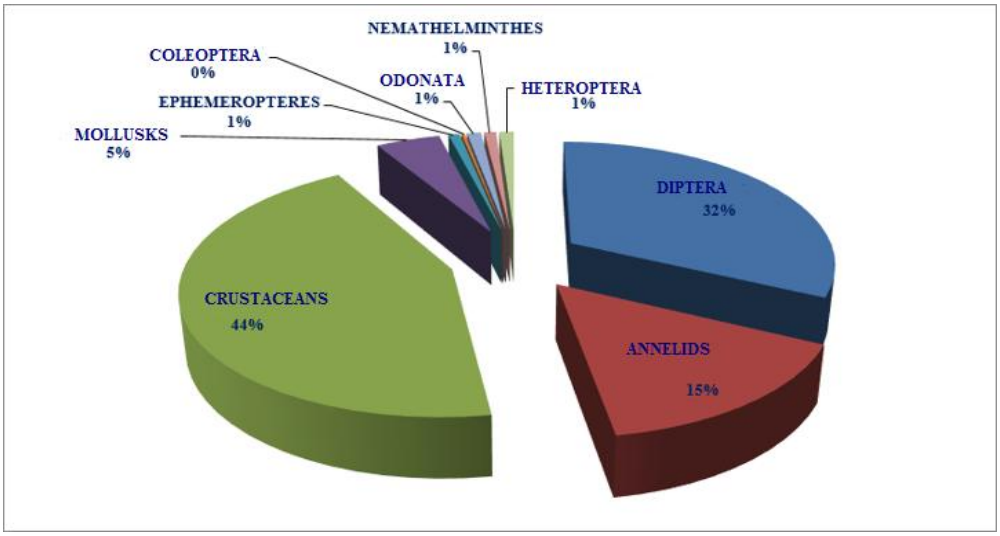

Figure 3: Abundance of the overall fauna of the studied stations at Afenourirlake

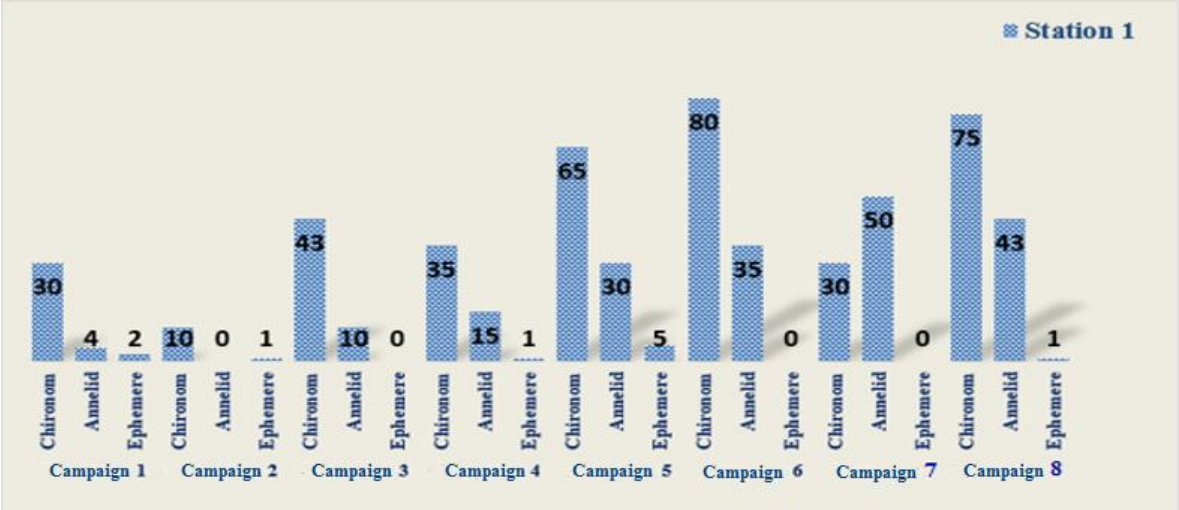

Figure 4: Abundance of pollu-tolerant and sensitive MIB's for station 1 at Afenourirlake

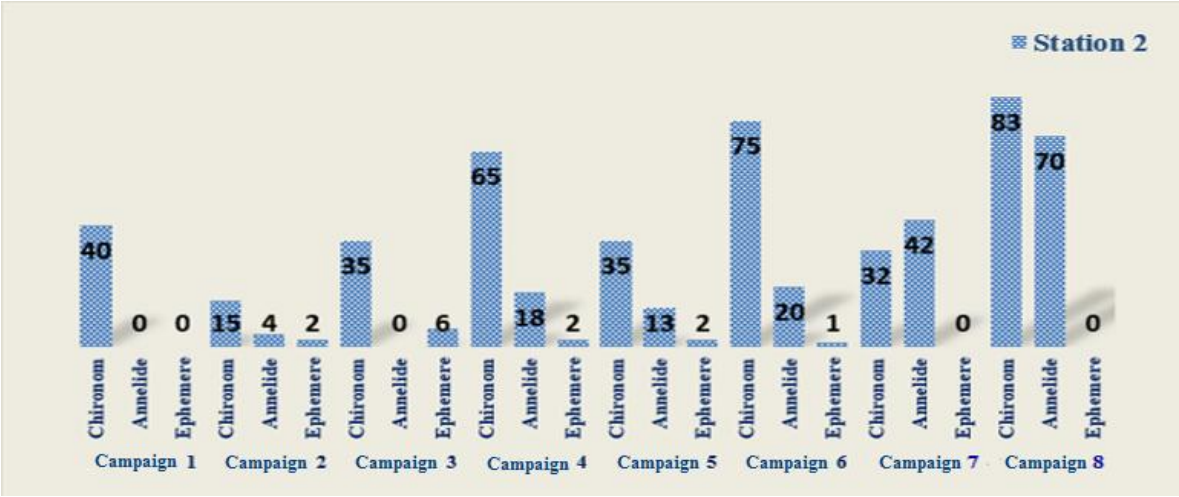

Figure 5: Abundance of pollu-tolerant and sensitive MIB's for station 2 at Afenourirlake

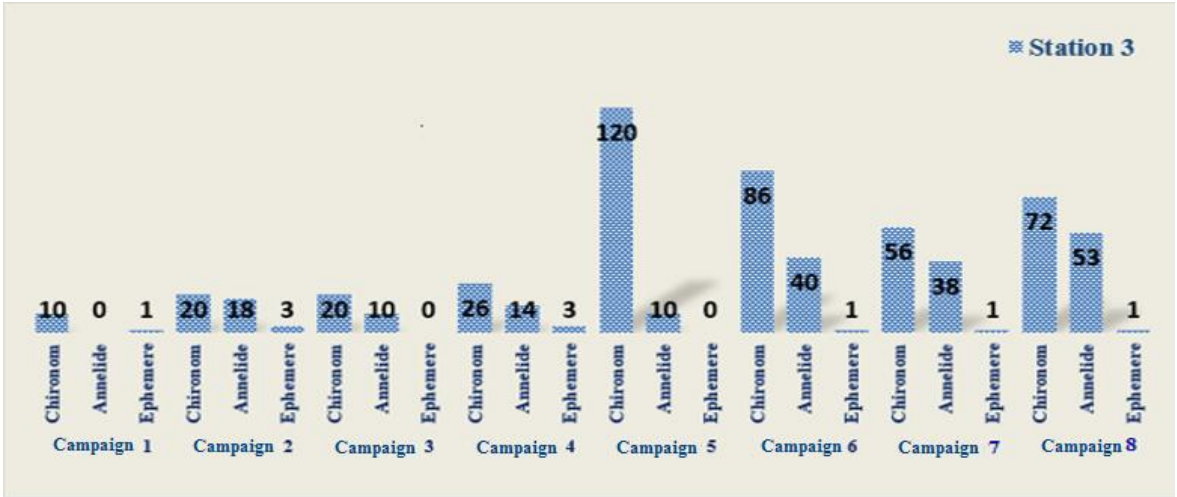

Figure 6: Abundance of pollu-tolerant and sensitive MIB's for station 3 at Afenourirlake

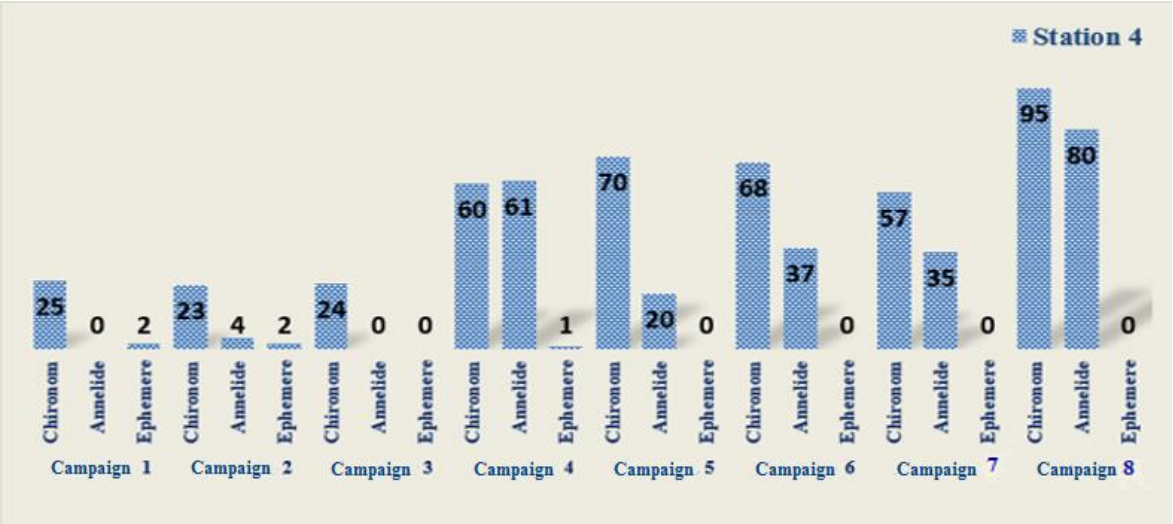

Figure 7: Abundance of pollu-tolerant and sensitive MIB's for station 4 at Afenourirlake

Discussion

It appears from our study that the different stations show an unbalanced structure in MIB with proliferation of Chironomidae and Annelids in 98% of what which support the pollution. This pollution is probably related to the presence of organic matter. On the other hand, there is a low presence of pollutants (Ephemeroptera: 2%).

The results show a degradation of the site by organic pollution, from upstream (S2, and S3) to downstream (S1, and S4). The latter may be due to anthropic activities (overgrazing, washing, household waste, tourist activities, etc...) which could lead to the disappearance of pollu-sensitive taxa.

The Afenourir lake stands are much less diversified compared to other national and international plans. The benthic macroinvertebrates of OuedKhoumane were studied by Ben Moussa et al [4], from samples taken monthly during August 2010 and July 2011.

The fauna recorded in this work consisted of 17124 individuals belonging to 3 main faunistic groups (Annelids, Mollusks, arthropods). He reported that the more they advanced downstream, the more they witnessed decreases and disappearances of pollu-sensitive taxa such as Ephemeroptera. The opposite is true for pollu-tolerant taxa such as Chironomidae and Oligochaetes. They deduced an alarming situation of the water quality of OuedKhoumane and especially in its downstream stretch because of several sources of pollution in the region (the *Ain HammaMoulayIdriss*thermal source, wastewater discharges).

Fargani and Arab [13] they evaluated, in September 2007 and April 2008, the benthic macroinvertebrates of the Oued El-Harrach, which is one of the largest Oueds in the Mitidja plain (Algeria). They identified 10 faunal groups belonging to 53 families (Ephemeroptera, Pleoptera, Trichoptera, Heteroptera, Coleoptera, Diptera, Odonata, Mollusca, Crustacea and Oligochaetes). They showed that the biological quality of Oued El Harrach is not satisfactory. It varied from average to mediocre for all the stations with the exception of certain stations which were the most upstream of the hydraulic network.

Agneby is the largest coastal river in Côte d'Ivoire for which, samples carried out by Diomandé et al [14] were taken during January and October 1997. The inventory of benthic fauna consisted of 50 individuals, and showed that for the whole river there is a relatively diverse presence of Ephemeroptera (pollu-sensitive), which would reflect a good water quality of the river.

These studies showed the sites were infected by several types of pollution and this by identifying the benthic macroinvertebrates, which among them are identified in our case by a high abundance of pollu-tolerant (Chironomidae, Annelids) of 2254 individuals representing 98%, while pollu-sensitive species represent only 2% of the fauna. This could be related to the various anthropogenic activities practiced at the lake.

Conclusions

Deterioration of water quality causes degradation of aquatic ecosystems. To remedy to this situation, this study of the variation of existing benthic macroinvertebrates is very useful. Our study focused on the water quality of Afenourirlake, a shallow mountain site, located in the Central Middle Atlas and belongings to the perimeter of the National Park of Ifrane and ranked RAMSAR since 1990. The faunistic inventory of the MIB's constitutes

an important first database. The fauna is characterized by a taxonomic diversity that varies according to the degree of water pollution. It consists of 4945 individuals corresponding to 17 families belonging to 4 faunal groups: (Arthropods (79%), Annelids (15%), Mollusks (5%), and Nemathelminthes (1%)). The benthic population showed that Crustaceans, Diptera and Oligochaetes are dominant (91%). Odonata, Heteroptera, Coleoptera and Ephemeroptera constitute only a small fraction (9%) of the harvested fauna.
The comparison between pollu-tolerant and sensitive shows a dominance of Chironomidae and Annelids compared to Ephemeroptera with respectively, 98% and 2%. We deduce that the Afenourirlake runs a risk of imbalance given the different anthropogenic actions such as water pumping, grazing, washing, tourist waste, etc. Subsequently, strict measures must be taken in order to put an end to all these threats.

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