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First data on the benthic macrofaunainthe SidiBouali source (Middle Atlas, Morocco)

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Abstract - The objective of this work is to investigate the State Limnological source SidiBouali, one of the major outbreaks of the basin of Sebou (Middle Atlas, Morocco), to make an inventory of the macroinvetebres that there are specific, to analyze their distribution and define the interactions between the different taxa and abiotic environmental factors. Sampling of macrobenthos is made using the Surber NET, with a width of mesh 400µm at a monthly frequency in the year 2013. Samples of water, for the physicochemical and bacteriological analysis has been also made in station synchronously with those of benthic macrofauna.Examination of the results of analyses physic-chemical and bacteriological of water samples collected, shows that the waters of SidiBouali are calcium hardness high with an average concentration of 148.7 (mg/l), but which are still less than drinking water standards. Bacteriological standpoint, SidiBouali flows are excellent, they are free of indicator microorganisms of fecal pollution. Fauna found in this work consists of 7423 individuals corresponding to 23 families and 35 taxa, belonging to 3 main faunal groups (crustaceans, gastropods, insects). The Turbellaria, Arachnids, Oligochaetes, Achaetesconstitute only a small fraction of the total fauna. The principal component (ACP) analysis revealed that the vast majority of species are indifferent to the effect of seasonality. and there are correlations between physicochemical parameters of the environment and some species such as Gammarusrouxii,Caenispusilla, Calopterixsplendens and Cypridina sp. It follows that SidiBouali is a biotope heterogeneous, with a good wealth specific and less influenced by anthropogenic activities.

Index terms: benthic invertebrate macro, biodiversity, sources, ACP, Morocco.

1. Introduction.

Morocco, the North Africa region best appealed in wetlands compared to the other Maghreb countries. This is related to its geographical location which equipped it with a marine coastline of about 3500km and 4 mountain ranges, including the Middle Atlas is the cornerstone. The high altitude of its well-watered reliefs and the predominance of superficial phreatic waters so its mainly karstic lithology generate a multitude of sources permanent fresh (10-18 ° C), generally high rate [1]. They fulfil functions hydrological, socioeconomic and ecological valuable across the country [2]. They are also biotopes which usually contain a variety of forms of life. All the links uniting these different groups is a food chain, in which benthic macro-invertebrates are a driving piece [3].

Macro-benthos connects so often very complex, different sources of organic matter, higher trophic chain; it is a relevant indicator of the level of disruption of aquatic ecosystems. It is this exceptional reactivity is responsible for the integration of the study of this compartment in different international strategies to define the Habitat quality and especially the sources.The sources of my are home to a rich and diverse biota which remained marginalized and unrecognized for a long time, yet these biotopes were considered much more for their water resources for their ecological values and their biodiversity. The waters of springs were also colonized by microorganisms and many species adapted and water and microclimatic factors that confer habitat-dependent animal. The most representative groups of species include aquatic invertebrates (*crenobiontes)* who have specialized to take advantage of the specific conditions of these ecological niches such as some who exploit the crevices of the rocks dripping (*fauna hygropetrica*) [4]. In a context of sustainable development and the need for the preservation of the biodiversity of sources of the Middle Atlas Moroccan faunisticendemism cradles, we undertook this investigation of the sidiBoualisource one of the large outbreaks of the Middle Atlas and for which we have no ecological data. We have started a study in several aspects; physicochemical, limnic, and statistical.

Not only to be fitted with updated data of the State but also to take a relevant and compelling tool for the establishment of a legal framework for the conservation of the wetland. As the results of this work will be an educational tool to become aware of the great heritage value of these macrobenthic species endemic to the sources, the spaces they occupy and their dynamics.

2. Material and method

2.1. Study site

Belonging to the rural municipality AhlSidiLahcen, 18 km from the town of Sefrou (Middle Atlas, Morocco) (Figure 1), SidiBouali source nestled in the middle of an olive grove.the main source and its resurgence are completely natural. This resurgence is part of the Midlle Atlas causses. It's deaf from liassic aquifer of the Fes-Taza corridor, at 1100 m above sea level. According to the classification of Emberger, the station is part of the sub-humid bioclimatic floor cold winter. Analysis of the diagrams (Figure 2) ombrothermics of this station shows that the dry season is four months (of the month of June to September) [5]. Its regular flow is approximately 180 (l/s) with an average velocity of 48 cm/s. the station is held by a covered plant comose primarily algae and pteridophytes. Thanks to its spiritual value, until recent years, SidiBouali was not plundered by anthropogenic activities, the surrounding population sought rather to preserve. But in a perspective of sustainable development, the risks of a possible deterioration of the quality of its waters are indeed present.

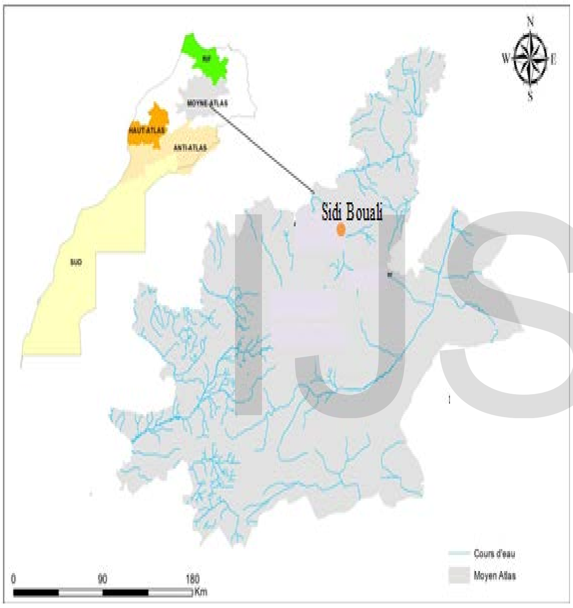

Figure 1: Location of the SidiBoualisource

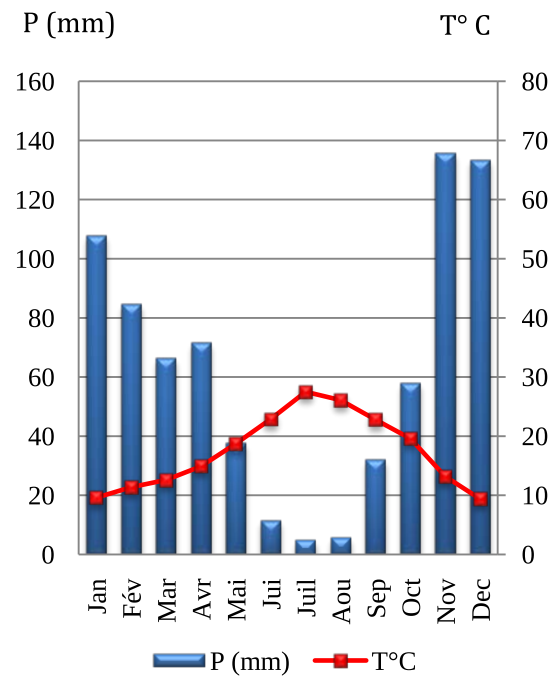

Figure 2:Ombro-thermal diagram of the SidiBouali station

2.2 Sampling of the macro-invertebrate benthic

2.2.1. Sampling Schedule

Seasonal variability in the structure of the community is high because the life cycle of several benthic macro invertebrates' species is annual or shorter and it culminates with an adult phase. Thus, the presence of mature larvae, nymphs or adults may be short. So it is better to collect samples, a monthly frequency in a year, and it is the schedule called for this study. We conducted monthly samplings from the month of January 2013 until December 2013.

2.2.2. Sampling method

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 Macro-invertebrates 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 [6]. Species in each group are sorted, identified, counted, and classified among functional feeding groups according to [7].

In addition to these biological surveys, samples of water samples for chemical and bacteriological analysis was made during the year of study in the same places of sampling to have precisely the evolution of these parameters in local time and monitor their synchronism with benthic stands of sources.

2.3 Analysis of physic-chemical parameters of the water

In order to assess the physicochemical quality of the underground water masses of the station, a monthly survey of water samples was conducted during a year every 4 weeks, for a total of 12 months of sampling between January 2013 and December 2013. According to the who recommendations, a volume of 1, 5 litres of water is collected each month in bottles, polyethylene from the main resurgence. And kept at 4 ° C during transport to the laboratory to be analysed within 24 hours following. The methods of analysis are those recommended by the standards [8; 9]. Measurements of temperature, pH and electrical conductivity were conducted in the field using a multi-parameter pH/conductivity Analyzer / temperature CyberScan PC10. The methods used are: volumetric measurement for dissolved oxygen, bicarbonates, chlorides, calcium and magnesium and sulfates and ortho molecular absorption spectrophotometry phosphates (table 1).

Table 1: Chemical component analysis method

Parametres	Unité	Measuring equipment and method of analysis
Temperature	° C	Analyzer multi parameters Cyber Scan
Conductivity	µS/cm	Analyzer multi parameters Cyber Scan
pH		Analyzer multi parameters Cyber Scan
Dissolved O_2	mg/l	Winklermethod
Total hardness	mg/l	EDTA Complexometry of with eriochrome black
Calcium hardness	mg/l	EDTA Complexometry of with calcone
Magnesiumhardness	mg/l	Difference between total and calcium hardness
Alkalinity	meq/l	Volumetric dosing with sulfuric acid and methyl orange
Organicmatter	mg/l	Oxidizability of hot potassium permanganate
Chlorides	mg/l	Metering,withMohrmethod
sulphates	mg/l	absorption spectrometryat 650 nm
Orthophosphates	mg/l	absorption spectrometry at 750 nm

2.4 Microbiological analyses.

Microbiological water characterization, is part of the commonly practiced analyses. Indeed, the purpose of a bacteriological study is to identify the presence or not of fecal contamination, sought microorganisms are the FMAT, fecal coliforms, total coliforms and faecalstreptococci.The sampling of water made in situ in sterile bottles. Filtration and seeding, petri dish, were made the same day. The methods used in this follow-up meet Moroccan drinking water standards (NM.03.7.002.2011). Different culture media recommended for the bacteriological analysis of water are explained in table 2. After incubation, the colony forming units (CFU) were counted macroscopically in each Petri dish.

Table 2: Method of sampling and enumeration of bacteria

	Technique	**Sampling volume**	**Culture medium**	**Incubation temperature**
FMAT	Incorporation in solid medium	1 ml	Yeastextract agar	20°C et 37°C
Total coliforms	Filtration	100ml	Agar lactose to the TTC	37°C
Fecalcoliform	Filtration	100ml	Agar lactose to the TTC	44°C
Faecalstreptococci	Filtration	100ml	Agar Slanetz	37°C

2.5 Calculation of statistical descriptors of data

2.5.1. 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:

$$H' = -\sum (ni/N) \cdot \text{Log } 2 \, (ni/N)$$

H': diversity specific
N: total number of individuals
ni: 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.

2.5.2. 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:

$$E = H' / H_{max}$$
$$H_{max} = \log_2 (S)$$

E= H' / Hmax
Hmax= Log2 (S) S: Total number of species

2.5.3 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

$$Pi = Ab(a)*100/ Ab(t)$$

Where, Ab (a): total number of individuals of a species.
Ab (t): total number of individuals

2.5.4. 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.

$$Fi = Pa * 100 /Pt$$

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%

2.6.Analysis of principal components (ACP)

On the other hand, to visualize and analyze existing correlations between the different variables through their behaviors and orientations, to identify the main factors responsible for the quality of the waters of the searched environment. We statistically processed all the data by component analysis main c.p.a. by the Unscrambler 9.2 software.
The Unscrambler 9.2 focuses on the interpretation rather than statistics to improve the decision-making process and the speed at which decisions can be taken.

3. Results and discussion

3.1. Water chemistry

The results of this study provide a first description of the SidiBoualisource hydro chemical status.
At neutral pH waters whose content hovers around 7.They are moderately mineralized, their electrical conductivity varies little, with values ranging between 1086 µS/cm (February) and 1104 µS/cm (August).The waters of the resurgence are characterized by a calcium hardness is very high, their average is 148,67 (mg/l), the deaf resurgence of an aquifer purely Karst and such concentrations in calcium ion would seem to be a no-brainer. These waters are well oxygenated, minimum dissolved oxygen concentration is registered in the month of August with a grade of (4.32 mg/l), and the maximum is reported in January (5.72 mg/l) (table 2). This dissolved oxygen availability could be explained by the fact that station (SB) is held by a significant canopy macropphytes and algae. Organic matter expressed by the index of permanganate IP content does not exceed 0.34 mg/l and in the worst of cases, thus, indicating the good quality of water. We note a remarkable homothermy of the spring the average temperature waters, settled around 17.75 ° C. Concentrations of phosphates graze the value zero. As the sulphate content, it varies between 15.11 mg/l (March) and 16,778 mg/l (February). These levels remain significantly below the Moroccan standards set to 200 (mg/l) for drinking water and 250 (mg/l) for that for irrigation. Indeed, the review and interpretation of the results of physic-chemical analyses of water samples collected shows that SidiBouali waters are under the direct leadership of the geological substratum through and this in report has several previous works [9; 10; 11].

Table 3: Results of the physicochemical analyses the SidiBoualisource year 2013

	Ca_2^+ (mg/l)	Mg_2^+ (mg/l)	TAC (meq/l)	Cl- (mg/l)	I.P (mg/l)	SO_4^{2-} (mg/l)	PO_4^{3-} (mg/l)	dissolved O2 (mg/l)	EC (µS/cm)	pH	T °C
J	148,76	40,57	1,02	213,00	0,12	15,88889	0,0000	5,72	1093	7,19	17,96
F	147,72	31,21	0,98	202,35	0,21	16,778	0,0000	5,44	1086	7,38	17,2
M	148,76	30,17	1,02	205,90	0,19	15,111	0,0023	4,32	1099	6,98	17,35
A	148,24	36,93	0,97	207,68	0,20	16,000	0,0027	5,60	1102	7,06	17,83
M	151,36	35,89	0,95	211,23	0,23	15,556	0,0022	5,20	1103	7,23	17,92
J	150,84	37,45	0,98	209,45	0,30	15,778	0,0015	4,88	1100	7,25	17,99
JL	151,88	37,97	0,99	216,55	0,29	15,722	0,0013	4,56	1102	7,21	17,53
A	152,92	36,41	1,10	211,23	0,34	15,667	0,0009	4,32	1104	7,3	17,69
S	151,88	39,53	1,04	216,55	0,23	16,000	0,0006	5,44	1104	7,24	18,01
O	148,76	38,49	1,01	209,45	0,23	15,889	0,0000	5,60	1091	7,18	17,88
N	147,72	43,69	1,01	205,90	0,23	15,44444	0,0000	5,52	1088	7,22	17,82
D	135,23	41,61	1,01	207,68	0,02	15,66667	0,0000	5,60	1090	7,2	17,91

3.2. Bacteriological analysis

Water faecal coliforms, faecal streptococci and total coliforms as well that the FMAT comes from a human or animal fecal pollution and demonstrate the potential presence of pathogens capable of causing enteric diseases. None of these must be present per 100 ml of drinking water so that the water is safe for consumption. Thanks to the spirituality of the places for the coastal population, Sitemap SidiBouali (SB) has remained free of any fecal pollution; and this, by revealing a values zero for all themicroorganisms (table 4).

Table 4: Results of microbiological analyses inSidiBoualisource (year 2013)

Microorganismes	(UFC)
FMAT at 37ºC/100ml	0
FMAT at 22ºC/100ml	0
Total coliforms (TC)/100 ml	0
Fecalcoliform (FC)/100 ml	0
Faecalstreptococci (FS)/100 ml	0
FC/FS rate	0

3.3. Study of benthic macrofauna

3.3.1. Inventory of the benthic community

400 µm mesh, garnered a total of 7423 individuals belonging to 35 taxa, sidiBoualimacrofauna stands are organized in a manner relatively classic, table 5 presents the list of harvested organisms. The identified taxa belong to seven taxonomic classes: Gastropods, insects, crustaceans, Arachnids, Turbellaria, the Olifgochetes and Achaetes. Twenty (20) taxa identified up to species and 15 others to the kind. Gastropods include three families (Viviparid, Neritidae and Hydrobidae).

Three families of crustaceans are concerned: Gammaridea, the Potamidae and the Cypridinidae. Insects are represented by 18 taxa belonging to 10 families, themselves divided between 7 orders:Diptera (1 family of the Simuliidae), Odonata (the Calopterygidae 1 family), caddisflies (the Agapetinae 1 family), Heteroptera (Nepidae and Gerridae), Megaloptera (1 family of the Sialidae), mayflies (Baetidae, Caenidae and Heptagenidae), (Pontarachnidae, Pionidae), HydracariensTriclads (Dugesiidae, planaridae), Oligohetes (4 families) and finally Achaetes (1 family) (Figure 2).

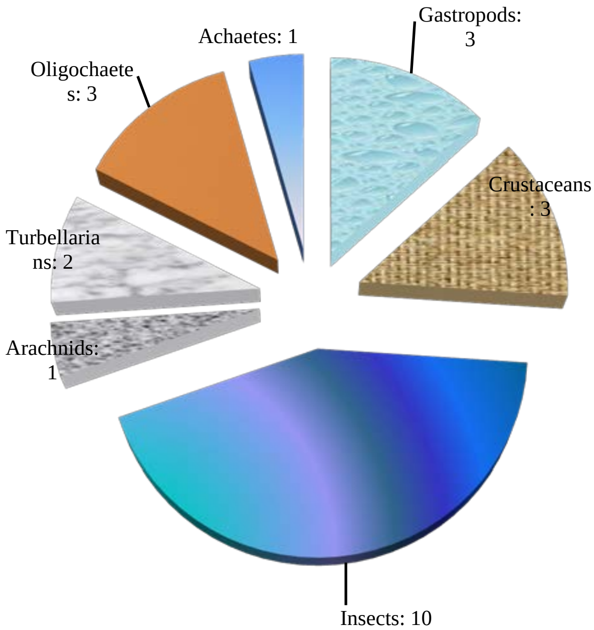

Figure 2: Number of family by taxonomic class in SidiBoualistation

Table 5: Monthly changes in the abundance of benthic macrofauna in the station (SB) in the year 2013

Species	J	F	M	A	M	J	J	A	S	O	N	D
MélanopsisPraemorsa	**199**	**245**	**223**	**230**	**183**	**86**	**10**	**44**	**72**	**79**	**42**	**85**
Theodoxusnumidica	**19**	**49**	**44**	**59**	**32**	**28**	**15**	**7**	**12**	**20**	**9**	**11**
Theodoxusfluviatilis	-	-	-	-	-	**1**	-	**3**	-	-	-	-
Horatiasp.	**14**	**1**	**1**	**1**	**57**	**10**	**10**	**18**	**80**	**63**	**22**	**5**
Gammarusmarocanus	**6**	**12**	**18**	**15**	**28**	**95**	**131**	**81**	**135**	**44**	**39**	**28**
Gammarusrouxii	**115**	**104**	**160**	**213**	**541**	**234**	**570**	**474**	**308**	**137**	**131**	**108**
Gammarussp.	**9**	**3**	**12**	**11**	**20**	**93**	**101**	**113**	**109**	**47**	**24**	**15**
Potamon fluviatile	**6**	**10**	**5**	**6**	**6**	**4**	**3**	**5**	**5**	**6**	**7**	**4**
Cypridinasp.	**1**	**8**	**2**	**3**	**2**	**4**	**3**	**4**	**2**	**1**	-	**1**
SimuliumPseudoquinum	**5**	**7**	**4**	**9**	**8**	**13**	**19**	**16**	**11**	**19**	**12**	**3**
Simuliumornatum	**1**	-	-	-	**3**	**3**	-	-	**2**	-	-	-
Simuliumsergenti	-	-	-	-	-	-	**1**	-	-	-	-	-
Simuliumcostatum	**2**	-	-	**4**	**1**	-	**2**	-	**1**	**6**	-	**2**
Calopterixhemoroidalis	**2**	**1**	**4**	**3**	**5**	**3**	**5**	**1**	**2**			**1**
Calopterixsplendens	-	**2**	**1**	**1**	-	-	-	-	**1**	-	-	-
Aquariussp.	**1**	**1**	**3**	**1**	**2**	**3**	-	**3**	**1**	-	**1**	-
Gerris sp.	**4**	**2**	**2**	**1**	-	-	-	-	**1**	-	-	-
Baetisalpinus	-	**2**	**1**	**3**	**3**	-	**5**	**4**	-	-	-	-
Baetisrhodani	**19**	**21**	**14**	**17**	**23**	**20**	**18**	**22**	**16**	**20**	**19**	**15**
Baetispavidus	-	**1**	-	-	-	-	-	-	**2**	**1**	**3**	-
Cloëonsp.	**1**	**1**	-	-	**2**	**3**	**2**	**2**	-	-	-	-
Procloeonsp.	**5**	-	-	-	**1**	-	-	-	-	-	-	-
Potamanthussp.	-	**10**	**8**	**3**	**7**	**5**	-	-	**3**	-	-	-
Caenispusilla	-	**4**	**2**	**6**	**5**	-	**2**	**3**	**4**	**2**	**6**	**8**
Caenisluctuosa	**9**	**13**	**10**	**15**	**18**	**16**	**7**	**11**	**10**	**14**	**13**	**11**
Ecdyonorusifranensis	**10**	**8**	**7**	**9**	**13**	**11**	**14**	**15**	**6**	**11**	**12**	**11**
heptageniasp.	-	**2**	-	**3**	**5**	**4**	**4**	-	-	**6**	-	-
Hydrachnidiasp.	**3**	-	-	**3**	**1**	-	**3**	-	-	**2**	-	-
Dugesiagonocephala	-	-	-	-	-	-	-	**1**	-	-	-	-
phagocatasp.	-	-	**1**	**2**	**1**	**2**	**3**	-	-	-	**4**	-
Lumbricussp.	-	**4**	**2**	-	**2**	**1**	**5**	-	**1**	-	-	**2**
Tubifex tubifex	-	-	-	-	-	-	**8**	-	**16**	-	**6**	-
Haplotaxissp.	-	**1**	-	-	-	-	-	**2**	**3**	-	**1**	-
Glossiphonidaesp.	-	-	-	-	-	-	-	-	-	**1**	-	**3**
Helobdellasp.	**1**	-	-	**1**	-	-	-	**3**	**5**	**2**	**2**	-

3.3.2. Total abundance

A first originality, SB is a source heavily populated by crustaceans and gastropods molluscs with successively, a monthly harvest of 4382-2089 individuals. The stand of insects collected in this station is of 854 specimens followed by Annelids Oligochaetes with a staff of 54 individuals and finally the Annelids and Achaetes, the Turbellaria and finally arthropods Arachnids, with respectively the strength of 18, 14 and 12. With regard to orders, these are amphipods that hold the front with a percentage of 57,71% followed by orderArchitaenioglossa (gastropodmolluscs) with a ratio of 20.18% of mayflies representing 8.65% of the total fauna and finally the other orders with percentages ranging from 0.16% to 4.16% (figure 3).

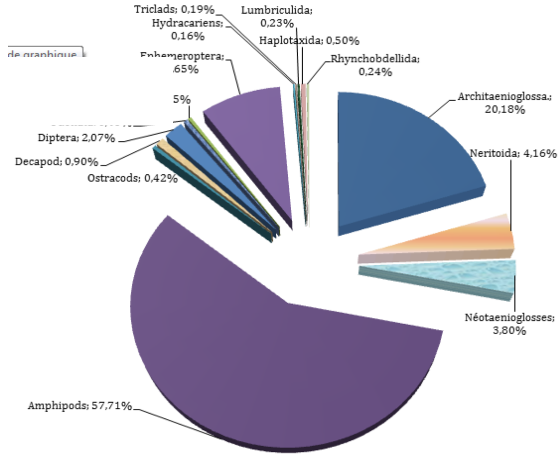

Figure 3: Abundance of different ordersto the SidiBouali

3.3.3 Specific diversity index

SB is equipped with a large enough taxonomic diversity, its index of species diversity is 2.89, this source which is a station of average mountain (1150 m altitude), is the result of several that abiotic as well biotic parameters that favoured its installation: a heterogeneous substrate, relatively abundant

3.3.5 Relative abundance

The counting of samples revealed that the source SidiBouali is governed by

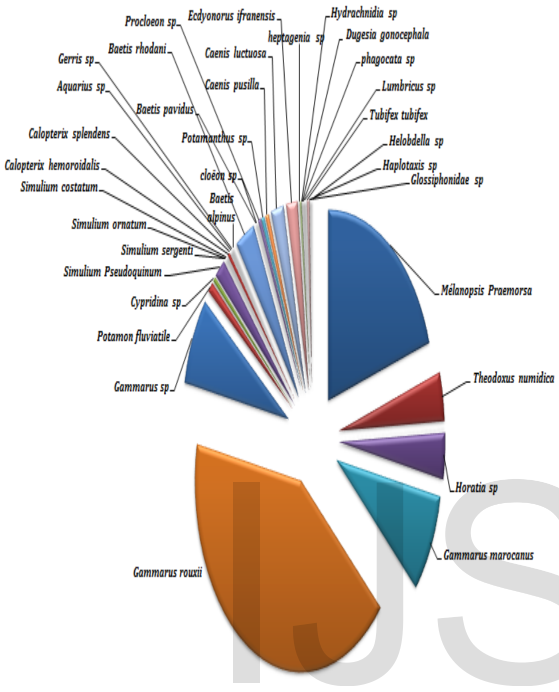

Figure 4: Relative abundance of taxa to SidiBouali

3.3.6 Relative abundance

At the level of the AinSidiBouali station, we noted the presence of 23 constant species on a total of 35 taxa colonizing this source; among others, are indicative *Melanopsispraemorsa*, *Theodoxusfluviatilis*, *Baetisrhodani* and *Caenisluctuosa*, bycatch species include 6 (table 6) while those whose presence is accidental are 6 taxa represented by *Tubifextubifex*. *Procloeon*sp. ;*Glossiphonidae* sp. ; *Simuliumsergenti* and finally *Dugesiagonocephala*.

Table 6: frequency of occurrence of the species colonizing SidiBoualisource

Species	Frequency (%)	Presence
Mélanopsispraemorsa	100	Constant (≥50%)
Theodoxusnumidica	100	
*Horatia*sp.	100	
Gammarusmarocanus	100	
Gammarusrouxii	100	
*Gammarus*sp.	100	
Potamon fluviatile	100	
*Cypridina*sp.	100	
Simuliumpseudoquinum	100	
Baetisrhodani	100	
Caenisluctuosa	100	
Ecdyonorusifranensis	100	
Calopteryxhemorrhoidalis	92	
Caenispusilla	83	
*Aquarius*sp.	75	
*Lumbricus*sp.	58	
Simuliumcostatum	50	
Baetisalpinus	50	
*Cloëon*sp.	50	
*Potamanthus*sp.	50	
*Heptagenia*sp.	50	
*Phagocata*sp.	50	
*Helobdella*sp.	50	
Gerris sp.	42	50<accessory<25
*Hydrachnidia*sp.	42	
Simuliumornatum	33	
*Haplotaxis*sp.	33	
Calopterixsplendens	33	
Baetispavidus	33	
Tubifex tubifex	25	Accidental≤ 25
*Procloeon*sp.	17	
*Glossiphonidae*sp.	17	
Simuliumsergenti	8	
Dugesiagonocephala	8	

vegetation, low temperature and rapid power at moderate speed.

3.3.4 Specific fairness index

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, it is 0.56 for the SidiBoualisource

Gammarusrouxii(41.69%), followed by *Melanopsispraemorsa* (20.18%) and tail leader moves the rest of the species (**figure 4**).

3.4. Statisticalanalysis of the stands by ACP

3.4.1. Studies of correlationsbetweenspecies

SidiBouali, the spring of the karst gushing of the Middle Atlas mountain is the living environment of four associations, the first is composed of *Gammarusmarocanus* and *Gammarus*sp., the second is formed by *Gammarusrouxii*, and such as AinRegrag the third group is represented by *Melanopsispraemorsa*, While the rest of the species colonizing the source are the fourth group. Gatherings of more or less similar to those species established in AinRegrag a remote source of 11 km from SidiBouali and that sprung from the same aquifer. (Figure 5).

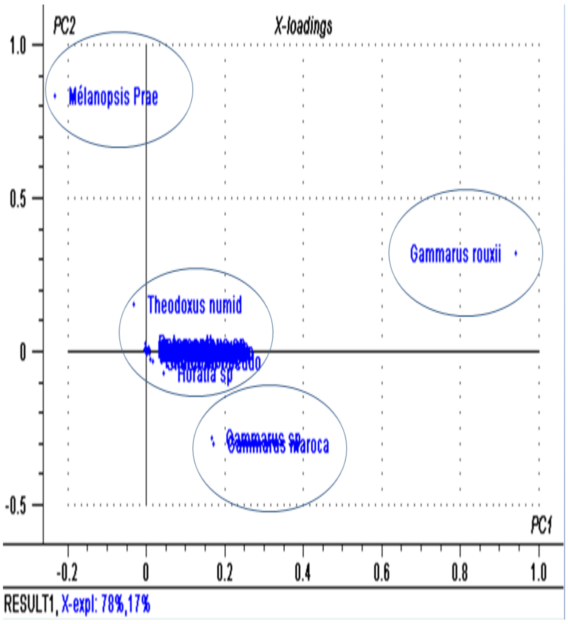

Figure 5: Analysis of associations between the SidiBoualisourcebenthic macroinvertebrates

3.4.2 Studies of the influence of the factor "season".

With the exception of the month of may, figure 6 reveals the non-involvement of seasonality in the abundance and biodiversity of benthic macrofauna of the SidiBouali source: vegetation, substrate, temperature, the speed of the current and many other parameters would be in question. It is a range of biotic and abiotic factors governing crenalecosystem in a direct way the biocenosisSidiBouali limnetic ecology.

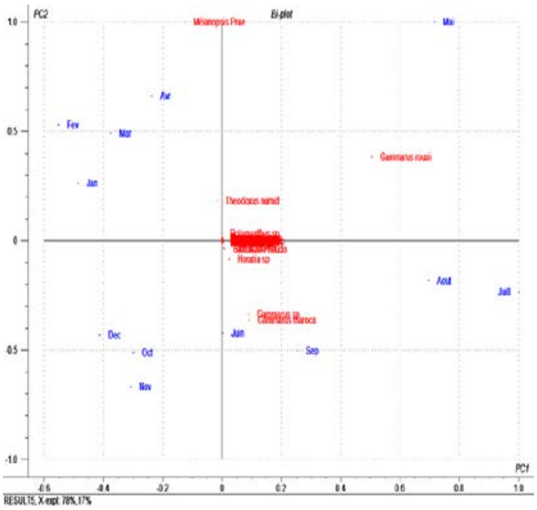

Figure 6: Principal component analysis of the distribution of the species in the source SB during the different months of the year 2013

3.4.3 Studies of Correlations between species and the physico-chemical parameters of the environment

A very large number of correlations are manifested in this source. This is clarified by the ACP (table 7). Beginning with two Ephemeroptera*Caenispusilla* and *Cloeon*sp. Also, *Caenispusilla* is negatively correlated with Ca2 + ion, i.e. raising the concentration of this parameter in the environment causes regression of its workforce, *Cloeon*sp., It is positively correlated with organic matter levels yet mayflies are polluted-sensitive organizations and do not support the increase in organic matter and oxygen-deficit. The two amphipods *Gammarus*sp and *Gammarusrouxii* are correlated positively to the permanganate index, which is in direct keeping with data from the literature [12; 13] stating that gammarids may well live in an environment rich in organic matter. The ostracod*Cypridina*sp, the odonate*Calopterixsplendens* and the oligochaete*Lumbricus*sp are negatively correlated to temperature, what are stenothermes species. Once again, data on Aquarius sp. confirm its tolerance to pollution parameters. Also, in the resurgence of SidiBouali,.*Aquarius*sp.confirms his choice by correlating negatively to dissolved oxygen. Finally, the annelid buys *Glossiphonia* sp. that is negatively correlated to the concentration of calcium and organic matter.

Table 7: statistically significant correlations between the SidiBoualisourcemacrobenthic species and the physicochemical parameters of the environment

Species	P.C parameters	r	Nb.Observations
*Glossiphonia*sp.	Ca_2^+	-0,89	12
*Glossiphonia*sp.	IP	-0,69	12
*Gammarus*sp.	IP	0,68	12
*Aquarius*sp.	O_2^+	-0,63	12
*Lumbricus*sp.	T °C	-0,63	12
Calopterixsplendens	T °C	-0,61	12
*Cypridina*sp.	T °C	-0,61	12
Gammarusrouxii	IP	0,61	12
Caenispusilla	Ca_2^+	-0,59	12
*Cloëon*sp.	IP	0,57	12

Conclusion

Indicators based on benthic invertebrates, unlike point chemical analyses, incorporate the quality of water and sediments (habitat) over long periods and reflect all the pressures "recorded" by the community. The Faunal inventory carried out in the present study constitutes a first important database. The studied fauna is characterized by a taxonomic diversity quite remarkable. Some relatively well diversified stand, with values of biotic indices ranking them either in the good category or even

very good ecological quality, even if our knowledge on the chemical environment quality indicate a little binding conditions, reflected by highly charged ion water Ca2 + and mineralization based around 1100µs/cm.
Benthic stands taxonomic structure shows that these stands are organized primarily around Polychaetes and some Gastropod Molluscs, crustaceans, and insects, polluted-tolerant groups such as , Achaetes them, the Oligochaete and the Turbellaria are weakly represented and do not exceed 1% of the total population. A first statistical approach to could be established through Analyses in components main. It follows that the benthic settlement are indifferent to the factor 'season', the specific association of some taxa, so a new vision of the concept of meta communities and finally several correlations positive and negative between some taxa and some physico-chemical parameters of the environment.
However these assumptions will have to be the subject of further studies in order to be confirmed. Thanks to all of these interpretations, several guidelines are proposed for the realization of bio SidiBouali monitoring in particular and the sources of the Middle atlas in general.
Thus, this census mainly referred as complete as possible inventory of different taxa that can be encountered in the waters of this aquatic system and thereby to enrich the list of Moroccan biodiversity.

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