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Statistical study of the benthic communities of sources Ain Regrag, Sidi Bouali and Tataw (Middle Atlas, Morocco)

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Abstract

The present work presents the results obtained from the sampling of benthic macro fauna on three major sources of freshwater in the Middle Atlas Morocco. The samples were taken monthly from January 2013 to December 2013 with a Surber NET with a width of mesh 400µm. A total of 22189 individuals belonging to 47 species were collected in the three studies 12 months of sampling stations. The statistical analyses by the ACP have shown several positive correlations between certain species creating benthic associations, so another vision of the multispecies trophic. The statistical tool has given rise to the involvement of the factor 'season' in the distribution of macro benthic species in the Tataw station, which would be manifested by a decrease or increase in abundance between seasons while in the source AR the vast majority of species are indifferent to a seasonal effect. The study of correlations between species and the physicochemical parameters of the environment revealed that, according to the station, several positive and negative correlations between some physicochemical parameters of the middle (T°C, Ca2 +, IP, dissolved O2) and some taxa colonizing studied habitats as the may flies, *Baetis rhodani*, *Ecdyonorus ifranensis*, the phoretic, *Agapitus incertilus*, the Aipteran, *Simulium ornatum* and the Amphipod *Gammarus rouxii*. Statistical analysis by ANOVA highlights the behavior of the species towards the two factors 'time' and 'space', indeed this review showed that for the majority of species (31 taxa), the number is stable in time but changes from one source to the other.

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Introduction

Biodiversity and habitats of freshwater are recognized as particularly threatened at global level. Monitoring of freshwater pools is revealed so be a necessary measure to prevent the loss of these ecosystems. Sources of the Middle Atlas particularly lend themselves to this exercise, the human population is dense and the impacts on the aquatic environment there are multiple, While the services rendered by the aquatic ecosystems are many (of the vital need for drinking water at recess).

This research work has for main objective the determination of the overall composition and monitoring of the dynamics of benthic macro stands of the sources of the Middle Atlas in relation to the main abiotic factors of the environment and the impact of human activities on ecology from different communities of the macro benthos having taken up residence in these sources. No study had been conducted on the benthos of Ain Regrag and Sidi Bouali, that of Tataw has been inventoried near the end of the 1970s. While the crenal community is defined as being fragile ecosystems, vulnerable and especially extreme.

Yet, in a perspective of sustainable development, the preservation of heritage and bio-surveillance, it turns out relevant to have this kind of information.

It is this void that we had to research specific objectives: (1) obtain and render qualitative and quantitative information on the benthic macro fauna of these three masses of water for which these data were virtually absent, too old and only qualitative; (2) use the statistical tool to elucidate the connections between species colonizing the sources and so a new vision of the concept of the metacommunaute, the impact of the factor 'season' on the distribution of species and the different correlation s between the physicochemical parameters of the middle and the benthic population residing there. This study also allowed to have a first look at the potential and limits of the use of biotic indices developed with the peculiarities of the benthic fauna of the niches systems.

Material and methods

Study sites

Located in the North Centre - the Morocco and at the foot of the Pre-rif, the FEZ Region Boulemane which part the main stations (Fig. 1), covers an area of 20 318 km², the relief of the region consists essentially of the hills at the foot of the Rif ranging in altitude from 400 m and 500 m, mountains of my with a highlight of 2796 m to Tichoukt high the Missour (700 m to 1200 m) hills and Plains of Sais (400 m to 700 m above sea level).

Fig. 1. Location of the study sites.

As he was quoted before, the diversity of forms of relief in the region corresponds different bioclimatic floors. Thus, the region is characterized by a continental climate in its northern part (cold and dry winter and hot summer), the average rainfall is 450 mm.

wet and cold in the mountainous areas of the centre and the average rainfall is more than 600 mm, and semi desert in the Highlands of the province of Boulemane, to the South where the average rainfall does not exceed the cap of 250 mm their cartographic and abiotic parameters as well as their administrative affiliations are set out in table 1.

Table 1. Settings map and abiotic of the study sites.

	Ain Regrag	Sidi Bouali	Tataw
Province	Sefrou	Sefrou	Boulemane
Commune	Sidi Youssef Ben Ahmed	Ahl Sidi Lahcen	Immouzzer Marmoucha
Longitude	-4,734	-4,708	-4,28
Latitude	33,782	33,776	33,476
Altitude m	1060	1100	1720
Annualprecipitations (mm)	750,7	750,7	429,17
Thermal gap (M-m)	43.1	43.1	31.6
Flow (l/s)	305	271	430
The current speed (cm/s)	111	48	76.3
Flow type	Veryfast	fast	fast
Dominant vegetation cover	Reed, Lily and hornwort	Algae, pteridophytes	Pteridophytes, spermaphytes
Transparency of the water	High	High	Lowduring the floods
Granulometric composition	Sand (10%) Gravel (20%) Pebble (50%) Block (20%)	Sand (15%) Gravel (35%) Pebble (40%) Block (10%)	Silt and argile(5%) Sand (5%) Gravel (20%) Pebble (40%) Block (30%)

Sampling of the macro invertebrate benthic

Schedule of sampling

We conducted monthly samplings from the month of January 2013 until December 2013.

Sampling method

For a general sample, we opted for a net surber to a width of mesh of 400µm.

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.

The collected samples are fixed in formalin at 40%, and then stored in water from the source to 10%. The sorting of samples is done using the loupe. Zoological groups are separated in the pill boxes containing 70% alcohol.

The species in each group are sorted, identified, counted, and classified among functional feeding groups according to (Tachet *et al* 2006).

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

Settings guides

A study of the physicochemical parameters as an accompaniment to the fauna analysis. Methods of analysis are those recommended by the standards (AFNOR; 1997; Rodier; 1996). They are set out in Table 2.

Table 2. Methods of analysis of the various physical and chemical parameters studied.

Parametres	Unit	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 with Mohrmethod
sulphates	mg/l	absorption spectrometry at 650 nm
Orthophosphates	mg/l	absorption spectrometry at 750 nm

Statistical treatment of data

Analysis of the main components (ACP)

The method of multivariate analysis (principal components analysis) ACP (Legendre 1984) has been used to highlight the structure of communities. The CPA is a multidimensional analysis that can project in one or several factorial designs, the best possible representation of the Euclidean distances between individuals or variables of a contingency table, the long lines of analysis.

The purpose of this study by ACP is to look for existing correlations between the different species and the months of payments. She was successively made by seeking to discriminate on the one hand, the importance of the 'species' factor, and on the other hand the factor 'season' on the ordination space stations and the species they support.

Analysis of variance (ANOVA)

The ANOVA is a method used to analyze the results of controlled experiments, carried out in the laboratory or in the field. In General, the purpose of this analysis is to test for significant differences between the averages of several independent groups of observations.

This procedure performs an analysis of variance to several factors for the variable "number of species. It displays various tests and charts to determine which factors have a statistically significant effect on this variable. It also tests if there is significant among factors interactions where there are sufficient data.

Results and discussion

Physicochemical parameters

In the light of the results obtained (table 4), we notice a significant homothermous to the three stations to study, the temperature was established around 11.41°C to (T), 18°C to (AR) and 17°C in (SB). (PH) is slightly neutral to alkaline. The electric conductivity values are weak to Tataw, with an average of 353,17 (µS/cm), medium for Ain Regrag 1098,92 (µS/cm) and Sidi Bouali 1096,83 (µS/cm).

The waters of the three research stations are highly responsible in ion Ca2 + by registering respective averages of 148 (mg/l); 146,68 (mg/l) and 100,91(mg/l) for SB; AR and t. the oxygen dissolved in the study area is far from deficit. Analysis of samples shows also that the workload in oxidizable materials is considerable during the summer period. Makers in ortho phosphate also the value zero levels of three resurgences.

Table 4. Physicochemical parameters of the three stations of studies during the year 2013.

	Site	J	F	M	Ap	M	J	Jl	A	S	O	N	D
T°C	SB	17,9	17,20	17,35	17,83	17,92	17,99	17,53	17,69	18,01	17,88	17,82	17,91
	AR	18,5	18,60	18,73	18,80	18,89	19,10	19,10	18,94	18,89	19,00	18,50	18,45
	T	10,8	11,00	10,90	11,20	11,30	12,00	12,40	12,20	11,40	11,36	11,50	10,91
pH	SB	7,19	7,38	6,98	7,06	7,23	7,25	7,21	7,30	7,24	7,18	7,22	7,20
	AR	7,04	7,09	7,10	7,10	7,10	7,10	7,10	7,09	7,09	7,09	7,03	7,04
	T	7,93	8,19	8,07	8,10	7,96	7,90	7,85	8,11	8,04	8,08	8,12	8,09
EC	SB	1093	1086	1099	1102	1103	1100	1102	1104	1104	1091	1088	1090
(µS/cm)	AR	1085	1095	1099	1100	1105	1109	1112	1108	1095	1098	1094	1087
	T	339	340	344	353	364	373	362	366	359	351	345	342
Ca^{2+}	SB	148,7	147,7	148,7	148,2	151,3	150,8	151,8	152,9	151,8	148,7	147,7	135,2
(mg/l)	AR	146,6	166,4	156,0	158,1	159,1	147,7	157	162	156	163	151	147,7
	T	100,9	115,5	124,8	118,6	112,4	121,7	102	110,3	103	95,7	103,9	107,1
Mg^{2+}	SB	40,57	31,21	30,17	36,93	35,89	37,45	37,97	36,41	39,53	38,49	43,69	41,61
(mg/l)	AR	39,53	20,81	32,25	32,25	38,49	38,49	39,53	35,37	39,01	30,17	33,29	32,25
	T	19,76	12,48	11,44	9,36	13,52	12,48	8,32	11,44	26,01	18,72	22,89	16,64
TAC	SB	1,02	0,98	1,02	0,97	0,95	0,98	0,99	1,10	1,04	1,01	1,01	1,01
(meq/l	AR	0,98	0,96	0,74	0,90	0,96	0,74	0,88	1,06	0,96	1,02	0,96	0,99
	T	0,58	0,66	0,64	0,50	0,62	0,72	0,68	0,80	0,82	0,90	0,45	0,50
Cl	SB	213	202,4	205,9	207,7	211,2	209,5	216,6	211,2	216,5	209,4	205,9	207,7
(mg/l)	AR	211	205,9	241,4	220,1	216,5	230,7	213	216,5	223,6	220,1	216,5	213, 0
	T	15,9	10,65	14,20	12,43	15,98	17,75	17,75	15,98	14,20	14,20	15,98	14,20
IP	SB	0,12	0,21	0,19	0,20	0,23	0,30	0,29	0,34	0,23	0,23	0,23	0,02
(mg/l)	AR	0,23	0,64	1,71	0,99	1,07	1,19	0,96	0,91	1,60	1,14	0,91	0,35
	T	4,43	1,28	2,10	0,99	1,92	1,38	2,31	2,74	4,60	5,28	4,70	4,52
O_2	SB	5,72	5,44	4,32	5,60	5,20	4,88	4,56	4,32	5,44	5,60	5,52	5,60
(mg/l)	AR	6,48	5,76	5,80	5,68	5,84	5,60	5,44	5,76	5,44	4,96	7,20	6,04
	T	5,36	8,24	7,44	7,52	6,56	6,72	6,40	5,84	5,44	4,96	5,08	5,24
SO_4^{2-}	SB	15,8	16,78	15,11	16,00	15,56	15,78	15,72	15,67	16,00	15,89	15,44	15,67
(mg/l)	AR	16,4	19,89	18,89	17,80	18,22	17,22	17,78	17,22	18,24	19,11	17,67	16,69
	T	15,4	20,26	19,26	22,00	20,67	17,00	15,78	9,33	10,67	13,22	21,00	19,44
PO_4^{3-}	SB	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
(mg/l)	AR	0,00	0,01	0,01	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,24	0,28
	T	0,05	0,06	0,06	0,04	0,06	0,01	0,01	0,06	0,00	0,00	0,04	0,06

Inventory of the benthic macro fauna

Following the taxonomic determination conducted in the laboratory, a list of fauna of the MIB could be established.

The results are available and present in Table 5 brought together the results of determination of the three stations. Related to each station staff are represented in the Table 5.

Table 5. List fauna of three studies stations AR, SB and T.

Taxons					Stations		
Phylum	Class	Order	Family	Species	AR	SB	T
Molluscs	Gastropods	Architaenioglossa	Viviparidae	*Mélanopsis praemorsa*	+	+	+
		Neritoida	Neritidae	*Theodoxus numidica*	+	+	-
				Theodoxus fluviatilis	+	+	-
		Neotaenioglosses	Hydrobidae	*Horatia* sp.	+	+	-
				Pseudamnicola sp.	+	+	-
	Bivalves	Eulamellibranche	Spharium	*Pisidium personatum*	+	-	+
				Pisidium casertanum	-	-	+
Arthropods	malacostraca	Amphipoda	Gammaridea	*Gammarus marmouchensis*	-	-	+
				Gammarus marocanus	+	+	-
				Gammarus rouxii	+	+	-
				Gammarus sp.	+	+	-
		Décapoda	Potamidae	*Potamon fluviatile*	+	+	-
	Ostracodes	Myodocopida	Cypridinidae	*Cypridina* sp.	+	+	-
	Insects	Diptèra	Simulidae	*Simulium pseudoquinum*	+	+	+
				Simulium ornatum	+	+	+
				Simulium sergenti	+	+	+
				Simulium costatum	+	+	-

Taxons					Stations		
Phylum	Class	Order	Family	Species	AR	SB	T
		Odonata	Calopterygidae	*Calopterix hemoroidalis*	+	+	+
				Calopterix splendens	+	+	+
		Trichoptera	Glossosomatidae	*Agapitus incertilus*	-	-	+
		Heteroptera	Nepidae	*Nepa* sp.	+	-	-
			Gerridae	*Aquarius* sp.	+	+	-
				Gerris sp.	+	+	+
		Megaloptera	Sialidae	*Sialis* sp.	-	-	+
		Hymenoptera	Agriotypidae	*Agriotypus* sp.	-	-	+
		Ephemeroptera	Baetidae	*Baetis alpinus*	+	+	-
				Baetis rhodani	+	+	+
				Baetis pavidus	+	+	-
				Cloëon sp.	+	+	-
				Procloeon sp.	+	+	-
				Potamanthus sp.	-	+	+
			Caenidae	*Caenispusilla*	+	+	+
				Caenisluctuosa	+	+	+
				Brachycercus sp.	-	+	-
			Heptagenidae	*Ecdyonorus ifranensis*	+	+	+
				Heptagenia sp.	+	+	+
	Arachnids	Hydracariens	Pontarachnidae	*Hydrachnidia* sp.	+	+	+
			Pionidae	*Piona uncata*	+	-	+
Plathelmintes	Turbellarians	Triclades	Dugesiidae	*Dugesia gonocephala*	+	+	+
				Dugesia tigrina	+	-	-
			Planariidae	*Phagocata* sp.	+	+	+
Annelids	Oligochaetes	Lumbriculida	Lumbriculidae	*Lumbricus* sp.	+	+	+
		Haplotaxida	Tubificidae	*Tubifex tubifex*	+	+	+
			Haplotaxidae	*Haplotaxis* sp.	+	+	+
		Opisthopoa	lumbricidae	*Eiseniella tetraedra*	+	-	+
	Achaetes	Rhynchobdellida	Glossiphonidae	*Glossiphonidae* sp.	+	+	+
				Helobdella sp.	+	+	+

Table 6. Different taxa related to each station.

Species	Tataw	Ain Regrag	Sidi Bouali
Pisidium personatum	28	5	0
Pisidium casertanum	3	0	0
Mélanopsis praemorsa	2	2476	1498
Theodoxus numidica	0	365	305
Theodoxus fluviatilis	*0*	*389*	*4*
Horatia sp.	0	103	282
Pseudamnicola sp.	0	0	0
Gammarus marmouchensis	6345	0	0
Gammarus marocanus	0	1219	632
Gammarus rouxii	0	652	3095
Gammarus sp.	0	1002	557
Potamon fluviatile	0	41	67
Cypridina sp.	0	42	31
Simulium pseudoquinum	71	93	126
Simulium ornatum	62	6	9
Simulium sergenti	4	9	1
Simulium costatum	0	10	18
Calopterix hemoroidalis	17	19	27
Calopterix splendens	9	4	5
Agapitus incertilus	422	0	0
Nepa sp.	0	3	0
Aquarius sp.	0	13	16
Gerris sp.	24	6	10
Agriotypus sp.	9	0	0
Sialis sp.	1	0	0
Baetis a pinus	0	1	18
Baetis rhodani	79	259	224
Baetis pavidus	0	96	7
Cloëon sp.	0	28	11
Procloeon sp.	0	17	6
Potamanthus sp.	39	0	36
Caenis pusilla	10	1	42
Caenis luctuosa	51	101	147
Brachycercus sp.	0	8	0
Ecdyonorus ifranensis	50	66	127
Heptagenia sp.	25	16	24
Hydrachnidia sp.	18	26	12
Piona uncata	10	3	0
Dugesia gonocephala	30	6	1
Dugesia tigrina	0	25	0
Phagocata sp.	37	10	13
Lumbricuss p.	43	8	17
Tubifex tubifex	31	23	30
Haplotaxis sp.	18	11	7
Eiseniella tetraedra	6	42	0
Glossiphonidae sp.	29	6	4
Helobdella sp.	40	43	14

On the 22189 specimens captured, we have identified 18 families, 34 genera and 47 species. The class of insects arthropods are in the majority on all sites, they are represented by 15, 19 and 18 species respectively to T, AR and SB.

It is this class is also predominant in terms of families, 30% at Ain Regrag, 32% in Sidi Bouali and 40 % to Tataw. Only 20 species are common to all stations.

Among them, *Simulium pseudoquinum, Simulium ornatum, Simulium sergenti, Simuliu mcostatum, Calopterix hemoroidalis, Calopterixs plendens, Baetis rhodani, Caenisp usilla, Caenis luctuosa, Phagocata* sp. and *Glossiph onidae* sp. These ubiquitous species do not seem to have a narrow altitudinal distribution and strict microhabitat preferences

Statistical analysis of the data by ACP

The statistical study by the ACP with the Unscrumbler 9.2 software gives many results presented in table 7 where the eigenvalues, percentages of expressed variances are recorded by each component and their stacks. The C1 component, explains a variance of 61%, 78% and 94% (respectively for AR, SB and T). Furthermore, to know the number of components for the ACP from each source was based on the criterion of Kaiser, who says that during a normalized ACP carry the components whose values are greater than 1.

For the Tataw source we have seen the first two components which account for 99% of the variability of the data, for Ain Regrag we selected the first two components that account for 85% of the variability of the data, and finally the source Sidi Bouali why the first two components were retained as they explained 95% of the variability.

Table 7. Principal components analysis of the distribution of benthic macro fauna in AR, SB, and T.

Component number	Eigenvalue			Percentage of variance			Cumulated percentage		
	T	AR	SB	T	AR	SB	T	AR	SB
1	21991,7	4925,2	33679	93,829	60,68	78.367	93.829	60.685	78.367
2	1293.14	1993.99	7339.03	5.517	24.569	17.077	99.346	86.253	95.444
3	68.288	604.918	1048.2	0.291	7.453	2.439	99.637	92.707	97.883
4	23.752	330.04	649.76	0.101	4.067	1.512	99.739	96.773	99.395
5	17.3996	92.7913	140.395	0.074	1.143	0.327	99.813	97.917	99.395
6	14.381	62.6646	74.9035	0.061	0.772	0.174	99.874	98.689	97.722
7	11.2687	48.4248	13.9491	0.048	0.597	0.032	99.922	99.285	99.896
8	6.83882	23.3382	12.1972	0.029	0.288	0.028	99.951	99.573	99.928
9	5.51686	18.5455	9.35518	0.024	0.229	0.022	99.975	99.801	99.957
10	4.20839	9.52546	5.37673	0.018	0.117	0.013	99.975	99.919	99.978
11	1.64375	6.58563	3.89416	0.000	0.081	0.009	99.993	100.00	99.991

Studies correlations between species

The meta-communauties is an emerging concept that considers the impact of the exchange between her and between different environmental variables (Urban & Skelly, 2006) species. The current issue is no longer the decline of biodiversity that the consequences of this decline on the functioning of ecosystems (Loreau; 2001) and beyond, on the services provided by ecosystems to the human race (Gray; 2007). Because some species play equivalent roles in an Assembly (redundancy), it seems particularly important to understand the interactions between species, to understand the consequences of the erosion of biodiversity on the eco-geochemical balance (Mc Cann; 2007), and determine how far this network of interactions can be changed before that its operation becomes unstable (Fonseca, and Ganade; 2001). The sources of the Middle Atlas subject to many pressures which the binding is drought, are characterized by variable annual cycles which always remains at the mercy of the vagaries of climate, their high biodiversity is in contrast with their sensitivity and their vulnerability to external disturbances. This crenal system is an ideal model to study the ecology of the meta-communauties given by their structure, their local abundance and their biodiversity. The study of these possible associations turns out so a great need to better explore this amazing world of biodiversity that has not yet revealed all these secrets

a) Source Tataw

The graph of the correlations (Fig. 2) gives us an idea of the existing associations between species. It indicates that the presence of any species is almost identical in this source with the exception of two species: *Gammarus marmouchensis* and *Agapitus incertilus*.

The size of these two species are the highest and ahead by far all other small co-inhabitants, with successively a percentage of 84,45% and 5.62% for *Gammarsus marmouchensis* and *Agapitus incertilus*.

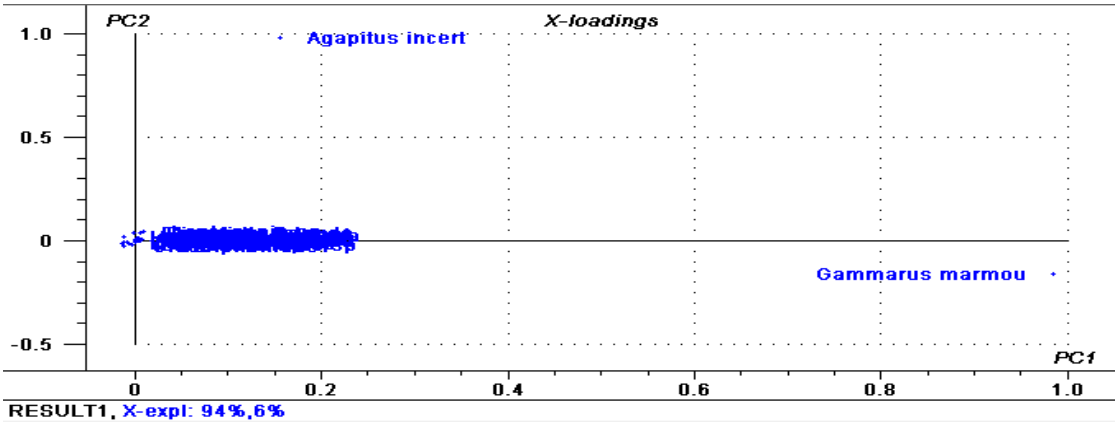

Fig. 2. Analysis of possible associations between the benthic macro invertebrates of the source of Tataw.

b) Source Ain Regrag

The main component of this resurgence analysis reveals the presence of 4 important groupings (Fig. 3). The first is formed by the kind Gammarus assembling *Gammarus marocanus*, *Gammarus* sp., *Gammarus rouxii*, the second is an alloy between *Theodoxus numidica, Theodoxus fluviatilis*, the third is represented by the single species *Melanopsis praemorsa* and a fourth set represented by the rest of the species.

The explanation of these groups is the more logical that is: first of all three species are crustaceans that have clear preference for calcareous circles, then, there is the grouping of the Gastropod *Theodoxus* who have great similarities, and, referring to several works investigating the ecology of these two species (Anistratenko, 2005; Van Damme & Ghamizi, 2007; Glöer, 2012). *Melanopsis praemorsa* here is a specimen very represented in the calcareous waters of the Middle Atlas and the Morocco in general (Ghamizi, 1998) and finally other species who chose the source Ain Regrag as medium home but with an abundance of much weaker than other taxa.

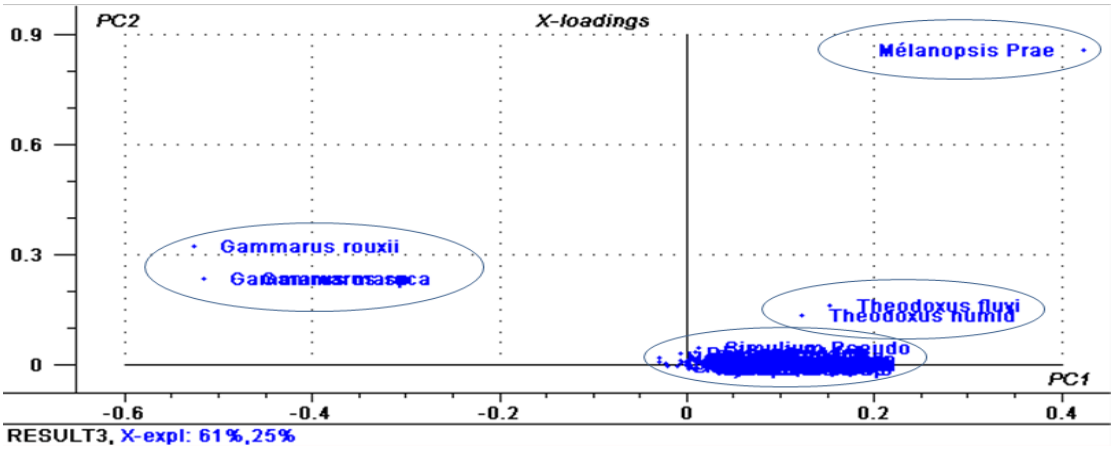

Fig. 3. Analysis of associations between the benthic macro invertebrates of the source Ain Regrag.

c) Source Sidi Bouali

Turn Sidi Bouali, the springing of the karst of the Middle Atlas mountain spring is the living environment of four associations, the first is composed of *Gammarus marocanus* and *Gammarus* sp., the second is formed by *Gammarusrouxii*, and such as Ain Regrag the third group is represented by *Melanopsis praemorsa*.

While the rest of the species colonizing the source make up the fourth group. Rallies of species more or less similar to those established in Ain Regrag. Therefore, the explanation of these assemblements would be the same as those set forth above, it is true that it is not the same habitat, but still, it should be noted that the factors that govern these grouping are the same (Fig. 4).

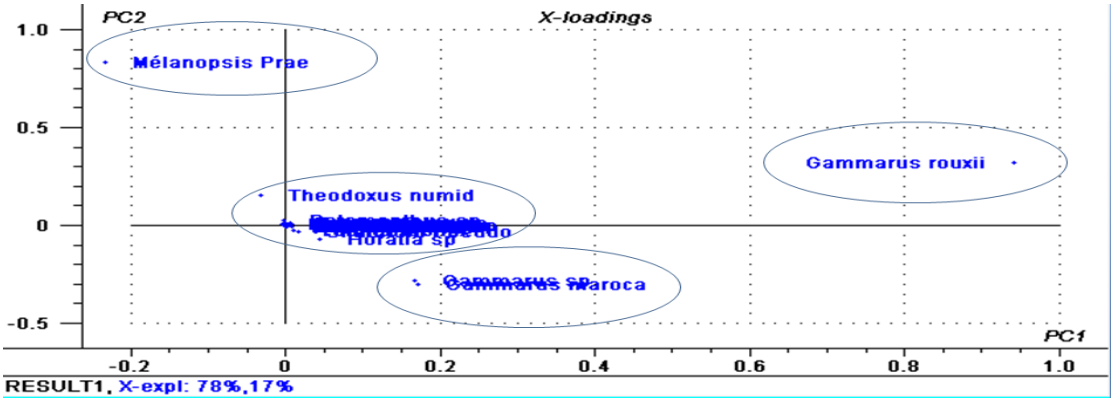

Fig. 4. Analysis of associations between the benthic macro invertebrates of source Sidi Bouali.

Studies of the influence of the factor 'season' in the distribution of species

d) Source Tataw

The study principal components brought out the involvement of the factor 'season' in the distribution of macro benthic species in station Tataw. (Fig. 5). Indeed, while knowing that this resurgence is home to a total of 30 taxa, twenty-eight of these have a clear preference for the months tempered (spring-summer).

Only the month of September is still rejected some of these gatherings. This unusual one month of the year spacing could be the result of human disturbance suffered by the source at the end of the summer season, or more, yet the flood that disrupts the crenal ecosystem given that this resurgence is often subject to this phenomenon whose scope varies from once to another.

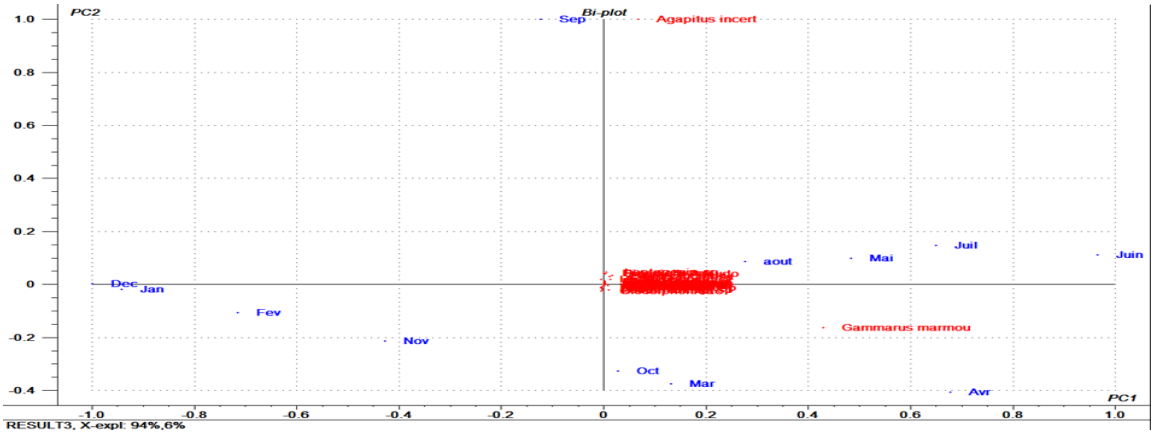

Fig. 5. Analysis in the main component of the distribution of the species in the source Tataw during different months of the year 2013.

e) Source Ain Regrag

According to Fig. 6, the macro benthos of the source AR is indifferent towards the season factor. The presence of the species is almost stable year round except for the month of August, it is here, a source that has the best index of biodiversity, abundant vegetation throughout the year, a water temperature oscillating between 17 and 18°C, a current speed ensure good ventilation of the environment and in addition to all these conditions, a neighbouring population rather conscious of the values of heritage of their wetland. Therefore, several factors set in motion for the preservation and the proliferation of diverse and rich biocenosis in a relatively stable environment.

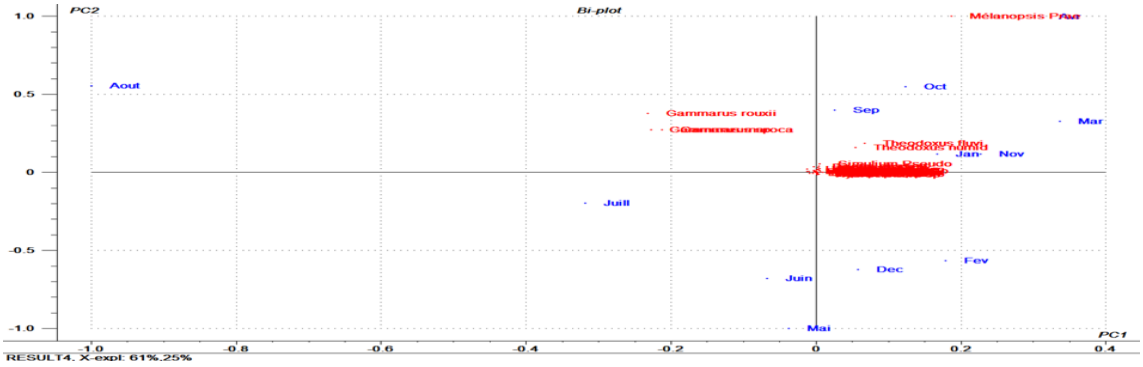

Fig. 6. Analysis in the main component of the distribution of the species in the source AR during the different months of the year 2013.

f) Source Sidi Bouali

With the exception of the month of may, Fig. 7 reveals the noninvolvement of the seasonality in the abundance and biodiversity of benthic macrofauna of the Sidi Bouali source: vegetation, substrate. Temperature, the speed of the current and many other parameters would be in question. It's a series of factors, biotic and abiotic ecosystem crenal governing in a direct way the biocenosis Sidi Bouali limnetic ecology.

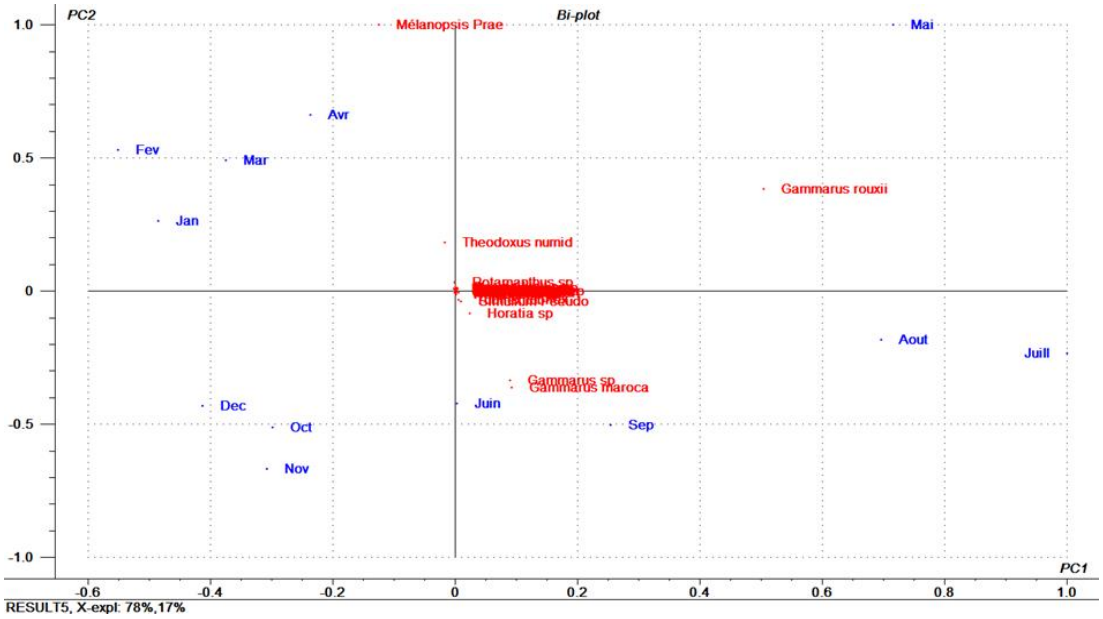

Fig. 7. Analysis in the main component of the distribution of the species in the source SB during the different months of the year 2013.

Studies of Correlations between species and the physicochemical parameters of the Medium

Benthic animal communities are excellent biological indicators, because they incorporate the physicochemical conditions present and past the middle. The structure of these stands has the disadvantage to be determined both by external abiotic factors and biotic factors internal (competition between species), which makes the interpretation of the results difficult. The purpose of this analysis by the ACP is to determine the most clear and logical way, that is, nature and it extended the influence of physicochemical parameters of the environment on the benthic fauna of the Middle.

g) Source Tataw

In the station Tataw, temperature is the only physicochemical parameter which has a correlation with some species. According to the ACP. *Caenis luctuosa, Simulium ornatum, Baetis rhodani, Ecdyonorus ifranensis, Gammarus marmouchensis, Calopterix splendens* and *Agapitu sincertilus,* are positively correlated with temperature. In other words, these species tolerate well the temperature rise, however, Tataw source is classified cold source because its waters do not exceed 12°C and despite the clarity of these data cannot come forward a nomination to eurythermie, the view that these changes in temperature do not exceed the 1.5°C in this case. However *Haplotaxis* sp. and *Phagocata* sp. are negatively correlated to this setting and do not tolerate temperature changes (Table 8).

Table 8. Statistically significant correlations between the source Tatawmacrobenthic species and the temperature.

Species	Physicochemi-calparameter	Nbr Obs
Caenisluctuosa	T °C	12
Simuliumornatum	T °C	12
Baetisrhodani	T°C	12
Ecdyonorusifranensis	T °C	12
Gammarusmarmouchensis	T °C	12
Gerris sp.	T °C	12
*Haplotaxis*sp.	T °C	12
*Phagocata*sp.	T °C	12
Calopterixsplendens	T °C	12
Agapitusincertilus	T °C	12

h) Source Ain Regrag

Table 9 shows negative correlations between *Baetis pavidus, Lumbricus* sp. and the ion Ca2 +, so these are taxa that do not tolerate calcium waters, the *Aquarius* sp heteroptere. is positively correlated to the permanganate index, in other words the dynamics of the population of this specimen is in synergy with the organic matter content in the middle. A last taxon is the dipteran, *Simulium ornatum*, which is positively correlated with oxygen dissolved in the medium. It is commonly known that in general the Diptera tolerate pollution, in other words, they can live in a deficit environment in oxygen (hypoxia), our results do not confirm this tolerance because of the abundance of this dipteran is closely related to the oxygen content.

Table 9. Statistically significant Correlations between the macro benthic species of the source Ain Regrag and the physicochemical parameters of the environment.

Species	Physicochemicalparamete r	Nbr Obs
Baetis pavidus	Ca_{2}^{+}	12
Lumbricus sp.	Ca_{2}^{+}	12
Aquarius sp.	IP	12
Simulium ornatum	O_{2}^{+}	12

i) Source Sidi Bouali

The largest number of correlations manifest themselves in this source. This is clarified by the ACP (table 10). Starting with two Ephemeroptera Caenispusilla and Cloeon sp., has like its cousin Baetispavidus at Ain Regrag, ephemeroptere Caenispusilla is negative with the ion Ca2 + correlate, in other words the elevation of the concentration of this setting in the Middle led the decline in its numbers, when Cloeon sp., it is positively correlated with organic matter levels yet Ephemeroptera are polluosensitive organizations and do not support the increase in organic matter and the deficit for oxygen. Two amphipods *Gammarus* sp. and *Gamma rusrouxii* are correlated positively to the permanganate index, which is in direct convergence with data from the literature (Fadil, 1994; 2002) Claiming that the *Gammarus* can live in an environment rich in organic matter.

The Ostracode *Cypridina* sp., the Odonate *Calopterixs plendens* and Oligochete *Lumbricus* sp. are negatively correlated to temperature, what are stenothermes species. Once about *Aquarius* sp. confirm its tolerance to pollution parameters. At Ain Regrag she revealed his preference for organic matter and in the resurgence of Sidi Bouali, she 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 10. Statistically significant correlations between the macro benthic species source Sidi Bouali and physicochemical parameters of the medium.

Species	Physicochem-icalparameter	Nbr Obs
Glossiphonia sp.	Ca_2^+	12
Glossiphonia sp.	IP	12
Gammarus sp.	IP	12
Aquarius sp.	O_2^+	12
Lumbricus sp.	T°C	12
Calopterixsplendens	T°C	12
*Cypridina*sp.	T°C	12
Gammarusrouxii	IP	12
Caenispusilla	Ca_2^+	12
Cloëon sp.	IP	12

Statistical analysis of the data by the ANOVA

Table 11 summarizes the data of the ANOVA for all species for which sampling time (temporal variable) or instead of sampling (variable space) have significant effects. A species that has a probability value lower than 0.05 for the source variable, is a taxon whose number is stable in time but changes from one source to the other. While a species that has a probability value lower than 0.05 for the month to levy variable is specimen whose number is stable from one source to the other but changes from one month to the other or from one season to another.

The species behave in four different ways:

• Species number changes over time and from one source to the other these are Gammarusmarocanus and *Gammarus* sp.

• Of the species for which the number is stable at the time but changes from one source to another and it is the most dominant case there are thirty-one taxa listed on table 11 which include all species of gastropods, bivalves and Ephemeroptera.

• Species whose number is stable in time and from one source to the other. These are all the rest of the specimens that are part of the benthic macro su-city inventory and are not on the table.

Table 11. Summary the ANOVA test for communities of benthic macrofauna colonizing the three stations to study

Species	Studied Variables			
	Months of levy		Source	
	Sum of squares	*Probability*	*Sum of squares*	*Probability*
Simulium pseudoquinum	277,222	0,1171	127,722	0,0222
Simulium ornatum	42,3056	0,6962	184,722	0,0000
Simulium costatum	14,2222	0,6172	13,5556	0,0260
Baetis alpinus	11,6389	0,5668	17,0556	0,0041
Baetis rhodani	401,889	0,3706	1518,06	0,0000
Baetis pavidus	68,9722	0,4546	477,389	0,0000
Potamanthus sp.	143170,	0,2651	443677,	0,0000
Cloëon sp.	8,75	0,8033	33,1667	0,0002
Procloeon sp.	18,9722	0,1518	12,3889	0,0087
Caenis pusilla	24,3056	0,5451	77,3889	0,0001
Caenis luctuosa	281,639	0,4447	384,222	0,0027
Ecdyonorus ifranensis	40,3056	0,9122	672,389	0,0000
Heptagenia sp.	46,2222	0,3554	24,8889	0,0483
Gammarus marmouchensis	78395,4	0,4767	2,23661E6	0,0000
Gammarus maroccanus	21518,1	0,0490	61943,2	0,0000
Gammarus sp.	20699,6	0,0215	42007,7	0,0000
Potamon fluviatile	15,3333	0,6762	190,167	0,0000
Agriotypus sp.	2,08333	0,4767	4,5	0,0003
Horatia sp.	3038,31	0,4308	3393,72	0,0059
Mélanopsis praemorsa	45390,2	0,1917	258755,	0,0000
Theodoxus numidica	1842,56	0,4460	6384,72	0,0000
Theodoxus fluviatilis	2236,08	0,5071	8321,17	0,0000
Pisidium personatum	24,75	0,6905	37,1667	0,0077

Species	Studied Variables			
	Months of levy		Source	
	Sum of squares	*Probability*	*Sum of squares*	*Probability*
Pisidium casertanum	0,75	0,4767	0,5	0,0422
Piona uncata	2,97222	0,7556	4,38889	0,0124
Agapitus incertilus	6537,22	0,4767	9893,56	0,0020
Agriotypus sp.	2,08333	0,4767	4,5	0,0003
Lumbricus sp.	45,5556	0,4916	55,0556	0,0060
Glossiphonia sp.	38,75	0,6318	32,1667	0,0414
Phagocata sp.	30,0	0,5856	36,5	0,0096
Eiseniella tetraedra	77,3333	0,4470	86,0	0,0066

Conclusion

The benthic settlement approach helped show that benthic wildlife harvested in this station at the level of sources of the Middle Atlas is represented by a very large number of taxa specialized in comparison with other work of middle Sebou and the Sebou top; on the oued Boureg- reg and on the Oued Tensift of the High Atlas. The statistical analyses by the ACP have shown several positive correlations between certain species creating benthic associations, so another vision of the multispecies trophic. Within the three research stations, stands are organized according to the action of different physicochemical factors and their interactions with the biocenosis but the main element responsible for the spatial organization stands of macro fauna in the lagoon is likely the abiotic environmental conditions. Great similarities appear between Sidi Bouali and Ain Regrag stations, they reflect almost the same species groupings and indifference to the season factor, this stipulation is are confirmed by the ANOVA test, which indicates that the number of the largest majority of the taxa (31) is stable at the time but changes from one source to another and it does all the species of gastropods, bivalves and Ephemeroptera.

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