INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 9, No. 2, p. 191-206, 2016
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Hydro biological study of three major sources of the Middle Atlas (Morocco) habitat, water chemistry, distribution of the benthic fauna

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Article published on August 31, 2016

Key words: Benthic macro fauna Habitat, Ecological index, Sources.

Abstract

This research work has for main objective the determination of the overall composition and monitoring of the dynamics of benthic macro stands of three major sources of the Middle Atlas (Ain Regrag, Sidi Bouali and Tataw), in relation to the major abiotic factors of the environment and the impact of human activities. Interpreting results of physico-chemical analyses of water samples collected, shows that the waters of the Sidi Bouali and Ain Regrag are high calcium hardness, those of Tataw are weakly mineralized and low hardness calcium and magnesian Tower. From bacteriological point of view, Sidi Bouali flows are free from indicator microorganisms of fecal pollution, however sources Ain Regrag and Tataw waters are waters also prone to bacterial contamination that exceeds the tolerable thresholds for health. In all of plant crops. A total of 22189 individuals belonging to 47 species were collected in the three research stations. Arthropods of the class of insects, are in the majority on all sites, they are represented by 15, 19 and 18 species respectively Tataw, Ain Regarg and Sidi Bouali. This class also predominates in terms of families. The station Ain Regrag, which culminates in biodiversity by hosting the largest number of species with a total of 40 species and having the highest index of diversity.

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Introduction

It is globally accepted today that wetlands, play a crucial role in the maintenance of life on Earth in the same way as farmland and forests. The abundant presence of water is their main feature (UN, 2014). In addition to water, these environments are structurally also composed of fauna, flora, soil and air.

The interactions between these components, determine the importance of biotic processes responsible for the functional services they provide. As a result, wetlands are among the natural, the most productive environments in the world and are remarkable living environments by their biodiversity.

Morocco, the region of North Africa the better fitted with continental waters. It is the richest wetland country compared to the other Maghreb countries (Chillasse, Dakki 2004). Among its wetlands, the Middle Atlas (MA) is the angular part.

This mass of Highlands is a Moroccan reservoir of biodiversity unequivocally. It differs from the other Moroccan mountains by the abundance of its sources, favored by rich aquifer, which explains the high density of its hydrographic network.

The high altitude of its relief well watered and the predominance of superficial phreatic waters generate a multitude of permanent cool springs (10-18°C), usually high-volume (Giudicelli, Dakki 1984). These meet features hydrological, socioeconomic and ecological valuable across the country.

Their biodiversity and their originality give global interest. Besides, several sites are home to exclusive endemic species that exist only in their community of origin [Dakki and El Agbani, 1995; Chillasse, 1999; Fadiland Dakki, 2006; Lamhasni, 2013]. As a result, knowledge of benthic fauna, associated with rivers and the Moroccan sources concern in recent years naturalists, scientists and officials of the development (Touabay 2002; Abba 2006).

This interest displayed to the Moroccan benthic fauna offers, by its richness and diversity (Lamri, Belghyti. 2011) fields of investigation broader and more complex (Melhaoui and Boudot, 2009). It is a diverse and rich biocenosis which remained marginalized and misunderstood for a long time, as a result of its biotopes were considered much more for their water resources for their ecological values and their biodiversity.

A State of art found in a time where the conservation of biological diversity has become a common concern of humanity. In a context of sustainable development and the need for the preservation of the biodiversity of the Middle Atlas, cradles of endemism fauna.

Moroccan sources, establishing a comprehensive inventory of the benthic macro fauna colonizing the sources of this mountain chain and the study of their hydrobiology is necessary, not only to be provided with updated data from the State of affairs, but also, so bring a relevant and compelling tool for establishing a legal framework for their conservation.

For this, we have opted for the choice of three stations main Ain Regrag, Sidi Bouali in the region of Sefrou and Tataw of Imouzzer Mamoucha at a frequency of monthly collection covering the year 2013.

Material and methods

Study sites

This sample of stations includes a wide variety of biotopes of the crenal.

Thus, the range of temperatures of the waters is between 8.7°C and 19°C. They are located at different altitudes, different bioclimatic floor, different types of substrates and different socio-economic settings and offer a variety of biotopes and seem so well reflect the diversity of the habitats of the crenal in this massif (Table 1).

Table 1. Abiotic parameters of the three stations of studies.

Bioticparameters	Ain Regrag	Sidi Bouali	Tataw
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	Medium	fast
Dominant vegetationcover	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%)

Source Tataw of Imouzzer Marmoucha (T)

Located in the eastern part of the Middle Atlas, Immouzer Marmoucha is a hinge between the Middle Atlas and the Eastern Morocco (Fig. 6). The commune belongs to the water of my pleated, which is characterized by the outcrop of limestone and dolostone of the Jurassic period allowing a storage of groundwater, spring the emergences of Tataw. The massive presence of the inhabitants of local communities, livestock, pumping, diversions and measures to capture at the level of the source, are risks that threaten the quality of its waters by compromising its various uses and thus reduce the chances of a socio-economic progress of the region. Independently already climate change.

Source Regrag (AR)

Ain Regrag is part of the hydrogeological unit of the Causse way Atlasique. Ain Regrag is not just a water resource, but also a real resort with its Lake and its flat banks covered by a shaved vegetation which makes a particular type of source of fresh water in North African Mountain. Ain Regarg is currently undergoing the effects of anthropogenic pressure accentuated.

Several boreholes are set up and draw in the waters of the groundwater, an arboriculture full swing is that risk by runoff affect the physicochemical quality of the water underground. The source also, is the most coveted tourist resort by residents, which would involve organic pollution that may be threatening.

Source Sidi Bouali (SB)

Located in the middle of an olive grove, at 18 km from the town of Sefrou, the main source and its resurgence are completely natural, like in Ain Regrag, Sidi Bouali source is located within liasiques through its spiritual value, and until the last years touches the source didn't was not plundered by the activity anthropogenic, the neighbouring population sought rather to preserve. Ain Sidi Bouali is not better than the other two previous sources, this resurgence of spiritual value also ancient history of the region, is subject to the same constraints, perhaps not with the same magnitude but in a perspective of sustainable development, the risks of a possible deterioration of the quality of its waters are indeed present.

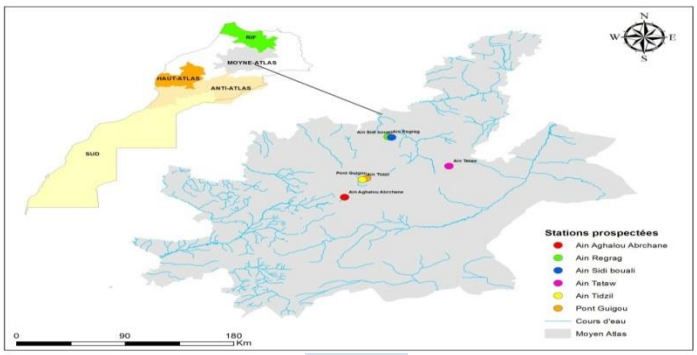

Fig. 1. Location of the three stations of studies.

Sampling of the macro invertebrate benthic

Schedule of sampling

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

Method of sampling

For a general sampling, 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, 2013). 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.

Analysis of the physical and chemical parameters of the water

Methods of analysis are those recommended by the standards (AFNOR, 1997; Rodier, 1996). Measures of temperature, pH, and conductivity were conducted in the field using a multi parameter pH/conductivity Analyzer/temperature Cyber Scan PC10. The methods used are: the Massing for dissolved oxygen, the bicarbonates, chlorides, calcium and magnesium and the sulfates and the ortho molecular absorption spectrophotometry phosphates (Table 2).

Table 2. Parameters measured and the methods used to perform their analysis.

Paramètres	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	Winkler method
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 spectrometryat 650 nm
Orthophosphates	mg/l	absorption spectrometry at 750 nm

Microbiological analyses

Microbiological point of water characterization, part of the commonly practiced analysis. Indeed, the purpose of a bacteriological study is to identify the presence or not of fecal contamination, sought microorganisms are the FMAT, fecal coli forms, total coli forms and fecal streptococci. Samples of water made in-situ in sterile vials.

Filtrations and seeding, in Petri dish, have been made the same day. Methods, during this follow-up, are Moroccan standards of drinking water (NM.03.7.002.2011). The different culture media recommended for the bacteriological analysis of water are explained in Table 3. After incubation, forming Colonies (CFU) units have been counted macroscopically in each dish.

Table 3. 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

Calculation of statistical descriptors of data

Different index used in this article are set out in table 4. The use of these index to estimate the behavior of the settlements of the crenal system. Their indications, including the classification of the ecological state of the stations, should in no way be interpreted in the strict sense. Indeed, these biotic indices are not necessarily adapted to the peculiarities of the benthic macro fauna of the sources and their effectiveness in semi-closed environments is extreme. The conclusions provided by these indices have therefore only indicative allowing to have a first look at the reaction of these indices in these environments.

Table 4. Ecological Indices studied.

Index	Formula	Reference
Specificdiversity index	H'= -∑ (ni/ N) . Log 2 (ni/ N) H' : Specific diversity N : Total number of individuals ni : Membership of the species i	Pérès J.M., 1961
Equitability index	E= H' / Hmax Hmax= Log2 (S) E= H' / Hmax Hmax= Log2 (S) S : Total number of species	Dauvin J.C., 1993.
Jaccard index	J=a/(a+b+c) a: number of common species between two habitats b: number of unique species for habitat 1 c: number of unique species for habitat 2	DE BELLO *et al.*, 2007).
Relative abundance	Pi = Ab(a)*100/ Ab(t) Ab(a) : total number of individuals of a species, Ab(t) : Total number of individuals	DE BELLO *et al.*, 2007).

Results and discussion

Physical chemistry of water

Temperatures oscillate around 11.41°C (T), 18°C (AR) and 17°C (SB). (PH) is slightly neutral to alkaline as well in times of rain that during the dry season, its average levels are 7.08 to (AR) 8.04 for (T), and 7.20 for (SB). The electrical conductivity, expressed in (µS/cm), is directly related to training crossed in the hydrogeological basin of the Gryphons. These 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). Moreover, the comparison of the conductivity in the three resurgences with the Moroccan standard set at 2700 (µs/cm) place these waters in the excellent grid.

The waters of the two sources AR and SB are heavily loaded in ion Ca^{2+} by registering respective averages of 148 (mg/l); 146,68 (mg/l) and 100,91 (mg/l) for SB; AR and T. We believe that this would be related to the importance of the karst reservoir from which spring the resurgences. The average values in chlorides evolve in the same way as the conductivity for almost all of the measuring points. The temporal profiles of dissolved oxygen have revealed the contents of this parameter are higher during the wet period. Indeed, all the registered maxima mark winter, they are 5.6 (mg/l) at the level of the station (SB) with 7.52 (mg/l) in the station (T) and 7.2 (mg/l) at the source (AR) in November. This is mainly due to the decrease of the temperature of the water; because cold water contains a lot of dissolved oxygen than warm water (Hébert 2001).

Still, it should be noted that (AR) station is enfeoffed by important vegetation of algae and macropphytes which explains the wide availability in oxygen dissolved compared to (SB) and (T). Overall, the regime of the dissolved oxygen in the study area is far from deficit.

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Coveted, not only by its residents, but also by all surrounding settlements, the other side of the coin would be increased index permanganate in summer, which seems an immediate consequence of the increased anthropogenic activity. A State of affairs that seems less rigour in the source SB. By comparing these results with those of Tataw where the permanganate index spent 0,995 mg/l to 5.2 mg/l after the introduction of a collection system at the level of secondary resurgences. Makers in ortho phosphate are generally at low levels of the three resurgences (Fig. 2).

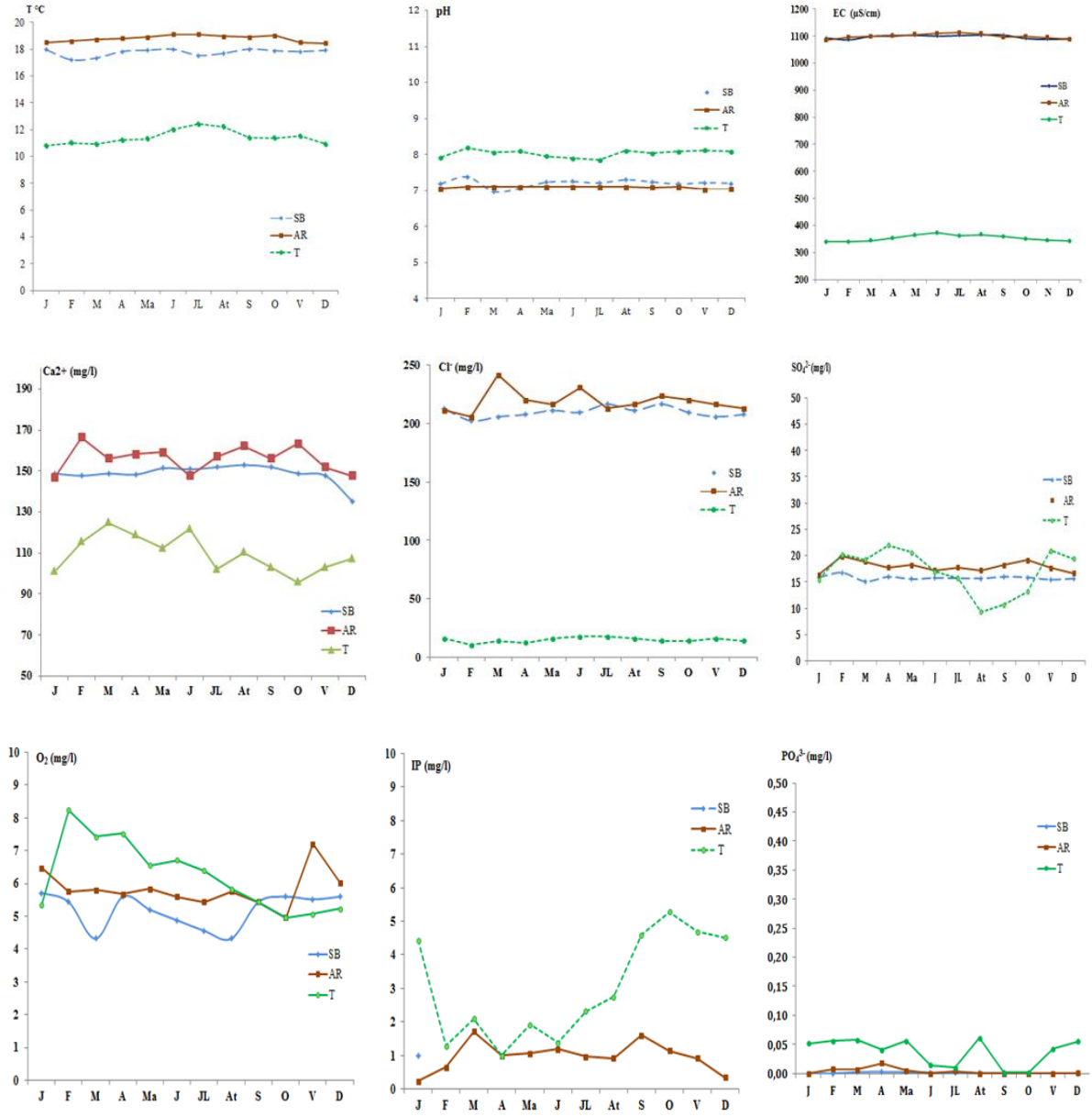

Fig. 2: temporal profiles of different physicochemical parameters of AR, SB and T stations3.2 3.

Microbiological analyses

Microbiological results are reported in table 5

Coliform total

Counts of total coliforms in water reveals a concentration of 150 CFU/ml to Ain Regrag and 80 CFU/ml to Tataw. Such values clearly indicate fecal contamination of these two resurgences. While the Sidi Bouali station has no signs of contamination by total coliforms

Fecal coliforms (FC)

Bacteriological analysis of samples of water from the three stations of studies, indicates the presence of Fecal coliforms at a rate of 4 CFU 100 ml to Ain Regrag and 50 CFU/100 ml in the source Tataw. This presence of fecal coliforms indicates that there is a source of fecal matter (manure, septic or other ditch). Then the Sidi Bouali station is free doubt you evidence of fecal contamination.

The fecal streptococci (SF)

Research of fecal streptococci in samples of water revealed their presence in the Tataw source at a rate of 60 CFU 100, and 1 CFU 100 in the source Ain Regrag. However, Sidi Bouali source contains no trace of this group of bacteria. This interest in enterococci can be explained by the fact that, compared to the coliform they are more resistant to harsh environmental conditions and persist longer in the water. These conditions are typical of groundwater where the temperature is usually cooler and are poor in nutrients. All this leads us to say that Tataw and Ain Regrag sources are subject to heavy noble contamination remains to prove its origin and is the CF/SF which is the right tool that will help us to answer this question.

Report CF/SF

For several decades, the fecal coliform/fecal streptococci report was used as an informative of the first order element to determine if a fecal pollution was of animal or human origin. When this report CF/SF is greater than 4, pollution is essentially human (rejection of waste water). When it is less than 0.7 the origin is animal.

The origin of the contamination is mixed animal-dominated if R is between 0.7 and 1. This origin is uncertain if R is between 1 and 2 and the origin is said to be mixed human-dominated if R is between 2 and 4. During our investigation, the report CF/SF is 0,833 to Ain Tataw and 4 in Ain Regrag. Such results prove contamination of human origin in Ain Regrag and these are septic tanks that are pointed the finger. From septic systems and contaminants that can enter groundwater include bacteria, viruses, detergents and household cleaning products. These can create serious problems of contamination. Despite the fact that septic tanks and sumps are known sources of contamination, they are poorly monitored and very little studied. On the other hand, Tataw source is subject to a joint contamination mainly of animal origin, indeed, this resurgence is a place of drinking of the cattle of the local residents. Thanks to the spirituality of the places for the riparian population, the site Sidi Bouali (SB) has remained unscathed from fecal pollution. The exploitation of these results shows that stations AR and T deserve special attention and require disinfection pushed because of the unusually high presence of fecal pollution indicator bacteria.

Table 5. Results of microbiological analyses of the waters of the sources AR, SB and T.

Microorganismes	AR	SB	T
FMAT at 37°C/100ml	52	0	52
FMAT at 22°C/100ml	18	0	48
Total coliforms (TC)/100 ml	150	0	80
Fecalcoliform (FC)/100 ml	4	0	50
Faecalstreptococci (FS)/100 ml	1	0	60
FC/FS rate	4	0	0.833

Structure of the benthic community

The understanding of the structure and the overall functioning of benthic ecosystems is a fundamental first step: the description of the communities that constitute. This initial stage is often used as a 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, fauna relationships - substrate,). This census is to establish a comprehensive inventory of different taxa that can be encountered in the waters of the water system and would thus enrich the list of Moroccan biodiversity. The descriptive stage of this long and tedious work was conducted at different scales, both spatial and temporal. This implies a high degree of knowledge of the macro fauna, both taxonomic level, in terms of its structural composition, or its time evolution.

Overall wildlife harvests

A total of 22189 individuals belonging to 47 species were collected in the three stations of study during 12 months of sampling that a new species for science *Horatia* sp. inventory of the macro-invertebrates established wildlife inventory, includes the distribution of stands in the different sampling stations (table 6) belonging to the class of gastropods. Saw that we had not yet the results of the molecular identification of the individuals in this group all the species will be designated in the manuscript under the name of *Horatia*sp., the species will be described and will be the subject of a publication.

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 percent to Tataw. On the 22189 specimens captured, we have identified 18 families, 34 genera and 47 species. Only 20 species are common to all stations. Among them. *Simulium Pseudoquinum, Simulium ornatum, Simulium sergenti, Simulium costatum, Calopterixh emoroidalis, Calopterix splendens, Baetis rhodani, Caenis pusilla, Caenis luctuosa, Phagocata* sp. and *Glossiphonidae* sp. These ubiquitous species do not seem to have a narrow altitudinal distribution and strict microhabitat preferences.

Table 6. List fauna of three studies AR, SB & T stations.

Taxons					Stations		
Phylum	Class	Order	Family	Species	AR	SB	T
Molluscs	Gastropods	Architaenioglossa	Viviparidae	*Mélanopsis praemorsa*	+	+	+
		Neritoida	Neritidae	*Theodoxus numidica*	+	+	-
				Theodoxus fluviatilis	+	+	-
		Néotaenioglosses	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	Simulidés	*Simulium pseudoquinum*	+	+	+
				Simulium ornatum	+	+	+
				Simulium sergenti	+	+	+
				Simulium costatum	+	+	-
		Odonata	Calopterygidae	*Calopteri xhemoroidalis*	+	+	+
				Calopterix splendens	+	+	+
		Trichoptera	Glossosomatidae	*Agapitu sincertilus*	-	-	+
		Heteroptera	Nepidae	*Nepa* sp.	+	-	-
			Gerridae	*Aquarius* sp.	+	+	-
				Gerris sp.	+	+	+
		Megaloptera	Sialidae	*Sialis* sp.	-	-	+
		Hymenoptera	Agriotypidae	*Agriotypus* sp.	-	-	+
		Ephemeroptera	Baetidae	*Baetisalpinus*	+	+	-
				Baetisrhodani	+	+	+
				Baetispavidus	+	+	-

Taxons					Stations		
Phylum	Class	Order	Family	Species	AR	SB	T
				Cloëon sp.	+	+	-
				Procloeon sp.	+	+	-
				Potamanthus sp.	-	+	+
			Caenidae	*Caenispusilla*	+	+	+
				Caenis luctuosa	+	+	+
				Brachycercus sp.	-	+	-
			Heptagenidae	*Ecdyonorus ifranensis*	+	+	+
				Heptagenia sp.	+	+	+
	Arachnids	Hydracariens	Pontarachnidae	*Hydrachnidia* sp.	+	+	+
			Pionidae	*Pionauncata*	+	-	+
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.	+	+	+

Taxonomic richness in every station

A good taxonomic richness is often synonymous with good health of the environment and it is the Ain Regrag station which culminates in biodiversity by hosting the largest number of species with a total of 40 species (Fig. 3), 35 species in sidi Bouali while the lowest taxonomic richness was recorded in the source Tataw to I. Marmoucha. The floods are now recognized as one of the most important engines of the structure and functioning of ecosystems of freshwater (Poff, 1997; Hart, 1999; Malard, 2006) Tataw is a source that has been prone to winter flooding from December until the end of the winter. The benthic macro fauna biomass was reduced by the first flood, then remained at low levels during the entire period. Species richness, biomass and density of macro-invertebrates have also been significantly reduced. A decrease of the taxonomic richness marked, even if the abundance is high. Finally, a decrease of taxonomic richness and abundance is usual a sign General inhibitory effects, such as toxicity or smothering. It must, however, remember that changes in the composition of the population are not always related to changes in the abundance or the taxonomic richness, since benthic populations can be affected in many ways. Due to direct or indirect effects complex (e.g. replacement of more sensitive species by less sensitive species), the anthropic pressure exposure can have effects on the composition of the community without any significant effects on abundance or the taxonomic richness, and vice versa.

The settlement of macro invertebrates collected in the three sources is marked by the absence of Plecoptera. This group known by its strong polluosensibilite does not exist. This suggests in the light of our samples, either the existence of organic pollution affecting the waters of the stations of studies which is a factor limiting of life for this group. is this group's environmental requirements (temperature, dissolved oxygen, vegetation bordering and the nature of the substrate) are not satisfied in the three study sites. In addition, the high levels of calcium and magnesium (hardness) of the waters of the three resurgences can also explain the absence of Plecoptera, which according to (Boumaizaand Thomas, 2006) resent very calcareous water, as the Middle Atlas has been known for its great poverty in Stoneflies (Dakki, 1979).

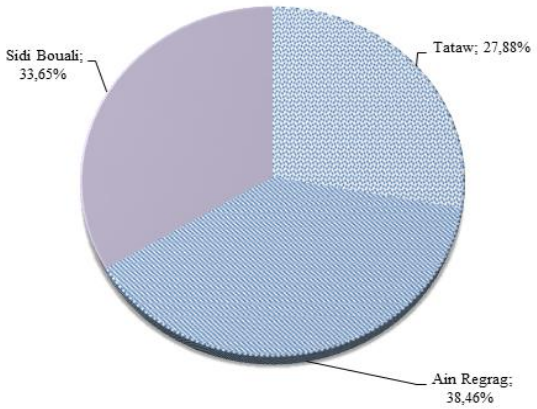

Fig. 3. Relative percentage of the taxonomic richness to each station to study.

Total abundance

Abundance is a measure of basic ecology of freshwater: it represents the set of wildlife harvested during the 12 months of sampling in the three studied emergences. This abundance fluctuates following stations. The Tataw station represents the largest number harvested 7513, followed by the Sidi source bird with a total abundance of 7423 individuals and finally Ain Regrag with an annual collection of 7253 specimens. These spatial variations could be attributed to the various influences that undergoes circles and to the also to the nature of the different habitats (Fig. 4,5,6).

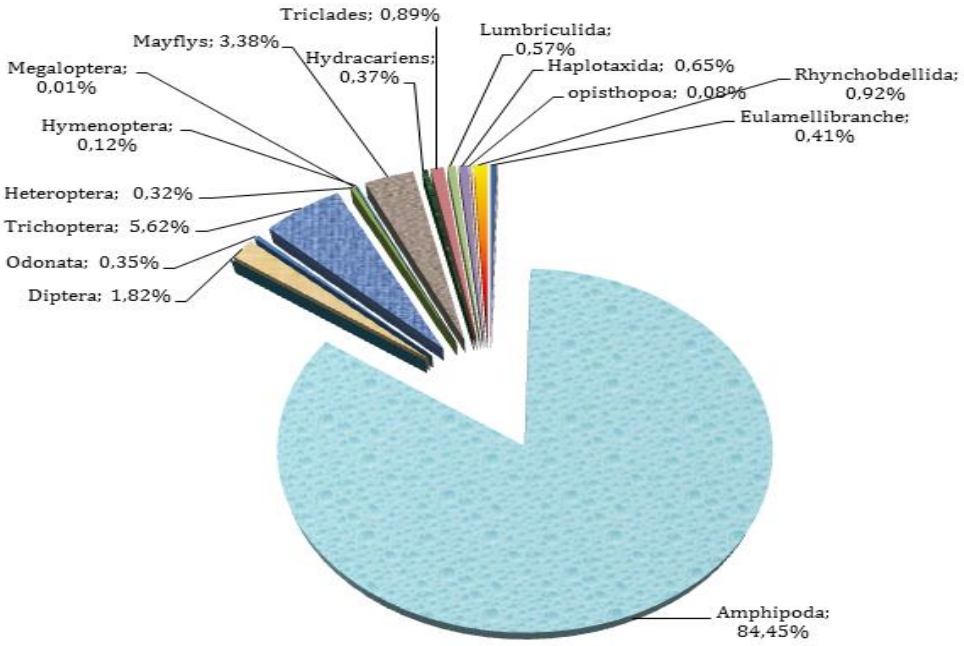

Fig. 4. Abundance of different orders to Ain Tataw.

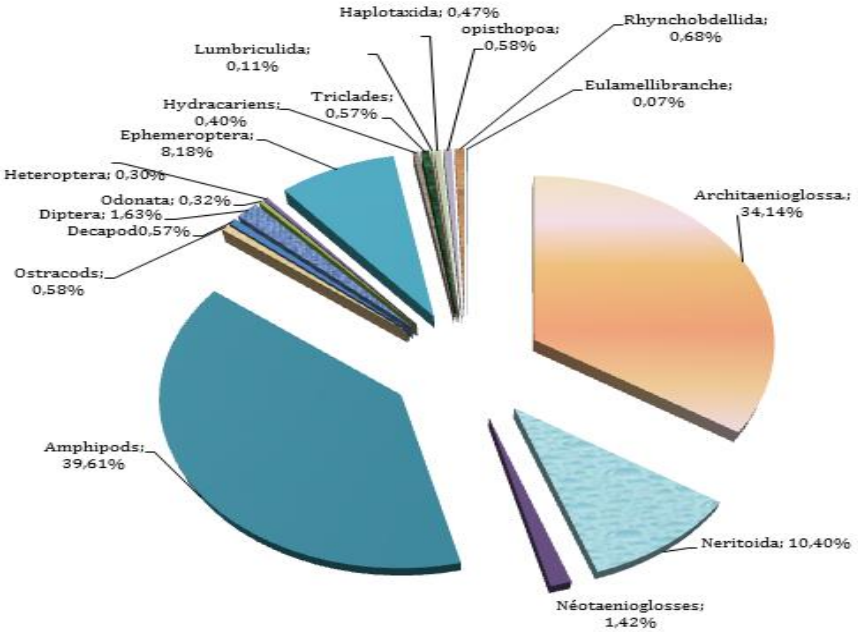

Fig. 5. Abundance of different orders to Ain Regrag.

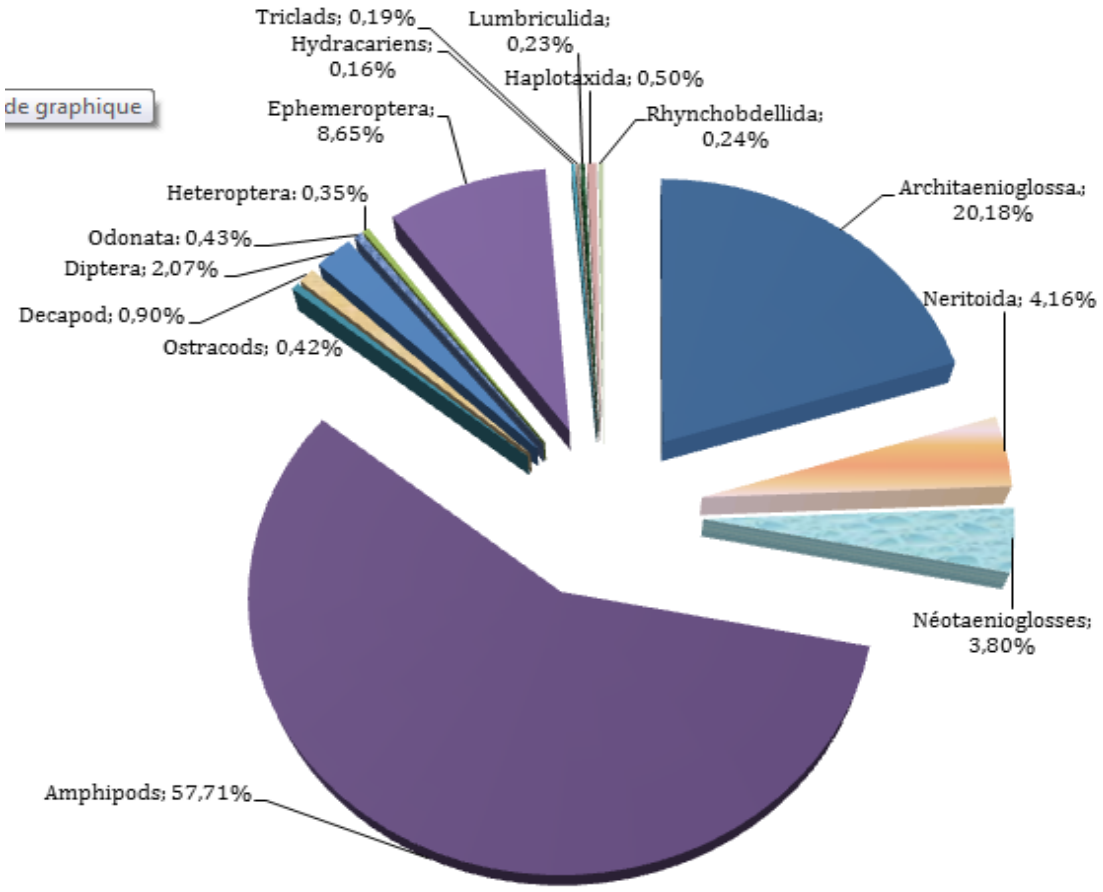

Fig. 6. Abundance of different orders to Sidi Bouali.

Ecological index

Specific diversity index

Species diversity can be defined as a measure of the species composition of an ecosystem in terms of number of species and their relative abundance. Many indices of diversity are cited in the literature.

The index of Shannon (H), used in this study has the advantage of being more frequently used in the studies of benthic ecology. There is minimal when the sample contains only a single species.

H is maximum (theoretically infinite) when each individual belongs to a different species. Maximum diversity is Log 2 (N).

Among the three contacted stations is AR that has the highest index of diversity with a value of 3.18 followed by Ainsidi Bouali who has a 2.89 and finally Ain Tataw with the lowest index of 1.2 (Fig. 7).

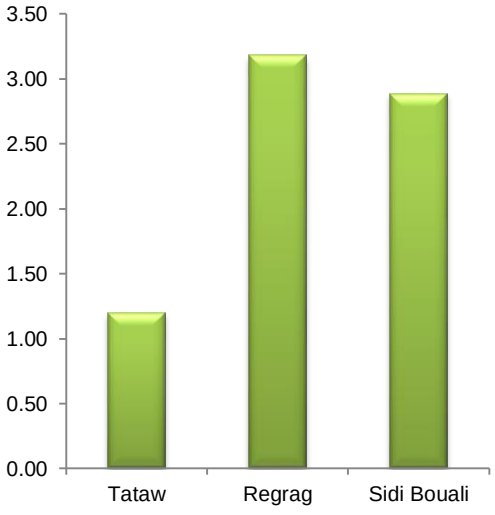

Fig. 7. Index of species diversity in the three study stations.

The settlement identified in Ain Regrag is very diverse, with families of different orders that occupy the whole of microhabitats.

This maximum diversity in this source, which is an average Resort Mountain (1150m above sea level), is the result of several that abiotic as well biotic parameters that favoured its installation: a heterogeneous substrate, a relatively abundant vegetation, a low temperature and a fast current at moderate speed. Then the phenomenon of flooding suffered by frequently by the source Tataw has strongly influenced the diversity of this station resulting in its deterioration. In addition there are anthropic pressure that in addition to the looting of the benthic heritage of the station, it was prejudicial to its natural landscape which has always been a source of pride for residents of I. Marmoucha. Indeed, a disturbed streams may create unfavourable conditions for some organizations (polluosensibles) leaving the place so other agencies more tolerant (polluoresistants).

Index of specific equitability

Equitability is also called regularity (Frouin 1996) or equi-distribution, varies between 0 and 1, more a taxon is abundant, lower us fairness appears. This is the case for the source Tataw or index of equitability is 0.25 (Fig. 8), data that will pair with those of the diversity index revealing the lowest taxonomic diversity in this station. It is the *Gammarusm armouchensis* species that dominates the rest of the taxa. A State of affairs which differs from that of Ain Regrag and Sidi Bouali or the equitability index is higher than it is 0.60 and 0.56 respectively.

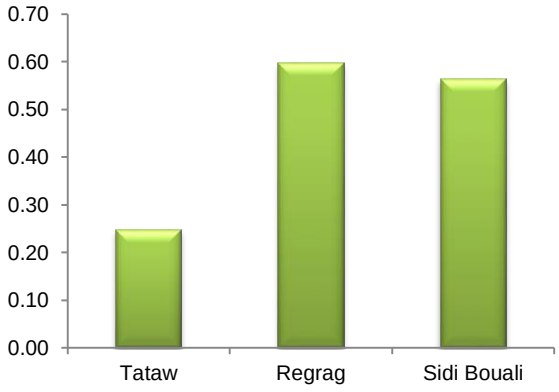

Fig. 8. Index of specific equitability in the three study stations.

Jaccard index

Fig. 9 highlights of great similarities between the two stations Ain Regrag and Sidi Bouali so that a completely different scenario arises between Ain Regrag and Tataw on one side resorts and Sidi Bouali and another Tataw.

It is the habitat that would be cause of this state of affairs, While it is true that two stations SB and AR have a canopy are different as well as a disjunctgranulometric composition, however it is clear that they have a physicochemical composition similar and identical climate conditions and a lithology identical factors that undoubtedly influence the ecology of macro fauna colonizing a watercourse.

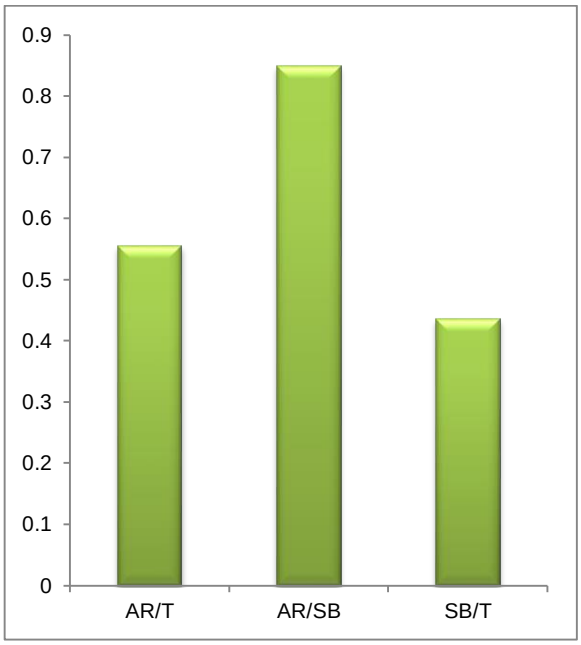

Fig. 9. Index of Jaccard in the three study stations.

Relative abundance

Analysis of all stands harvested during the study period, shows that Ain Regrag, *Melanopsisprae morsa* species is the most counted and represents the highest percentage (34.14%) followed the two crustacean *Gammarus marocanus* (16,81%),

Gammarus sp. (13.81%) and finally the procession of the 37 remaining species, with residence at this station. In turn,

Ain Sidi Bouali is governed by *Gammarus rouxii* (41,69%), followed by *Melanopsis praemorsa* (20.18%) and in tail leader puts the rest of the species.

As he has been quoted above, Tataw, the source of high mountain is populated mainly by *Gammar usmarmouchensis* representing 84,45% of population total station, followed by minorities by the Tichoptera *Agapitus incertilus* (5.62%) and finally the rest of the taxa (Fig. 10, 11 and 12)

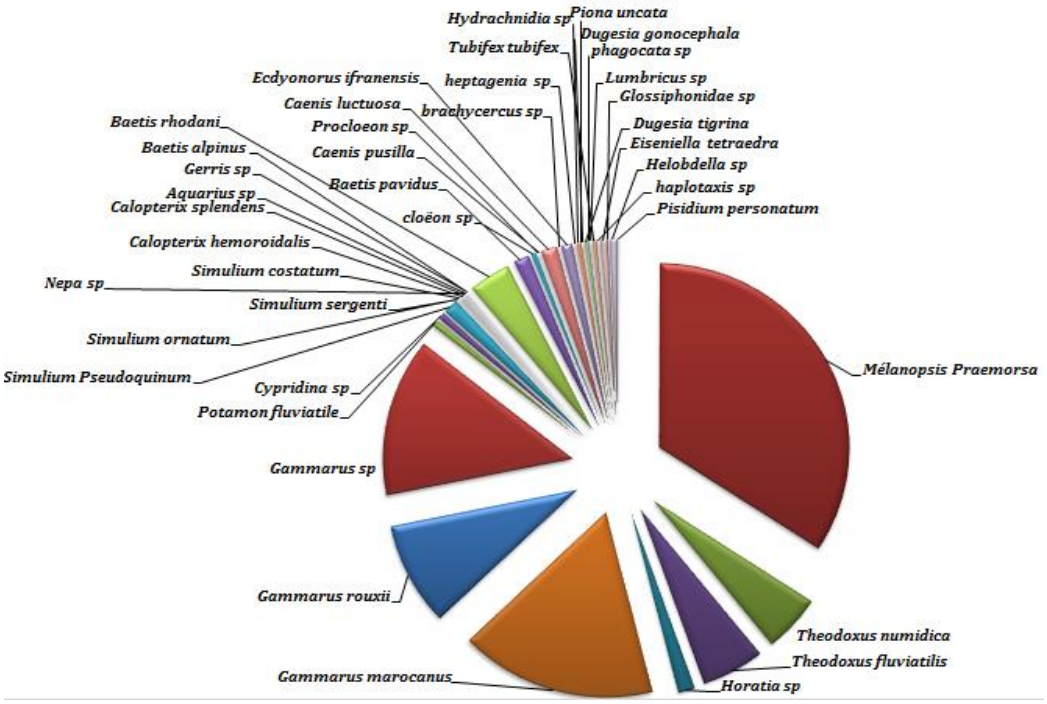

Fig. 10. Relative abundance of the various taxa in Ain Regrag.

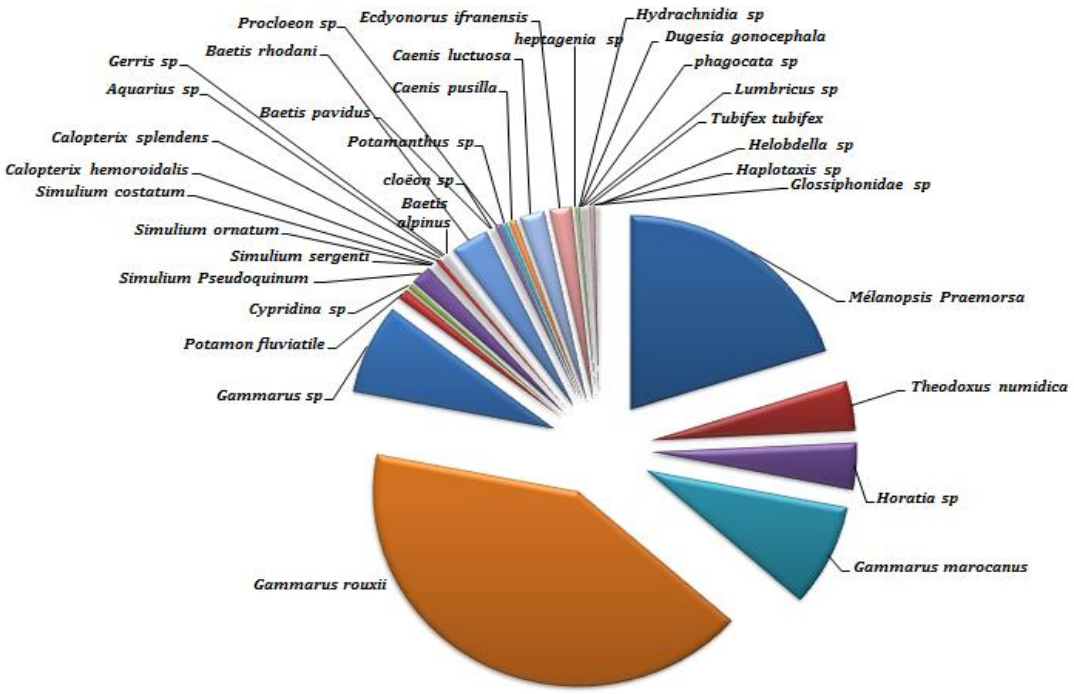

Fig. 11. Relative abundance of the various taxa in Sidi Boulai.

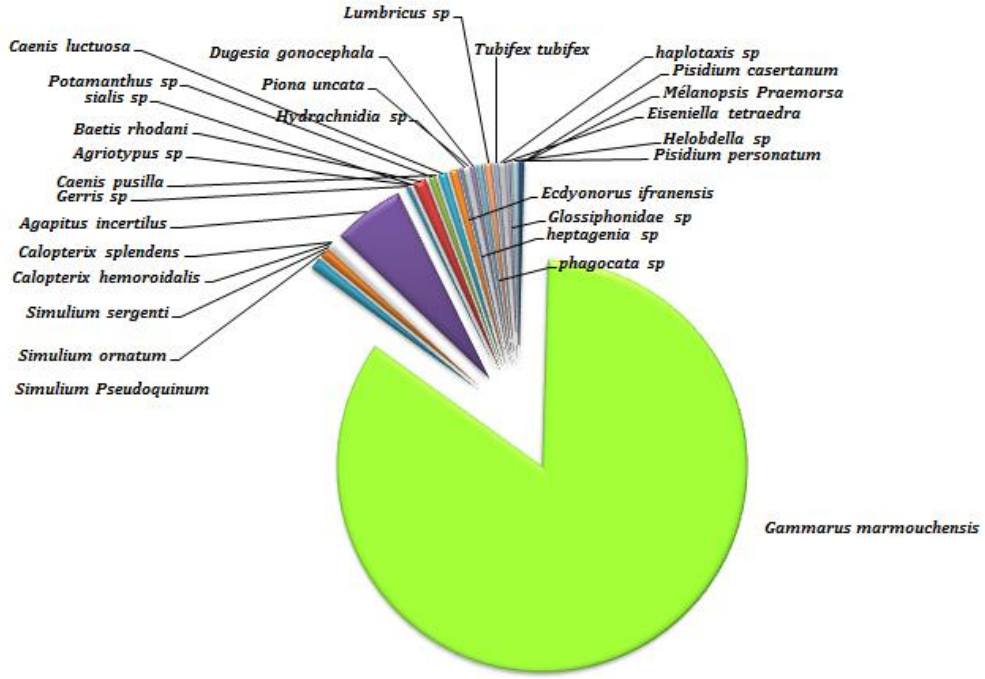

Fig. 12. Relative abundance of the various taxa in Tataw.

Conclusion.

Hydro biological analysis focused on the three main stations sampled on a monthly basis on annual period covering the year 2013. This work therefore, gives some interesting comments on a set of three sources of fresh water in the Sebou top, in areas or groundwater have always been an important source of drinking water for local people, for the watering of animals and for irrigation. The review and interpretation of the results of analyses physicochemical and bacteriological of collected samples shows that Sidi Bouali waters are calcium hardness with an average concentration of 148.7 (mg/l) but remains still below the potability standards. From bacteriological point of view, Sidi Bouali flows are excellent, they are free from microorganisms indicators of fecal pollution, however sources Ain Regrag characterized by hardness water and a quite high mineralization reveal not only the presence, of pathogenic bacteria, it is abnormally high as a result of an infiltration by septic. The waters of Tataw to turn weakly mineralized, low temperature and low hardness calcium and magnesian are also prone to bacterial pollution exceeding hardly tolerable thresholds for health.

Overall wildlife harvests, a total of 22189 individuals belonging to 47 species were collected in the three studies 12 months of sampling stations, class of insects Arthropods are in the majority on all sites, they are represented by 15, 19 and 18 species respectively Tataw, Ain Regarg and Sidi Bouali. This class also predominates in terms of families, 30% at Ain Regrag, 32% in Sidi Bouali and 40% to Tataw. A good taxonomic richness is often synonymous with good health of the environment and it is the station Ain Regrag, which culminates in biodiversity by hosting the largest number of species with a total of 40 species and with the highest index of diversity specific with a value of 3.18 followed by Ainsidi Bouali, who has a 2.89 index and finally Ain Tataw with not only the lowest index 1.2 diversity but also the lowest index of equitability 0.25.

Analysis of the settlement raised during the study period, all shows that Ain Regrag, *Melanopsis praemorsa* species is the most counted and represents the highest percentage (34.14%) followed the two crustacean *Gammarus marocanus* (16,81%), *Gammarus* sp. (13.81%) and finally the procession of the 37 remaining species, with residence at this station.

In turn, Ain Sidi Bouali is governed by *Gammaru srouxii* (41,69%), followed by *Melanopsis praemorsa* (20.18%) and in tail leader puts the rest of the species (Fig. 11). As cited above, Tataw, the source of high mountain is mainly populated by *Gammarusmar mouchensis* representing 84,45% of total population of the station, followed by the Trichoptera *Agapitusince rtilus* minorities (5.62%) and end the remaining taxa. the phenomenon of the anthropization of sources, could be at the origin of a disappearance of polluo sensitive taxa and the proliferation of polluotolerant groups such as Diptera. The absence of Plecoptera is a pressure gauge and these are the human activities that are pointed the finger. This diagnosis should encourage the public authority to make recommendations to contribute to strategic thinking for biodiversity management and integration of data in the decision-making process, set up a network of monitoring of biodiversity and promote dialogue and communication between stakeholders

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