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DIVERSITY AND DISTRIBUTION OF MACROINVERTEBRATES IN ABIOD WADI OF THE AURÈS REGION (NORTHEAST ALGERIA)

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Abstract

This study aimed to inventory, identify and describe the macroinvertebrate community in six stations at Abiod wadi between February to June 2018, in order to know the health of the aquatic ecosystem. Physico-chemical parameters showed a significantly higher values among sampling sites ($p<0.05$), except for the speed of the water, which had no significant values ($p> 0.05$). The species were determined and the ecological indices were calculated (abundance, richness, Shannon index, Simpson index and equitability). The fauna recorded in this work is composed of 1979 individuals belonging to 31 families and 07 Orders corresponding to three faunistic groups (arthropods, annelids and molluscs). The groups with high abundance were Diptera (Chironomidae larvae) and Trichoptera. The Richness of the studied stations range from 7 families in Tiflfel station (S2) to 18 families at M'Chouneche station (S5). The values of the Shannon diversity index and Equitability were higher in M'Chouneche station (S5) ($H' = 2.537$, $E = 0.8776$) compared with the other stations. We observed a similarity of the community structure between the six sample sites due to the constant type of habitats and the water depth.

Key words: Macroinvertebrate, aquatic ecosystem, Abiod wadi, Algeria.

INTRODUCTION

Rivers are among the most complex and dynamic ecosystems (Dynesius, Nilsson, 1994). Streams in Mediterranean regions have highly seasonal discharge patterns, with predictable torrential floods and severe droughts (Bonada et al., 2007). Thermal fluctuations in the Mediterranean area are sometimes brutal and irregular heavy rainfall is concentrated in short periods of time (Ghougali et al., 2019). Dryland regions represent over one third of the world's land area, characterized by a low and variable rainfall pattern, yet sometimes containing a surprising array of aquatic habitats (Jenkins et al., 2005). The components of the macroinvertebrate community taxa vary from several biotic and abiotic factors such as altitude, substrate type, oxygen content, chemical pollution, etc. The Mediterranean region was characterized by macroinvertebrates with higher dispersion and colonization capabilities, suggesting that species loss in the temperate region, by extinction or northward emigration of taxa, would be compensated for by immigration of southern mediterranean taxa (Bonada et al., 2007). Macroinvertebrates reat quickly to a change in their environment, their presence, disappearance or

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decrease after a proven presence, and a significant change in their frequency show whether, the state of the water is satisfactory or not (Mimeche et al., 2019). Benthic macro-invertebrates are known by being a good indicator of the health of aquatic ecosystems (Djamai et al., 2019). The Aurès region in Algeria, characterized by a semi-arid to arid Mediterranean climate with low water levels, especially in summer. High anthropogenic activities in this region, such as agriculture and sewage discharge, contribute to the degradation of water quality.

The aim of this study is to characterize the species composition, abundance, and diversity of the assemblages of the benthic macroinvertebrate species living in Abiod Wadi (Aurès region) in Northeast Algeria.

MATERIAL AND METHOD

The Abiod wadi watershed, draining an area of 1300 Km², is located in the Aurès massif (Fig.1). It is part of the endorheic watershed Chott Melghir. The length of the wadi is 85 km from its origin in Chelia (2326 m high) and Ichemoul (2100 m high) mountains. After crossing Tighanimine, it gradually flows into the canyons of Rhoufi and M'chouneche's gorges, and then opens a path to the plain until the Saharan's gorge Foumel Gherza.

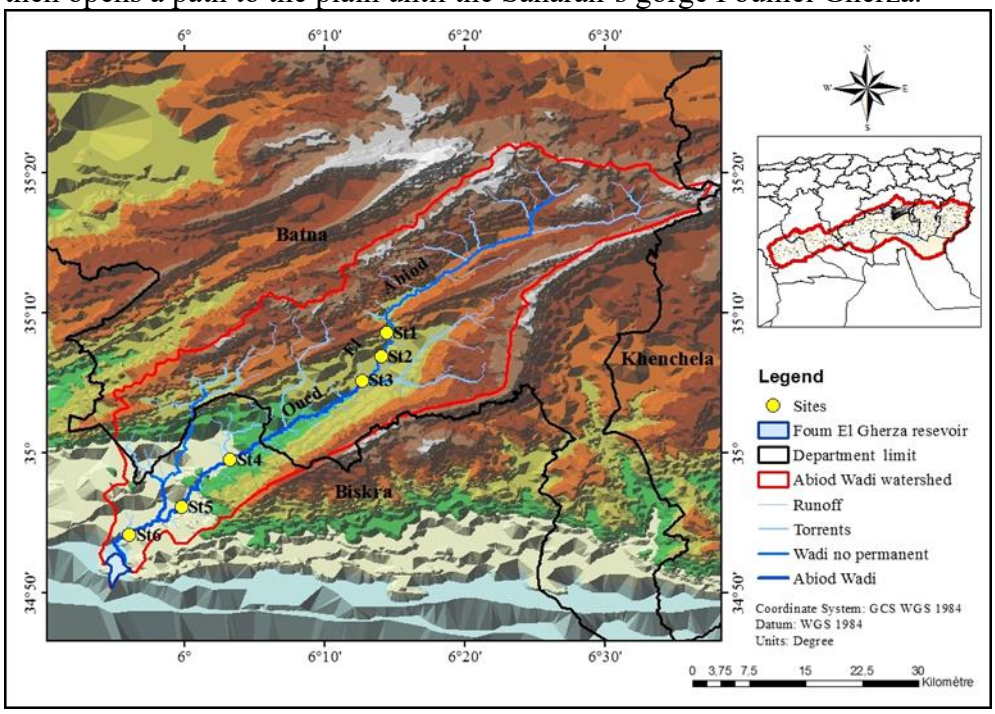

Fig.1. Map of the study area, with locations of sampling stations.

Abiod valley is mainly composed of sedimentary rocks, comprising alternating limestone, marl, soft sediments (sandstones, conglomerates)

and some evaporites (gypsum) dated of Paleogene (Benkhaled et al., 2013) (Fig. 1).

The Mediterranean climate of the region is subject to the influence of the Sahara and is characterised by wet winters and dry summers (Mimeche et al., 2013). We have chosen six stations (Table 1, Fig.1).

Table 1

Characteristics of studied Stations

Site	Taghit (S1)	Tiflfel (S2)	Ghassira (S3)	Baniane (S4)	M'chounche (S5)	EL habel (S6)
Lat.	35°08'33, 67''N	35°07'35, 36''N	35°05'55,62 ''N	35°,00'02, 55''N	34°56'21,11'' N	34°53'58,34 '' N
Long	6°,14'25.5 2''E	6°14'21,9 2''E	6°13'46,86' 'E	6°03'02,7 4''E	5°59'46,60'' E	05°56'04,77 '' E
Dp (cm)	6	7,6	5,55	10,28	14,81	5,72
Spe d/t	0,72	0,39	0,49	0,45	0,14	0,01
Veg	Fruit tree	Shrub Fruit tree	Shrub Grenadine Fruit tree	Palm	Palm	Palm Herbaceous
Sub	stone, fine sand	stone, fine sand	stone, fine sand	coarse sand, stone, rocks	coarse sand, stone, rocks	coarse sand, stone, rocks

Lat. Latitude; Long. Longitude; Dp. Depth; Veg. Vegetation; Sub. Substrate; spe. Current speed

The sampling was conducted between February to June 2018; three samples were taken at each station using a Surber net sampler (0.3 mm mesh). The captured specimens were collected using a flexible entomological forceps, then stored in jars filled with 70% ethanol. At the place of sampling, labeling is essential; we mention the date of capture and the sampling station. Samples were taken back to the laboratory for sorting, determination and analysis. All specimens were identified down to species under a binocular loop using books, collections and keys in the laboratory.

Water temperature, pH, salinity, and conductivity were measured near the surface (0.5 m depth) at six points distributed throughout the study area. In order to assess differences in physico-chemical parameters among sampling sites, we used one-way analyses of variance (ANOVA).

Data were analyzed using XLSTAT software (Version 2014.5.03) to evaluate the species abundance, species diversity and the differences in community composition and structure at each site. The indices used to examine macro-invertebrates community were: species richness (S), relative abundance (RA), Shannon diversity index (H), Simpson index, Equitability (E). In order to assess differences in macroinvertebrate descriptors among sampling sites, we used The Kruskal-Wallis test. These indices are useful for comparison between populations of six sites of Abiod Wadi.

RESULTS AND DISCUSSION

Environmental parameters

The substrate was mainly stone, fine sand, coarse sand and rocks (Tab. 1). The temperature of the water was significantly lower in Taghit (S1) and Tifefel (S2) compared to the other sites ($p < 0.0001$). The pH values were ranged between 7.00 and 8.52; they were significantly more alkaline at Taghit (S1) and Ghassira (S3) ($p < 0.05$). Significant difference was observed in conductivity and salinity between sampling sites ($p < 0.05$ and $p < 0.0001$). Significantly the highest depth was recorded in EL habel (S6) compared to the other ($p < 0.0001$). No significant difference was observed in speed of the water between sampling sites ($p > 0.05$) (Table 2).

Table 2

Mean ± SE (standard error), min and max of physico-chemical parameters per sampling site in Abiod Wadi

	T°C Water	pH	CE	salinity	Speed (d/t)	Depht (cm)
S1	11.20± 2.05 (13.1, 8)	7.76± 0.57 (8.4, 7.00)	1.65±0.33 (1.95, 1.19)	0.88±0.19 (1.04,0.19)	1.18±1.13 (2.5,0.2)	8.20±3.68 (13,3.68)
S2	14.50± 4.28 (21.3, 9.8)	7.94±0.55 (8.49, 7.00)	1.52±0.32 (1.84,1.14)	0.96±0.43 (1.74,0.54)	0.88±1.20 (3.33, 0.22)	7.92±2.56 (10, 2.56)
S3	17.78± 5.89 (26.6, 10.8)	8.25±0,23 (8.52, 7.98)	1.67± 0.33 (2.74,1.19)	0.88±0.16 (1.10, 0.64)	0.80±0.89 (2.32, 0.076)	5.63±1.93 (7.75, 2)
S4	21.00± 2.64 (26,18.8)	7.46±0.51 (8.28, 7.04)	1.44± 0.21 (1.80,1.25)	0.78±0.13 (1.01,0.67)	0.45±0.39 (1.18, 0.14)	12.73±7.07 (25,6.50)
S5	20.98± 2.97 (22.8, 15)	7.44±0.47 (8.16,7.10)	1.08± 0.07 (1.17,1.02)	0.58±0.04 (0.62, 0.54)	0.80±1.42 (3.33, 0.062)	16.34±4.8 (24,12)
S6	22.56±3.09 (26.1, 19.3)	7.77±0.45 (8.05, 6.98)	1.32±0.42 (1.94, 0.94)	0.53±0.05 (0.61, 0.50)	0.44±0.17 (0.58, 0.28)	14.90±3.68 (20,10.00)

The role of the substrate. which is an essential factor structuring the benthic communities is minimized in this study, due to the homogeneity of the sediment at the sampled stations which they are constituted exclusively of stone, fine sand, coarse sand and rocks. The Temperature, conductivity, salinity and pH concentrations in the Abiod Wadi seem to be comparable to a Wadi located in semiarid or arid region in Algeria (Mimeche et al., 2019).

The physical environment, water quality and food availability are important factors governing the abundance and distribution of benthic macroinvertebrates (Bae et al., 2011). Some natural chemical characteristics

of rivers and lakes significantly affect the abundance and diversity of invertebrates in influencing the quality of habitat (Djamai, 2020).

Taxonomic list and abundances of macroinvertebrate species

The analysis of the taxonomic composition of the species identified in the study area revealed the presence of 31 families from 1979 individuals in 8 orders (Table 3). 99.96% of the total fauna collected from six sampling stations in Abiod wadi were belongs to the insecta class. The most abundant were Diptera (57.89%), Trichopteres (32.15%), Ephemeroptera (6.22%), Coleoptera (3.08%) and Hemiptera (0.35 %). The smallest fraction was Gasteropod, it represented by just one order Littorinimorpha (0.15%), when the class of Cliteleta is represented by tow orders Arhynchobdellida (Hirudinae) (0.1%) and Haplotaxida (Oligochaeta) (0.05%). Over all, there was no difference in the frequency of abundance, as shown by the non-significant variation in abundances between stations (Kruskal-Wallis test $\chi 2 = 11.07$, $P = 0.945$).

Diptera (57.58 %) was the most abundant of the total fauna of Abiod wadi (it was represented by 11 families, Chironomidea, Culicidae, Simuliidae, Psycodidea, Empididae, Scatophagidae, Ceratopogonidea, Muscidae, Ephydridae, Anthomyidae and Limnoniidae. Chironomidae showed the highest numerical abundance which represented in 5 stations just (S6 el hbel) followed by Ephydridae which was represented in (S4 and S6) Ceratopogonidea was represented in (S3, S5 ,S6) Culicidae was represented in (S3, S4) Simuliidae was represented in (S1, S2, S3, S4), Empididae was shown in (S1, S2, S4, S5) Anthomyidae in (S4, S6) and Psycodidea in (S1, S2, S3) .Scatophagidae (S1, S4, S5 and S6), Limnoniidae and Muscidae were shown only at station 6. Mimeche et al., 2018, in the K'sob reservoir and Mimeche et al., 2019, in K'sob Wadi shows a high numbers of Chironomidae. The Chironomide are installed in places where the water flow is smoother and accumulate debris (Cupsa et al., 2010). The order Diptera shows a large degree of tolerance to extremes of pH and tolerance of other chemical stress (Bartoo, 1978).

Trichoptera was represented by 32.15% of the total of abundance fauna, it was contributed by 5 families, Limnephilidae the most numerical abundance family: it was represented in three stations (S1, S2 and S3) followed by Hydropsychidae: it was shown in tow staions (S4, S5), Hydroptilidae and Ecnomidae were represented only in station 5, and Pollycentropodidae was shown in tow staions (S5, S6). After analyzing the relationship between the number of individuals and the species diversity at each station we found that Thaghit S1 meets both the highest number of species and the highest number of individuals Tricoptera (Limnophliidae). They are common on both substrata (stone, fine sand) because they are

filterers also they favor the presence of suspensions in the water (Galdean et al., 2001).

Table 3

Systematic list and the number of individuals of insects recorded in Abiod Wadi in the northeastern Algeria

Class	Ordrer	Family	S1	S2	S3	S4	S5	S6
Insecta	Diptera	Chironomidea	285	209	246	141	4	0
		Culicidae	0	0	1	49	0	0
		Ceratopogonidea	0	0	1	0	1	50
		Simuliidea	3	1	4	14	0	0
		Psycodidea	1	1	1	0	0	0
		Muscidae	0	0	0	0	0	1
		Ephydridae	0	0	0	17	0	85
		Anthomyidae	0	0	0	1	0	11
		Scatophagidae	1	0	0	1	1	1
		Limnoniidae	0	0	0	0	0	1
		Empididae	1	8	0	3	1	0
	Ephemeroptera	Heptogeniidae	0	0	0	2	4	0
		Baetidae	0	0	1	10	0	0
		Ephemerillidae	0	0	0	0	7	0
		Caenidae	0	0	0	14	14	20
		Leptophelbiidae	2	45	1	0	3	0
	Hemiptera	Pleidea	0	0	0	0	2	0
		Corixidae	0	0	0	0	6	1
	Coleoptera	Elmidae	0	0	0	1	0	0
		Halipilidae	0	0	0	0	2	16
		Hydrochidae	1	0	0	0	0	19
		Dytiscidae	0	0	0	6	5	3
		Hydrophilidae	0	0	1	1	4	2
	Trichoptera	Pollycentropodidae	0	0	0	0	2	2
		Limnephilidae	474	52	92	0	0	0
		Ecnomidae	0	0	0	0	1	0
		Hydropsychidae	0	0	0	1	11	0
		Hydroptilidae	0	0	0	0	1	0
Clitellata	Haplotaxida	Limbriculidae	0	1	0	0	0	0
	Arhynchobdellida	Hirudinidae	1	0	0	0	0	1
Gasteropods	Littorinimorpha	Hydrobiidae	1	0	0	0	2	0

Ephemeroptera was represented by 6.45% of the total fauna of Abiod wadi by 5 families. Leptophlebiidae was the most abundant; it was shown in

fourstations (S1, S2, S3, S5), followed by caenidae where it was shown in three stations (S4, S5, S6) and Baetidae where it characterized stations 3, and 4, the Station 6) was contributed by Ephemerillidae, Heptogeniidae was characterized two stations (S4, S5) with a low percentage. The Ephemeroptera are presenting in all stations of Abiod Wadi. They have a high sensitivity to various contaminants and pollution (Beketov, 2004; Mare-Roșca et al., 2008).

Coleoptera was represented by 3.08 % of the total of abundance fauna. It was represented by 5 families, Hydrochidae showed the highest numerical abundance which presented in 2 stations (S1, S6) followed by Hydrophilidae was represented in four stations (S3, S4, S5, S6), and Halipilidae represented in two stations (S5, S6) and Dytiscidae was shown in three stations (S4, S5 and S6) and Elmidae was shown only in station S4. Coleopterans were found only on sandy substrate (Galdean et al., 2001) with a low number of species because they need submerged vegetation and a constant flow rate of the water to establish well represented communities (Cojocaru, 2005).

Hemiptera was the lowest abundant of the total fauna of Abiod wadi especially in the fifth and the sixth stations, it was represented by 2 families Pleidae, Corixidae, while it was absent in the rest of the other stations. There are few Heteroptera species, with small densities although they prefer sedimentary substrata (Baptista et al., 2001). Hemiptera are known to be salinity tolerant (Pinder et al., 2005).

Clitellata class was represented by Arhynchobdellida and Haplotaxida which they were the lowest orders in term of quantity with (0.10%) and (0.05%); then they were represented by one family for each order Hirudinidae and Limbriculidae they were shown at the first and the second stations respectively. According to Badri, 1993, the presence of Oligochetes indicates that the sediment is rich in organic matter and clusters of filamentous bacteria.

Andriev et al., 2008, stated the presence of Oligochaeta and Hirudinea in the lower sector of the rivers, in polluted areas or on substrates, rich in organic substances is very common in other rivers too.

Gasteropod class of Mollusca phylum was represented by Littorinimorpha, also it was the lowest order in term of quantity (0.15%); it was represented by tow family Hydrobiidae, where it was shown in first and fifth stations. Littorinimorpha (Gastropod) was observed on substrate according to (Cupșa et al., 2009) they are scrappers and they shows a well developed periphytic community especially on muddy substrate where they are present mostly on the submerged vegetation.

Variation of insect diversity parameters The values of diversity and equitability, calculated for the macroinvetebrates trapped in six stations in the Abiod Wadi are shown in Table 4.

Table 4

Diversity indexes of macro invertebrates of the six stations at Abiod wadi

	S1	S2	S3	S4	S5	S6
Richess (S)	10	7	9	14	18	14
Individuals (N)	770	317	348	261	70	213
Ratio N/S	77.00	45.29	38.67	18.64	3.89	15.21
Shannon H'	0.7554	0.9957	0.7492	1.545	2.537	1.766
Equitability_E	0.3281	0.5117	0.341	0.5856	0.8776	0.669
Simpson (SRI)	0.484	0.5176	0.4302	0.6606	0.8976	0.7601
Ratio SRI/S	0.0484	0.0739	0.0478	0.0472	0.0499	0.0543

The Richness value range from 7 families in Tiflfel station (S2) to 18 families at M'Chouneche station (S5). The values of the Shannon diversity index and Equitability were higher in M'Chouneche station (S5) (H′ = 2.537, E = 0.8776) compared with the other stations. However, the average number of individuals per specie s (ratio N/S) was higher in Taghit station (S1) compared with the other stations. In addition, the values of the Simpson recirocal index (SRI) were greater in M'Chouneche station (S5) (SRI = 0.8976) and SRI/S were lower in Tiflfel station (S2) (SRI/S = 0.0472) compared with the other stations.

The diversity indices provide more information than the number of species presents (Drouai et al., 2018). The differences of species richness composition and insect diversity parameters, between the sampling sites in Abiod Wadi, can be explained by the types of the substrate and the variability of climate factors and the physico-chemical parameters. There is only certain populations can adapt to these fluctuating conditions. The computed Shannon diversity index. Simpson (SRI) and Equitability indicated that the M'Chouneche station (S5) is a home to the more abundant and the most diverse insect communities compared with the others stations

CONCLUSIONS

The macroinvertebrate population is well adapted to live under the physical and biotic characteristics of each substrate (stone, fine sand, coarse sand and rocks). The Physico-chemical parameters were showen significantly higher values among sampling sites ($p < 0.05$), except for speed of the water, which had no significant values ($p > 0.05$).

The macroinvertebrate assemblages in sites of Abiode Wadi are similar, due to the similar dimensions, hydrological and substrate of the investigated water courses. 99.96% of the total fauna collected from six sampling stations in Abiod wadi belonged to the insecta class. The most abundant were Diptera (57.89%), Trichopteres (32.15%) and Ephemeroptera (6.22%).

The Richness value ranges from 7 families in Tiflfel station (S2) to 18 families at M'Chouneche station (S5). The values of the Shannon diversity

index, Equitability and the values of the Simpson reciprocal index (SRI) were higher in M'Chouneche station (S5) compared with the other stations.

The variation of community macroinvertebrates composition in the semi arid and arid river depends on the environmental factors in this Wadi. The length of water permanence and the water quality affected the macroinvertebrate assemblages.

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