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ORIGINAL ARTICLE

Use of macro invertebrates to assess the quality of Seybouse River (North-East of Algeria)

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The theme is based on the determination and the impact of pollution on the aquatic fauna of Seybouse River in the Wilaya de Guelma. This study aimed to evaluate the physicochemical properties of water, to determine the macro-benthic invertebrates of this ecosystem. The money samples of water are taken (November - May) at three stations at different depths, including a very polluted one at downstream of the Wadi. Several physicochemical parameters were measured (pH, electrical conductivity, turbidity, BOD5 MES, water temperature and salinity). The Bi-monthly sampling of macro invertebrates revealed the existence of 40 taxa, divided into 4 branches (amphibians, molluscs, arthropods, and annelids), made up of 2344 identified individuals, and distributed according to the bathymetry, where the majority are Arthropods with 95.38%. The annelids represent 3.71%, collected mainly at the level of the strongly anthropized site C. Therefore, the distribution of the macrobenthic fauna depends on the physico-chemical parameters, on the geographical position. Maintaining a standard water quality in this aquatic ecosystem requires continuous monitoring of its physicochemical characteristics.

Key words: Sybouse River; diversity; pollution; acuatic fauna; macro invertebrates; Guelma

Introduction

Wetlands have experienced significant degradation of their physicochemical and biological qualities for several years (Reggam et al., 2015). Knowledge of biological and ecological traits based on aquatic flora and fauna is very important to understand, monitor the terrestrial and marine ecosystem quality and evaluate the impact of any alteration (pollution) on life (Chaoui, 2007; Chaoui et al., 2013). So we should consider the use of the aquatic community as a bioindicator of ecological status linked to environmental parameters (Belhanachi, 2003). The quality of water in the world has experienced a great deterioration in recent years, due to human activities (uncontrolled industrial discharges, intensive agriculture) and it also caused an alteration of the environment by changes in its physicochemical properties which would make it unsuitable for the desired uses (Reggam et al., 2015).

In Eastern Algeria, industrial activities are expanding and their wastes are discharged directly into natural rivers, causing impacts on living aquatic communities (Belhanachi, 2003). In this context, it is extremely important to understand the plasticity of the ecosystem as a function of the variability of environmental parameters (Dovonou et al., 2011). Benthic macro invertebrates are good adopters into environmental conditions. This biological group has the advantage for being the most often dependent on an environment, having quick respond to stress and (Barbour et al., 1996) being one of the first links in the food chain in the rivers (Tachet et al., 2000). They play an essential role in aquatic ecosystems because they present a great physiological diversity which gives them sensitivity to pollutants (Bournaud et al., 1980). They serve as food for many numbers of fish, amphibians and birds (Barbour et al., 1996; Moisan, 2010).

For this purpose, and better understanding the Seybouse River water degradation, the macro-invertebrate sampling and water samples were collected in various river sites. These samples have gone through physicochemical characterization, whose interest is to focus on the impact of pollution on the main actors and factors of degradation of the water quality of this lotic ecosystem.

Material and Methods

Study area

Oued Seybouse is a river in northeastern Algeria which begins near the town of Guelma by two tributaries, Cheref and Zenati Rivers. It is bordered in north by the Mediterranean near Annaba (Fig. 1). The basin of Seybouse covers a total surface of approximately 6471 km2 and it consists 42 rivers including Zenati, Bou Hamdane and Cherif rivers. The two last rivers' confluence

at Medjaz Amar form the Seybouse Rriver which reaches the sea of Annaba (ABHCSM, 1999). The study was carried out at three sites that were chosen according to their location and therefore their degree of pollution.

Site A is located upstream on Medjez Amar. The width of the riverbed is 40 m, the geographical position is 6°26.611'N 007°18.870'E. Site B is located in the middle of Guelma City, close to agricultural land, has a width of 28 m and the geographical position is 36°28.786'N 007°24.956'E. Site C is a polluted site in Djeballah Khemissi with a riverbed width of 15 m and the geographical position is 36°28.117'N 007°32.087'E. The vegetation mainly includes *Juncus sp, Typha sp, Phragmites australis, Tamarix sp, Nerium oleander,* and *Lemna minor*.

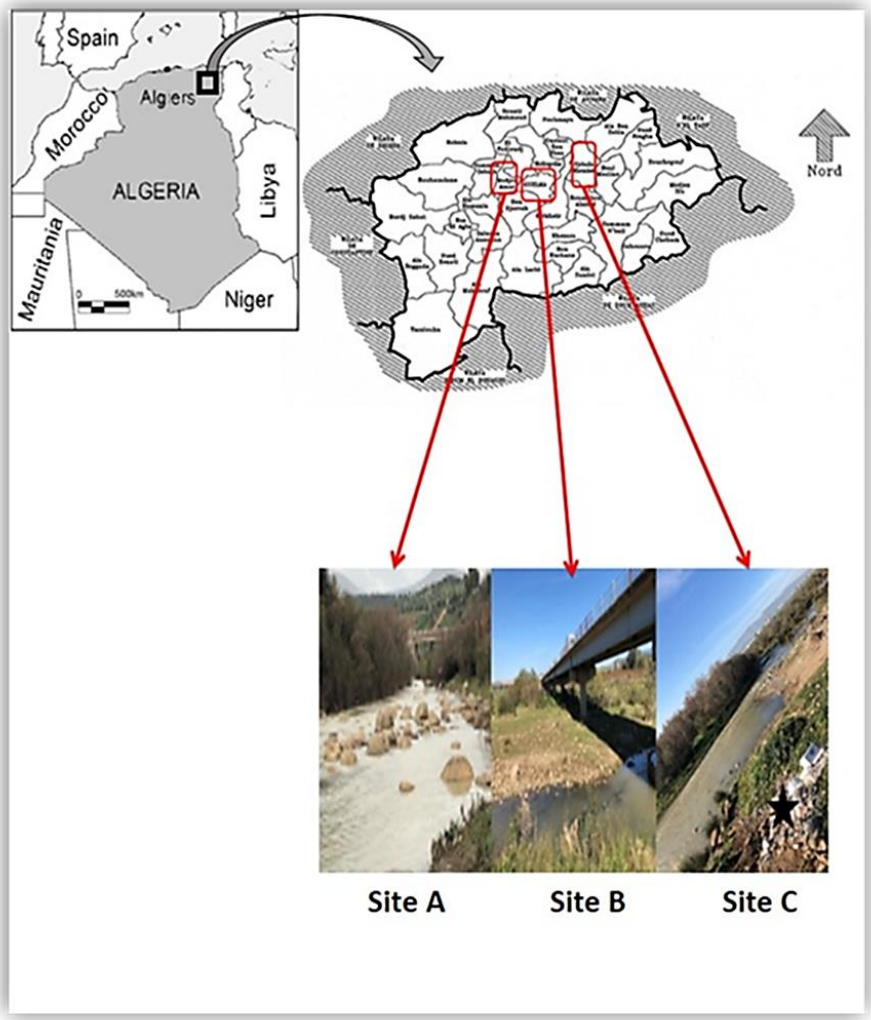

Fig. 1. Geographical location of the sampling sites

Sampling

During 2019, the sampling was carried out at three stations in Seybouse River. The distance between stations A-B and B-C is 12 and 14 km respectively. Bimonthly systematic sampling was carried out at each station. Using a large landing net with a mesh opening of 1mm. Since the vegetation is very abundant, the contents of the net are emptied into large bags for a second sorting in the laboratory in order to separate the macro invertebrates from the vegetation. The chosen stations were mainly selected due to the convenience on sampling and accessibility, in places that are fairly clear of vegetation. Sorting was carried out in the laboratory under a binocular loupe and the collected organisms were identified, thanks to several identifying keys (Tachet et al., 2012; Moisan, 2010; Greenhlg & Ovenden, 2009); them they were counted and categorized by family. Adult insects such as Coleoptera, Hemiptera and adult odonata have been pinned to polystyrene specifying the name of the species and the date, that were all kept in collection boxes.

For storage, the insects are placed in labeling vials (date, station, taxon, and abundance) and filled with 70% of ethanol. The water samples of Seybouse River were taken in clean plastic bottles with a capacity of 1.5 liters at 2m from the banks. The bottles were filled to the brim then the caps were screwed on to avoid any gas exchange with the atmosphere. The water samples were sent directly to the laboratory for physicochemical analysis. The following parameters were analyzed: the suspended solids "SS", the turbidity and the salinity. The following parameters (temperature, pH, dissolved oxygen, electrical conductivity, and depth) were measured directly *in situ* by WTW multi 1971 multi type.

Results and discussion

Characterization of environmental conditions

The physicochemical indicators of water quality are often subject to spatio-temporal variations induced by anthropogenic activities that modify and affect the characteristics and the quality of water (Karrouch & Chahlaoui, 2009). Water temperature is an abiotic factor of the greatest importance in development and growth. The average monthly ambient temperatures are 23 °C during the

April and 9.12 °C during the winter (Fig. 2A). Bathymetry plays an important role for the installation of the various aquatic fauna taxa. It does not only influence the warming of water but it also acts on the oxygen content in addition to the installation and proliferation of thermophilic flora and fauna. The three sites have very close average depths (Fig. 2B).

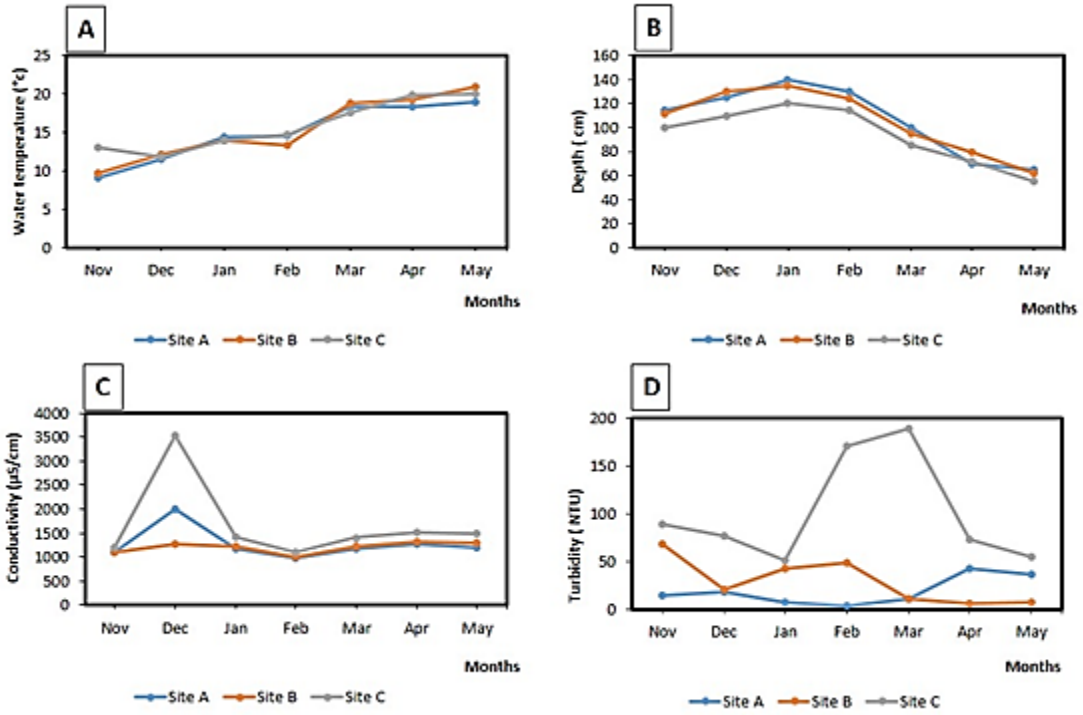

Fig. 2. Variation of physical parameters according to sites and dates

Electrical conductivity (EC) is a very important parameter for the dynamics of stands it represents the capacity of water to conduct an electric current .When water is richer in ionized minerals , the conductivity is higher (Derwich et al., 2010). Waters of the Seybouse are considered to be highly mineralized with values greater than 1000 µS / cm. We observe an increase in salinity levels from upstream to the mouth (Fig. 2C). Turbidity is a parameter that varies depending on colloidal compounds (clays, rock debris, and microorganisms) or humic acids (degradation of plants) but also on pollution which disturbs water (Hazourli et al., 2007). A significant turbidity of water leads to a reduction in its transparency, which decrease the penetration of solar radiation useful for aquatic life (photosynthesis). The measured values vary between 50 NTU (minimum value observed during the month of November at Site A) and 500 NTU (maximum value observed during the month of April at the same site) (Fig. 2D).

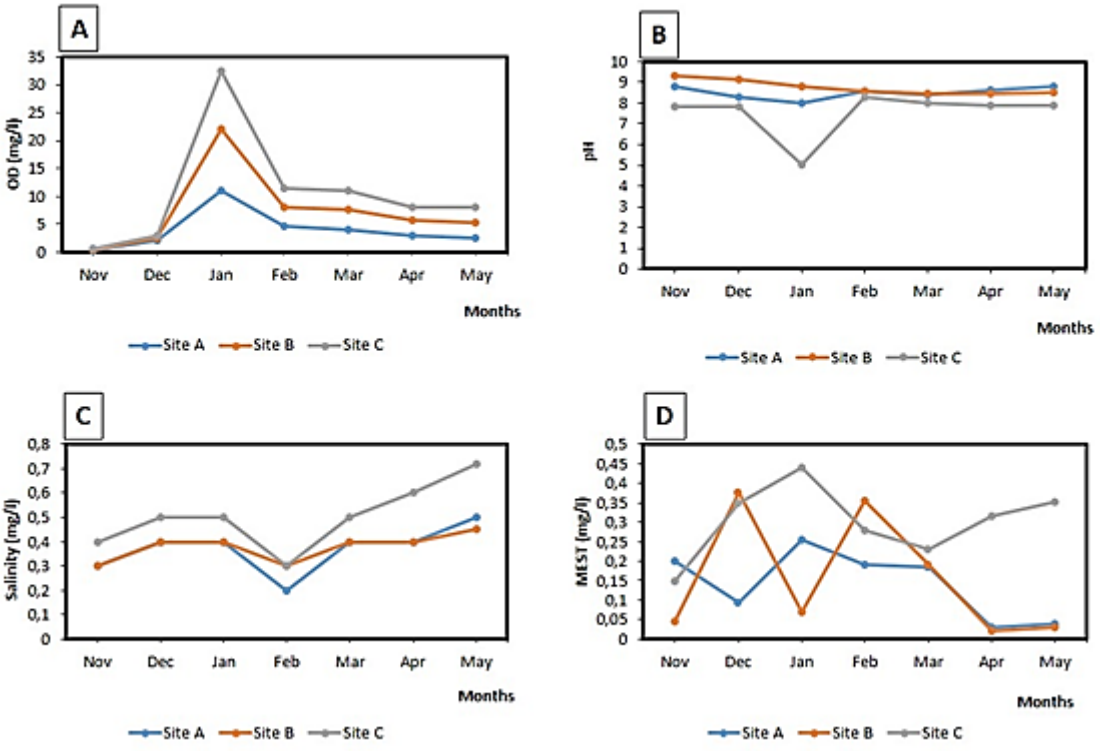

Fig. 3. Variation of chemical parameters according to sites and according to dates

Dissolved oxygen concentrations are one of the most important parameters of the quality of an aquatic ecosystem; they come mainly from the atmosphere and from the photosynthetic activity of algae and aquatic plants. Good quality water should be well oxygenated (Fig. 3A). The oxygen content continues to decrease from upstream to downstream, from 1.17 mg/l to 2.16 mg/l.

When the pH values become lower, this increases the risk of the metals being presented in a more toxic ionic form (Chapman, 1996). The pH is a factor that depends on the natural conditions of the environment, such as the plant cover and the nature of the rocks and the soil substrate and human activities (Dussart, 1966; Brémond & Vuichard, 1973). It decreases in the presence of higher organic contents and increases during periods of low water. In our study, the values fluctuate between 5.26 and 9.23 (Fig. 3B).

Table 1. Checklist of faunistic taxa. TN - total number, F/O - Frequency of occurrence

Branch	Class	Order	Family	TN	F/O
Arthropoda	Malacostracés	Décapodes	Atyidae	81	5/6
		Amphipodes	Gammaridae	01	1/6
	Insectes	Coléoptères	Haliplidae	01	1/6
			Dytiscidae	02	2/6
			Carabidae	02	2/6
		Diptères	Ceratopogonidae	96	1/6
			Simulidae	20	3/6
			Tipulidae	02	2/6
			Chironomidae	499	5/6
			Culicidae	01	1/6
			Dixidae	30	3/6
			Thaumaleidae	01	1/6
		Odonates	Platycnemididae	29	6/6
			Coenagrionidae	07	4/6
			Gomphidae	02	2/6
			Cordulgastridae	01	1/6
			Libellulidae	01	1/6
		Hémiptères	Gerridae	15	3/6
			Alydidae	01	1/6
		Hyménoptères	Apidae	01	1/6
			Cynipidae	03	1/6
			Siricidae	02	1/6
		Ephéméroptères	Heptageniidae	1360	6/6
			Caenidae	183	6/6
			Baetidae	151	5/6
			Ephemerellidae	11	3/6
			Potamanthidae	01	1/6
			Isonychidae	01	1/6
		Trichoptères	Hydropsychidae	26	4/6
	Arachnides	Araneae	Argyronetidae	02	2/6
Annelida	Clitellates	Haplotaxides	Tubificidae	65	4/6
			Lumbriculidae	18	3/6
			Naididae	02	2/6
			Proppapidae	01	1/6
		Rhynchobdellida	Glossiphoniidae	01	1/6
Nematomorpha	Gordiacés	Gordioidea	Gordiidae	05	2/6
Chordata	Amphibiens	Anoures	Bombinatoridae	03	2/6
Mollusca	Gastropodes	Basommatophora	Planorbidae	07	3/6
			Physidae	08	4/6
			Lymnaeidae	01	1/6

The salinity values are relatively close, while the contents fluctuate between 0.23g/L to 0.67g/L (Fig. 3C). We also noticed an increase in chlorides during the dry season, which would be favored by the lower flow of the river. Regarding suspended solids (SS), these measurements show great variability between the three sites (Fig. 3D). These contents are between 1.00 mg/l (S1) and 580 mg/l (S4). The exceptionally high load recorded during the month of April is probably the result of a sudden hydrological manifestation (flood), whose load in SS can be attributed to an intense erosion of the watershed, following torrential rains which caused an increase in these contents (Genin et al., 2003). The lowest concentrations were recorded at the third site. Further downstream, there was a significant decantation along the stream.

Characterization of populations

The taxonomic richness observed at the Seybouse River is high. Macro invertebrates are represented by 2344 individuals divided into 15 zoological groups (orders) including 40 families (Trichoptera, Ephemeroptera, Diptera, Coleoptera, Odonata, Heteroptera, Molluscs, Nematodes, Annelids) (Table 1). The latter were retained for the analysis of populations of macro invertebrates.
The analysis of faunal communities shows that the macrofauna is mainly composed of invertebrates (Figs 3A, 3B). The most frequent organisms are arthropods (95.38%), and the insects occupy the large part with 96.32% of arthropods (Fig. 3C). Among the insects, Ephemeroptera are the most abundant, constituting 79.43% of all the surveyed fauna. (Fig. 3D). The high taxonomic richness observed at site A with 24 taxon would probably be linked to the physical characteristics of the site (Fig. 4B). The size of the benthic population showed that Ephemeroptera are clearly dominating in site A. They are a sensitive group to pollution and are the first to disappear, which proves the good quality of the water and the good health of this site. Diptera are the second most abundant order and they are represented with a total number of 690 individuals. This taxon is presented regularly in site C with a higher number of 645 individuals (93 %) comparing to other sites. In site A and B this group is represented by 0.5% and 6.5% respectively, this proves that the good water quality of these two sites (Fig. 4A). The results of this study show that the Odonata order is very low because these larvae's prefer stagnant water for their development and this agrees with the results of Dublanchet (2001).

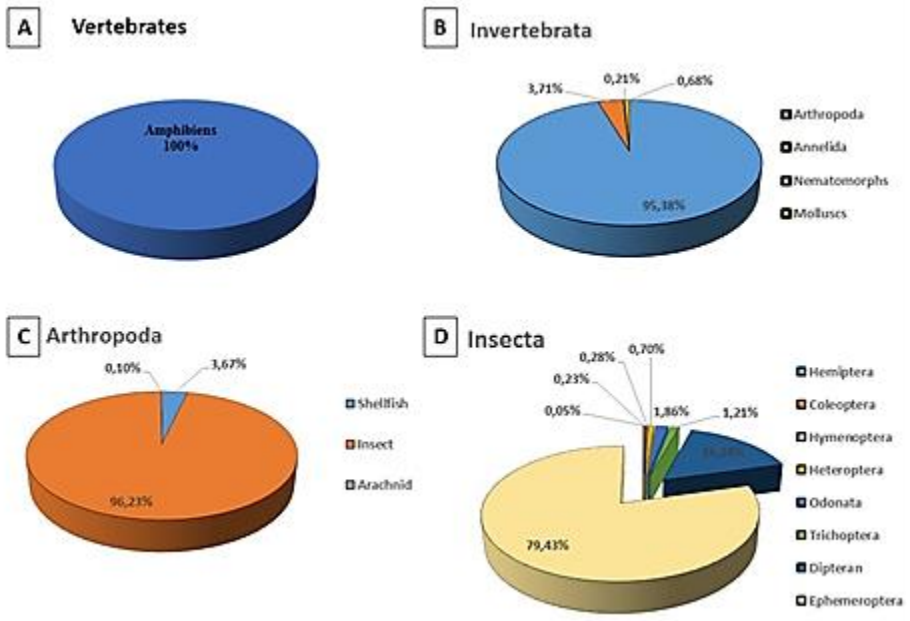

Fig. 3. The abundance of harvested fauna.

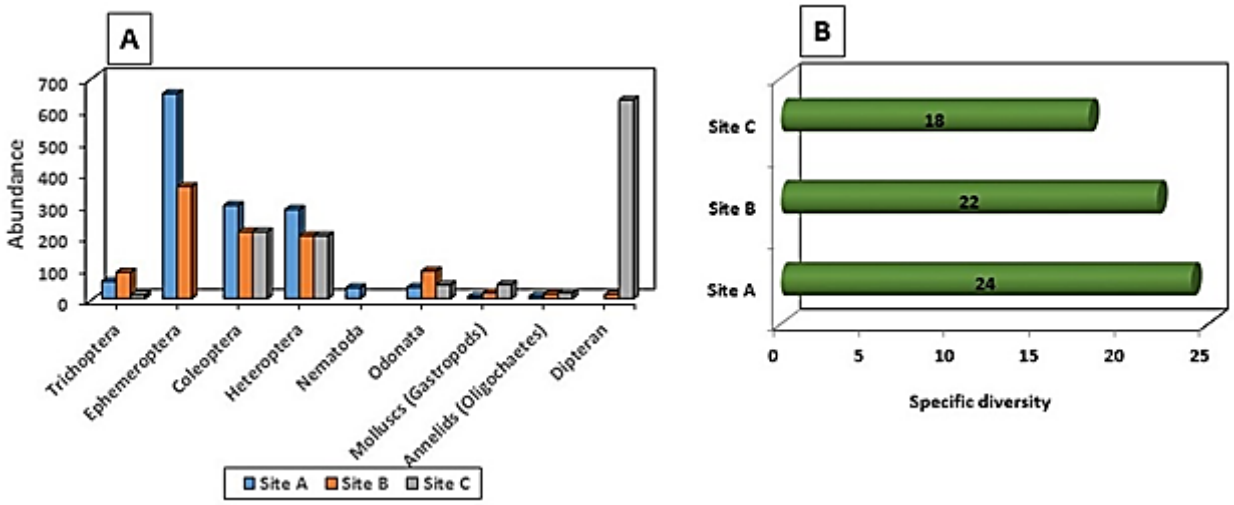

Fig. 4. Specific richness by site and by date.

Indeed, long-lived hydroelectric bodies allow the coexistence of more species due to the overlap of hatching and development times between the different species (Djabri et al., 2003; (Merzoug et al., 2010). Also, the importance of depth combined with the surface area of the study sites, contributes to the creation of a diversity of habitats (Vaufleury et al., 2013), which allows more ecological niches and a good sharing of food resources. The diversity of habitats in the same body of water allows the existence of more species (Khaldoun et al., 2013). The abundant vegetation (in the wadi and on the banks) could constitute a refuge for macro invertebrates against predation and against variations in temperature. The lower taxonomic richness recorded in December could be explained by the lower temperature which prolongs embryonic development (Barbour et al., 1996) ; (Greenhlg & Ovenden,

2009) and leads some species to enter diapause. It could also be explained by agricultural or domestic pollution and by the drop in the water level of this ecosystem (there was no rainfall until January) (Vivier, 1970). This study revealed a high abundance of aquatic fauna in the spring. The increase in temperature from the arrival of March allows these species to break the winter diapause that results in a significant taxonomic richness. In fact, the high temperature accelerates the hatching of eggs, larval development as well as the survival of macro invertebrates (Dajoz, 1985; Tachet et al., 2010, 2012; Thomas, 1975).

Conclusion

Our study at the Seybouse River based to evaluate the diversity of aquatic fauna, and the influence of pollution on their abundance and phenology. The spatio-temporal monitoring of several physicochemical parameters of water has given us the image of pollution; the rates measured at the level of this watercourse evolve gradually from upstream to downstream and result in a significant mineral and organic load. Thus, the third site C (the mouth of the river) is the most affected. We have identified a population of aquatic fauna made up of 2344 individuals, which includes 40 taxa composed mainly of invertebrates. Among the invertebrates, arthropods are the majority with 95.38%, the class of insects represents the majority of invertebrates (79.43%). The presence of Odonata with a significant number and Ephemeroptera and their abundance in January and March reflects good water quality for site A.

The results of this study show that Seybouse Rriver is home to a very diverse fauna whose vital requirements are very varied and which adapted to variations in environmental factors as well. We observed the highest number of Diptera (649 individuals) recorded in site C. Among these the Diptera and Chironomidae, which were represented by 499 individuals. It is known, that this group is tolerant to pollution and it is a filter feeder that feed on plant or animal microorganisms and organic debris. This fact proves the poor quality of the water in this site. The results of this study show that this biotope harbors a very diverse fauna, which is adopted to the physicochemical factors of the environment.

It is urgent today to put in place measures to protect the exceptional value of these environments in terms of biodiversity, cultural heritage and ecosystem services. In addition, a public awareness campaign must be carried out in collaboration with local authorities in order to conserve the ecosystems that have a paramount importance.

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