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RESEARCH ARTICLE

INVENTORY OF ZOOPLANKTON AND MACROINVERTEBRATES IN THE DAYA OF DAR BOUAZZA, CASABLANCA, MOROCCO

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Abstract

This study aims to contribute to the elaboration of an inventory of zooplankton and macro invertebrates in the daya of Dar Bouazza, Casablanca region, Morocco. The determination of macro invertebrates and zooplanktons was based on the study of benthic larvae sampled between March and June 2021 in 4 stations. In the 4 stations, the benthic macro invertebrates recorded are distributed over 4 major faunal groups, 27 families and 35 genera. Coleoptera are largely dominant with 7 families. Diptera are second with 5 families. The Hemiptera are in third place. The zooplanktonic fauna of the Daya is divided into 2 groups: Cladocerans which are represented by three genera (Bosmina, Daphnia and Diaphanosoma) and Copepods which are represented only by the genus Cyclops.The physicochemical results showed a strong mineralization in the Daya. This is probably the combined effect of the degradation of the waters of the Daya of Dar Bouazza and the water table of the coastal chaouia, of which Daya is part. These results are confirmed by bacteriological tests through the identification and enumeration of Coliforms and intestinal Streptococci. The presence of these bacteria translates a pollution of fecal origin making these waters unfit for human use.

Introduction:-

Water quality monitoring based solely on measuring the concentration of pollutants in the water does not allow conclusions to be drawn about the health of the ecosystem. Measurements of living things are often required. Biological monitoring is therefore the primary tool for assessing the biological health of aquatic environments (U.S.EPA. 2002).

Of the biomonitoring communities, benthic macroinvertebrate communities are the most widely used to assess the overall health of aquatic ecosystems (Hellawell 1986; Barbour 1999; WFD 2003). These are organisms that are visible to the naked eye and inhabit the bottom of streams and lakes. They are an important link in the food chain of aquatic environments, as they are a primary food source for many species of fish, amphibians and birds. They are known to be good indicators of the health of aquatic ecosystems because of their sedentary nature, life cycle, high diversity and variable tolerance to pollution and habitat degradation. They are abundant in most rivers and easily collected.

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Monitoring the abundance and taxonomic richness of benthic macroinvertebrates is a well-used method to assess the overall health of an aquatic ecosystem, track changes in the health of a river over time, assess and verify the effect of a known pollution source on ecosystem integrity, assess the impacts of restoration efforts (habitat and water quality), complement the biological monitoring program for bacteriological and physicochemical quality of streams, and document the biodiversity of benthic macroinvertebrates in streams.

Similarly, the devastation and pollution of the aquatic system affects in particular the distribution of zooplankton. These zooplankton play a major role in aquatic food webs as they are an important food source for fish and predatory invertebrates. They are thus an indispensable link in the food webs and energy transfers within aquatic ecosystems. They play a major role not only in the transfer of matter to the upper levels of the marine chain but also in the biogeochemical fluxes of elements (Banse, 1995). Furthermore, zooplankton are considered to be very sensitive and reactive to variations in environmental conditions (Harris, 2000) and with species that are largely tolerant of certain environmental conditions. They are therefore used as indicators of water pollution (Brummett, 2000).

The use of biological variables has thus progressively imposed itself as a means of assessing the quality of water and aquatic systems, because they present a certain number of advantages and complementarities compared to physico-chemical and bacteriological variables. Because of the integrative nature of the organisms studied, they make it possible to diagnose water pollution or a global degradation of the habitat without prejudging the causes of these alterations. They study disturbances by their effects and not by their causes. On the other hand, they can reveal a punctual, past pollution, contrary to a too late physico-chemical analysis of the water, the aquatic populations constituting a true memory.

The main objective of this work is to make a diagnosis of the community of benthic macroinvertebrate larvae and zooplankton in the Daya of Dar Bouazza. This approach is essentially to draw up a faunistic inventory, and to study in a global way the larvae of benthic invertebrates which are likely to be used as indicator taxa of disturbance or degradation of aquatic environments, as well as zooplankton.

Materials and Methods:-

Studyarea

The Dar Bouazzadaya extends along the Atlantic coast in a NE-SW direction (Figure 1). It is located about 15 km south-west of the center of the city of Casablanca and is part of the series of sub-Atlantic plains that develop along the ocean from Rabat to Essaouira. Administratively, it is located on the territory of the commune of Dar Bouazza, in the region of Casablanca - Settat. It occupies an area of 18 ha.

Figure 1:- Satellite image of the daya of Dar Bouazza.

The climate of the region is semi-arid, mesothermal, with a small surplus of rainfall in winter, favored by the oceanic influence. The Dar Bouazza area receives an average annual rainfall of about 320 mm.

Sampling stations

Two sampling campaigns were conducted between March and June 2021 along the Daya of Dar Bouazza. To carry out and complete this study, 4 stations were selected taking into account a number of criteria: lithological diversity, location of sampling points in relation to pollutant discharges, ease of access and sampling.

Figure 1 shows the four stations representative of all the biotopes sampled. Stations S1 and S2 have a stony and pebbly substrate and present filamentous algae and plant debris. Station S3, located near the water source, has a substrate formed by rocks and sand with an abundance of duckweed and plant debris. While the station S4, it has a sandy-silty substrate and the presence of lenses of water.

Sampling

Sampling of macroinvertebrates is carried out using a "Surber" type sampler provided with a 500 µm mesh void, which allows sampling of all fauna on a sampling surface of 1/20 of m². Eight samples are taken per station, seeking maximum representativeness, by sampling all the microhabitats present. All that is recovered in the net is placed in bins for preliminary sorting. In the field, depending on the time available, the coarsest elements are eliminated (stones, plants). The samples in the pots are fixed with a formalin solution of final concentration 10%.

For zooplankton, samples are collected by vertical tows using a plankton net with a mesh size less than 200 µm. The samples are packed in jars and fixed with 10% concentrated formalin (Menbohan, 2010). In the laboratory, these samples are washed with water and sorted with a binocular loupe. The identification of the collected specimens is carried out with the help of referenced books and determination keys. The results of the identification are established to the family and pushed, when it is possible, until the genus or the species.

For bacteriological analyses, samples are kept in 1L glass bottles, previously sterilized at 120°C for 20min. For physico-chemical analyses, 1L of sample is taken and packed in a polyethylene bottle. A precise label is elaborated for an easy recognition of the stations before the filling of the bottles. The transport to the laboratory was done in a clean refrigerated cooler (4 C). Analyses were performed within 4 hours of sampling.

Physico-chemical analyses

The physico-chemical study of the water was based on the determination of pH, conductivity, chloride, nitrates and sulfates according to the methods described by Rodier (2009). The concentrations of heavy metals: cadmium (Cd), chromium (Cr), iron (Fe), lead (Pb) and Copper (Cu) were determined using a SpectrAA-20 (Varian) atomic absorption spectrometer.

Bacteriological analyses

Bacteriological analyses of the Daya of Dar Bouazza water focused on indicators of faecal contamination (faecal and total coliforms and intestinal streptococci (or Enterococci)) and on pathogens such as Salmonella. These analyses were performed according to the protocols described in the Moroccan ISO standards (ISO/IEC, 2005)

Results and Discussions:-

Physico-chemical quality of water

Figure 2 shows the results of physicochemical analyses in the 4 stations of the daya. It is observed that the pH (fig. 2.a) varies from 7.08 at S4 to 7.61 at S2. The observed values reveal that pH is slightly neutral at all Daya stations. The variation in pH illustrates the buffering effect of the waters at the stations studied. This phenomenon can be explained by the combined effect of a significant photosynthetic activity (as evidenced by the development of algae), the lithological nature of the land as well as by the ionic reactions taking place in the inputs of the discharges of the settlements. According to the NMES, all the studied stations present waters of good to excellent quality. The values obtained in the present study remain comparable to those reported by Monjidand al. (2014) at the level of the Wadi Merzag which flows into the lithoral near the Daya.

Electrical conductivity (Figure 2.b) varies between 3600 µs/cm at S1 and 4420 µs/cm at S2, indicating very high mineralization of the water in the Daya. According to the Moroccan surface water standard, this water is classified as having poor to very poor electrical conductivity. These results corroborate those of ABHB (2004) and Zerouali and al. (2001) which confirm the high mineralization of the coastal Chaouia aquifer.

Figure 2.c shows the results of chlorides and sulfates measured in the 4 Daya stations. It can be seen that chloride values vary between 1049.7 mg/l (S3) and 1369.1 mg/l (S2) with the maximum measured in S1 and S2. Sulphate contents vary between 200mg/l and 240mg/l and the maximum is recorded in S1 and S2.

The evolution of chlorides and sulfates goes hand in hand with that of conductivity at the Daya. This is consistent with the findings of other authors who mentioned that the concentration of chlorides increases continuously and proportionally under the effect of urbanization (Edwards and Thornes, 1973; Bontoux, 1993; Cun and Vilagines, 1997; Lamrani, 2011) and according to the nature of the land crossed (Bermond and Vuichaard, 1973; Fawzi, 2002; Oubraim, 2002) but also under the effect of the input of the table. Chlorides are important inorganic anions contained in varying concentrations in natural waters, generally in the form of sodium (NaCl) and potassium (KCl) salts. They are often used as an index of pollution. They have an influence on the aquatic fauna and flora as well as on the growth of plants. For the 4 stations, chlorides record levels that exceed the Moroccan standards set at 750 mg/l (N.M, 2002). This makes it possible to classify these waters in the grid to very bad.

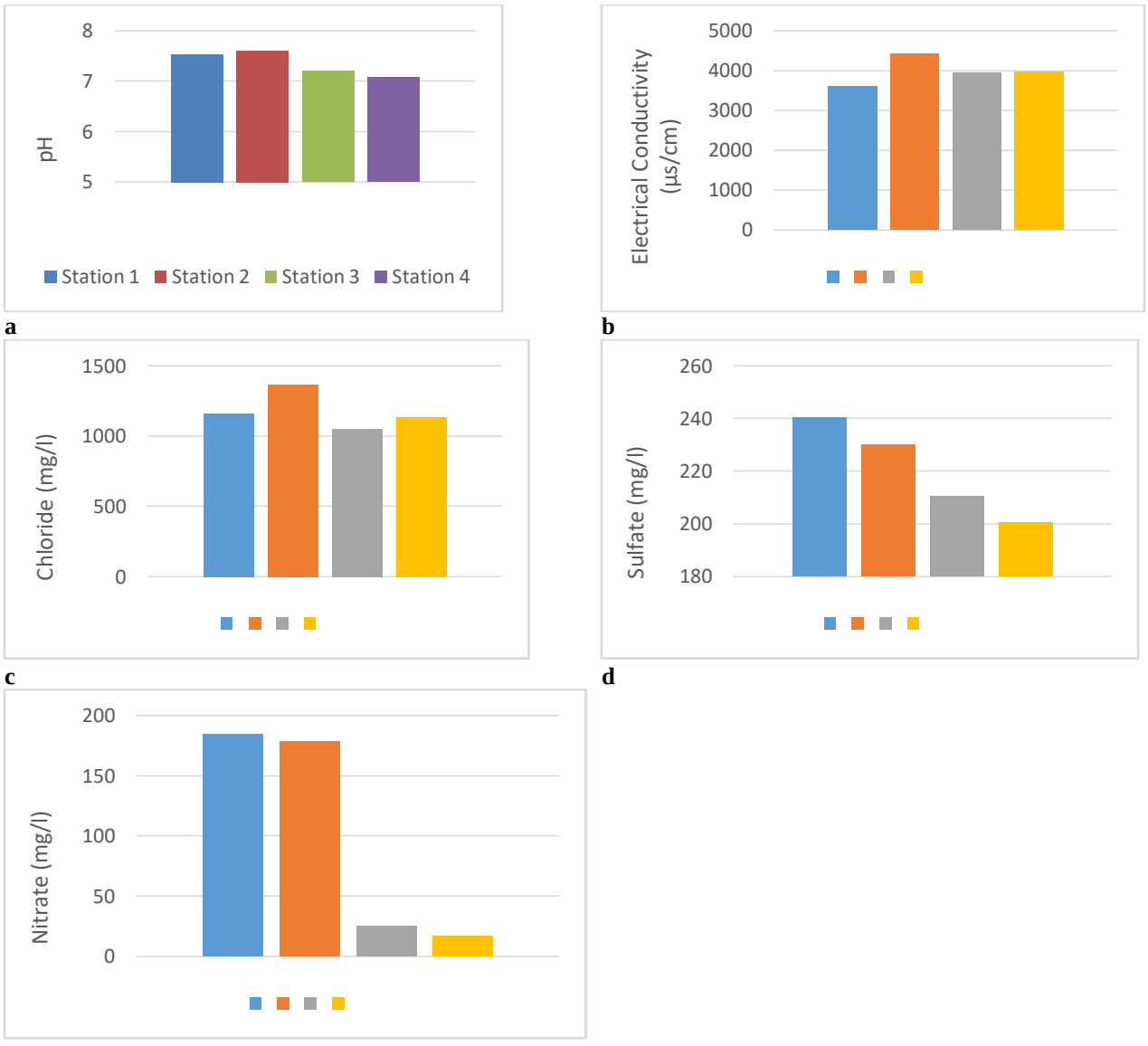

Figure 2:- Physico-chemical characterization of the waters of the 4 stations of Daya of Dar Bouazza. A) pH, b) electrical conductivity, c) Chlorides, d) Sulfate and e) Nitrate.

Sulfates are geochemical elements; they are released by the weathering of the granitic basement and additional loading can come from urban discharges. High sulfate concentrations can become a limiting factor for water productivity. Throughout our study, sulfate levels were consistently above 200 mg/l (Fig. 2.c). These high values reflect the nature of the soil. This indicates that the water studied is at risk of sulfate contamination. These levels remain higher than those reported by Monjid et al. (2014) in Wadi Merzg, which remain well below the NMRD recommended limit value (SEEE, 2007) equal to 250 mg SO4/l.

The significant mineralization, highlighted by the high values of electrical conductivity, chlorides and sulfates at all stations of the Daya of Dar Bouazza indicates the degradation of the coastal Chaouia water table that drains into the Daya.

Figure 2.d shows the results of nitrate analyzed in the 4 stations of the Daya of Dar Bouazza. The highest nitrate values (178.68 to 184.60 mg / L) were observed at the stations (S1 and S2). The decrease in nitrates in S3 and S4 is probably due to the presence of duckweed, which contributes strongly to the absorption of nitrates. Moreover, these values remain higher than those reported by Monjid et al. (2014).

According to the Moroccan surface water standard, the waters of stations (S1 and S2) belong to the very poor-quality class. The stations (S3 and S4) as for them present nitrate values of the order of 24.87 and 16.77 respectively, these values remain lower than the limit value fixed by NMES that is 30 mg/l.

Figure 3 shows the results of heavy metal analyses (Cu, Ca, Cr, Pl and Fe) at the 4 Daya stations. The waters of the Daya contain trace elements at negligible levels, which allows us to say that these elements do not present any danger to the quality of the waters of the Daya. Indeed, the concentrations of heavy metals remain well below the limit values recommended by the Moroccan standards. These low levels of trace metals are related to the absence of industrial activities in the study area, which generally constitute the source of pollution by these elements in Moroccan surface waters.

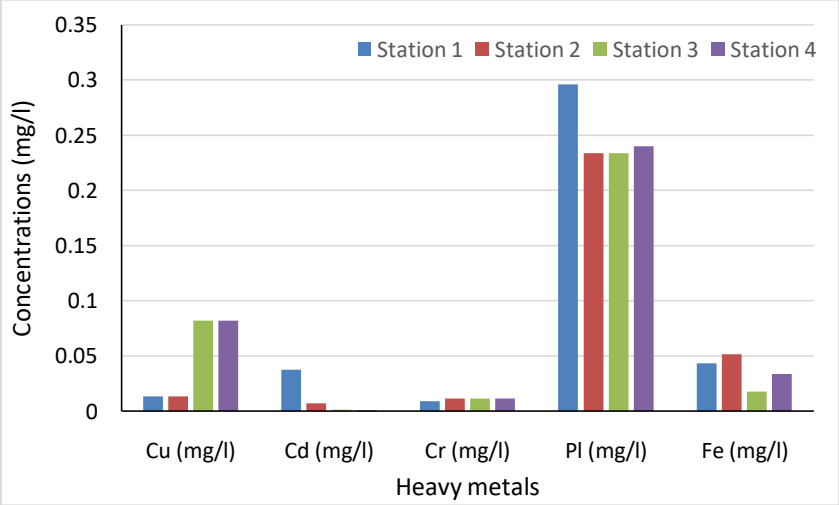

Figure 3:- Results of heavy metals analyzed in the 4 stations of the Daya of Dar Bouazza.

Bacteriological water quality

The bacteriological results from the four Daya stations are presented in Figure 4. The results obtained reveal that the abundance of total coliforms, varies from one station to another, the minimum value was measured at S3 (600 UFC/100ml), while the maximum value was recorded at S1 (870 UFC/100ml). As for the stations (2 and 4), they recorded a value of 800 UFC/100ml and 628 UFC/100ML respectively.

For fecal coliforms, the maximum value was detected at station S1 with a value of 300 CFU/100ml, which can be explained by the contamination of the water by animal feces near the sampling points. The minimum value was noted at station 3 with a value of 110 UFC/100ml. Stations 2 and 4 recorded a value of 280 UFC/100ml and 250UFC/100ml respectively.

Regarding fecal streptococci, which are the dominant intestinal flora in herbivorous domestic animals, their presence in the environment indicates a signal of recent fecal pollution of animal origin. The maximum value of fecal streptococci (Enterococci) was recorded at stations 2 and 4 with 500 UFC/100ml, while the lowest value was noted at S1 (276 UFC/100ml). Station S3 recorded a value of 374 UFC/100ml.

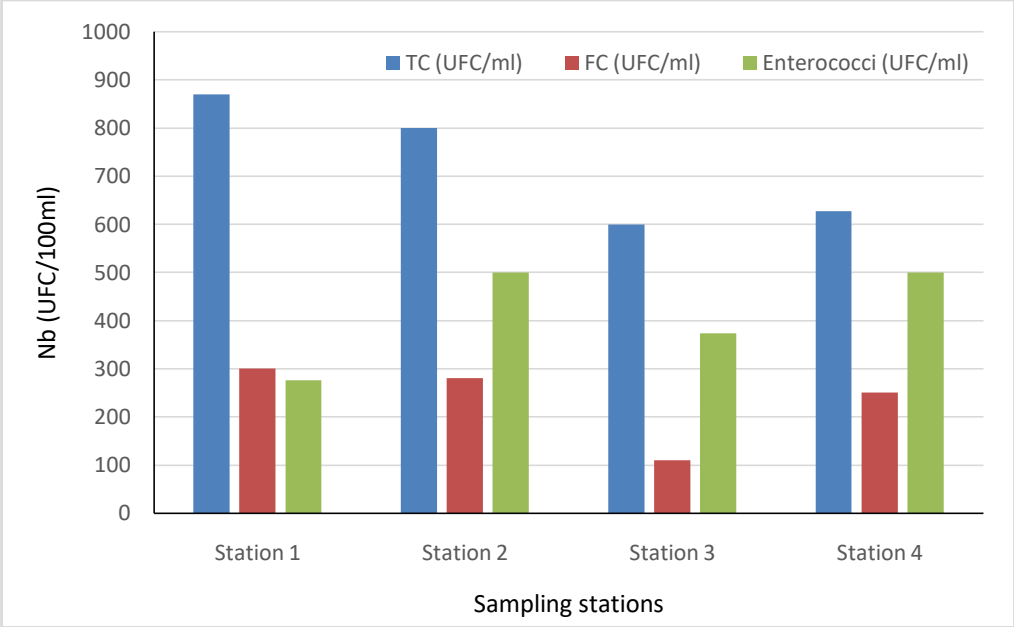

Figure 4:- Variation in the concentration of Total Coliforms (TC), FaecalColiforms (FC) and Enterococci in the waters of the Daya of Dar Bouazza.

Pathogenic germs

Pathogenic germs of the Salmonella genus were systematically searched for at all stations of the Daya of Dar Bouazza. No samples were positive for Salmonella bacteria.

Determination of the origin of the fecal contamination

The origin of the fecal contamination is determined by the quantitative ratio R: CF/SF. According to the criteria defined by Borrego & Romero (1990), the contamination is of animal origin if the ratio R is lower than 0.7. It is of human origin if R is greater than 4. The origin of the contamination is mixed and predominantly animal 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 and predominantly human if R is between 2 and 4.

Table 1:- Origin of the faecal contamination of the Daya de DarBouazza waters.

TheDayaofdarBouazza		
Stations	CF/SF	Origin
Station1	1,09	Mixed,predominantlyanimal
Station2	0,56	Strictlyanimal
Station3	0,3	Strictlyanimal
Station4	0,5	Strictlyanimal

The CF/SF ratio for the Daya of Dar Bouazza (Table 1), shows that the fecal pollution in stations (2, 3 and 4) is of animal origin, although the CF/SF ratio at S1 showed that the fecal contamination is mixed but predominantly animal. This contamination can be attributed to the presence of livestock that can contaminate the water, as well as migratory birds that are very abundant in the Daya and can pollute the water with their droppings.

In addition, there is visual and chemical pollution such as waste of all kinds and washing products used to clean hides, mopeds and cars.

At the end of this study, we can make a number of observations. The results of the water analyses during the water column indicate a strong contamination by fecal pollution indicator bacteria (SF, CF, CT) of animal or human origin which exceeds the standards for human consumption which should not contain any trace of this type of microflora, but these waters of the Daya remain usable for irrigation; the rate of total coliforms is always higher than fecal

coliforms in the water column, this is in agreement with theoretical data, since fecal coliforms are part of total coliforms (Mehanned and al., 2014).

The zooplankton of the Daya of Dar Bouazza

Table 2 presents the zooplankton taxa collected in the 4 stations of the Daya. The identification revealed that the waters of the Daya have a low taxonomic richness and only 2 faunal groups are recorded: Cladocerans and Copepods. The group of Cladocerans is the most diversified, with 3 genera belonging to 3 monospecific families: Daphnidae (Daphnia), Bosminidae (Bosmina) and Sididae (Diaphanosoma). The copepods group is represented by a single genus belonging to the family Cyclopidae and represented by the genus Cyclops (adults, copepodites and nauplii).

Table 2:- Main plankton identified in the Daya of Dar Bouazza.

Groups	Families	Genres	Species
Cladocerans	Bosminidae	Bosmina	Bosminalongirostris
	Daphnidae	Daphnia	Daphniamagna
	Sididae	Diaphanosoma	Diaphanosomabrachyurum
Copepods	Cyclopidae	Cyclops	Adult
			Nauplii
			Copepodite

Spatial taxonomic richness varied from station to station. Indeed, Cladocerans were observed in the two stations S1 and S2 with 3 taxa each. Copepods were present in all four stations with a different distribution, respectively 2 and 3 in S1 and S2 and 1 taxon in S3 and S4.

The benthic fauna

Global taxonomic richness of the benthic fauna in the Daya of Dar Bouazza.

Generally speaking, the benthos is made up of invertebrates living on the bottom of streams and stagnant waters where they are distributed in a heterogeneous way according to the nature of the substrate. Some are fixed, others crawling or burrowing. Table 3 shows the taxa identified in the 4 Daya stations during the two sampling campaigns. Indeed, individuals belonging to 10 taxonomic groups were identified, distributed over 27 families and 35 genera.

About the taxonomic richness, the best represented groups are the order Coleoptera (7 families including 10 genera), followed by the order Diptera (5 families and 5 genera), Hemiptera (4 families and 7 genera) and the order Ephemeroptera (3 families belonging to 4 genera).

Table 3:- Macrofauna recorded in the 4 study stations of the Daya of Dar Bouazza.

Groupes taxonomiques	Familles	Genres
Coléoptères	Dytiscidae	Hydrovatus
		Hydaticus
		Hydroporus
	Hydrophilidae	Hydrobuis
		Berosus
	Elimidae	Stenelmis
	Pleida	Plea leachi
	Helophoidae	Helophorus
	Hydroscaphidae	Hydroscapha
	Hygrobiidae	Hygribia
Diptères	Culicidae	Culex
	Tabanidae	Tabanus
	Ephydridae	Ephydra
	Chironomidae	Chironomus
	Stratiomoidae	Stratiomys
Hémiptères	Corixidae	Glaenocorisa
		Cymatia
		Micronecta
		Propinqua
		Corixa
	Mesovellidae	Mesoveila
	Notonectidae	Notonecta
	Naucoridae	Naucoris
Ephéméroptères	Beatidae	Beatis
		Procloean
	Caenidae	Caenis
	Ameletidae	Metreletus
Odonates	Caenagrionidae	Caenogrion
	Libellulidea	Sumpetrum
Mégaloptères	Sialidae	Sialis
Hyménoptères	Agriotypidae	Agriotypus
Mollusques	Physidea	Physa
	Planorbidae	Planorbis
Oligochètes	Lumbriculide	Lumbriculidae
Achète	Glossiphonidae	Helobdella

Figure 5 shows the results of spatial species richness. The most diverse stand is observed in station S1 (with 22 genera), followed by stations 2 and 3 with 16 and 14 genera respectively. Station 4 has the lowest richness with only 7 genera.

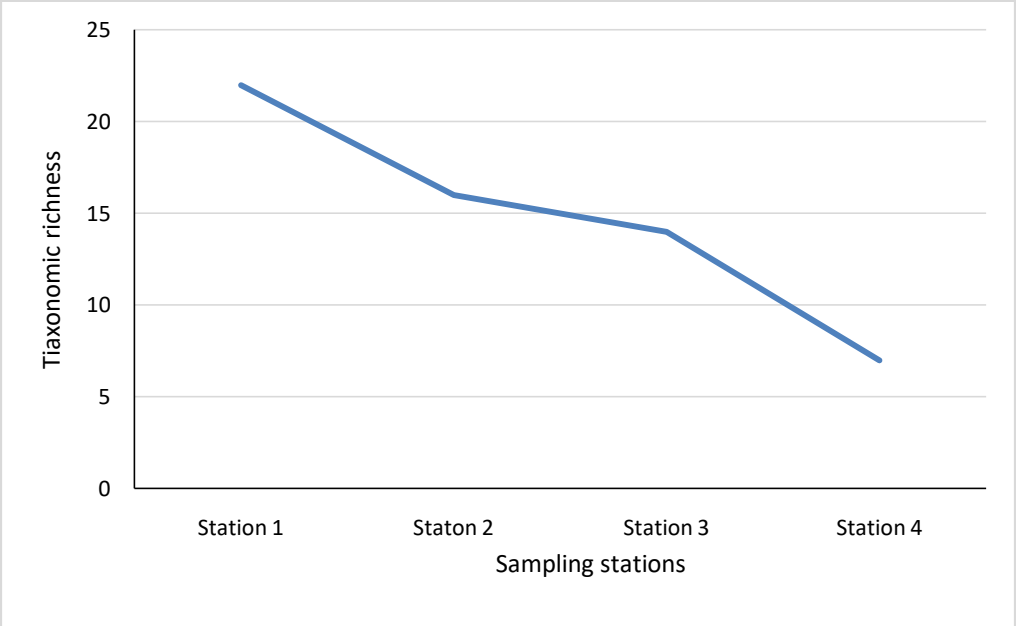

Figure 5:- Spatial evolution of taxonomic richness.

The stations (1 and 2) are characterized by the presence of a substrate dominated by pebbles and cobbles, in addition to the presence of aquatic vegetation and plant debris. Indeed, these stations constitute environments favorable to the installation of a rich and diversified fauna. Station 3, also contains an important number of taxa (14 taxa). At this point, the substrate is rocky and also contains sand. The vegetation at this station is dominated by duckweed and some plant debris, which provides an ideal habitat for benthic fauna. Station 4 presents a low diversity and counts 7 taxa and is poor in Coleoptera, Odonata and Molluscs. It is characterized by a sandy-silty substrate, which is probably related to the instability of the substrates, this same result was reported by Lavandier, P. (1979).

At the end of this first analysis, we can see that the distribution of benthic organisms is related to the nature of the substrate.

Conclusion:-

The present work represents a first contribution to the study of water quality of the Daya of Dar Bouazza. The results of physico-chemical analysis show that qualitatively, the waters of this river are characterized by a significant mineralization, as evidenced by the high values of electrical conductivity, chlorides and sulfates at all stations of the Daya. On the bacteriological level, all the stations of the Daya are contaminated by fecal contamination germs. This is due to the presence of livestock that can contaminate the water. The Daya is an important resting point for migratory birds, which contribute more to the pollution of the water by their droppings. The search for pathogenic germs of the Salmonella genus was negative during the study period.

The inventory of macroinvertebrate larvae includes 27 families and 35 taxa belonging to 3 faunal groups (Annelids, Molluscs, Arthropods). According to the results obtained, Coleoptera, Diptera, Hemiptera and Ephemeroptera are dominant. The other faunal groups constitute only a small fraction of the fauna collected. However, we note a total absence of the polluosensitive groups: the Plécoptères and the Trichoptères. This reveals the critical situation of the waters of the Daya, essentially due to the phenomenon of anthropization of the Daya.

The depletion of taxa due to the hydro-chemical characteristics and a strong mineralization of the water, leads to a reduction of the specific diversity in a benthic population. Indeed, the high conductivity values have led to the disappearance of the Plecoptera and Trichoptera, as well as certain species of Ephemeroptera, and thus an

impoverishment of the diversity of benthic communities. The dominance of pollutant resistant taxa, mainly Diptera. This result is linked to the high degree of organic pollution, which is favorable to the proliferation of these pollutant-resistant invertebrates.

The zooplanktonic fauna of the Daya is divided into two groups: Cladocerans, which are represented by three genera (Bosmina, Daphnia and Diaphanosoma) and Copepods, which are represented only by the Cyclops genus.

The exposure of the waters of the Daya to different sources of pollution contributes to the installation of unfavorable conditions for the presence of a very diverse population.

This work is in fact only a draft allowing us to obtain qualitative information on the Daya of Dar Bouaaza. However, the sampling period is not sufficient to make a complete dynamic study. It would be interesting to prospect in depth the different hydrographic networks and to initiate monthly follow-ups with a greater number of stations in order to establish the influence of environmental factors on the distribution of the fauna.

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