# Importance of Trophic Functions in the Distribution of Benthic Macroinvertebrates in Rivers: Case of Wadi El Harrach, Algeria

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**Abstract**

A combination of biotic and abiotic factors determines the distribution of benthic macroinvertebrates. Among the biotic factors, we studied 2016 2017 the role of different types of trophic functions on the micro-distributions of benthic macroinvertebrates along ten sampling stations in Wadi El Harrach (north-central Algeria). This was done to complete the information on the influence of the abiotic factors on their distribution as the different environmental parameters. We collected 8735 individuals, including 8587 insects, corresponding to 43 taxa. These insects are represented by: Ephemeroptera at 57.10%, Diptera at 27.54%, Trichoptera at 11.76%, while Heteroptera, Plecoptera, and Coleoptera are only represented with 4.07%. The results from the physicochemical analyses revealed a water quality degradation according to an upstream–downstream gradient between the different sampling stations. As for the mesological parameters analysis results, they allowed us to group these benthic macroinvertebrates according to their habitat preferences, essentially depending on substrate type, flow velocity, and vegetation. These metrics are related to each taxon. The benthic macrofauna is divided into four trophic groups: collectors with 86.71%, scrapers with 12.04%, and finally, predators and shredders with 0.67% and 0.57%, respectively. Though reduced, the shredders present mainly upstream have the role of shredders of coarse organic matter into delicate organic matter. The abundance of collectors downstream is the consequence of the action of the shredders, which was exercised further upstream. As for the scrapers and predators, they are more evenly distributed between the different habitats. These results showed that the distribution of benthic macrofauna on a more detailed scale is explained by trophic functions and their relation with substrate type. In addition, these different functional feeding groups combine with all environmental metrics of habitat, such as substrate, riparian and aquatic vegetation, current velocity, and water quality.

**Keywords**

Species distribution · Macroinvertebrates · Functional feeding · Environmental metrics · Substrate type · Wadi El Harrach

## 1 Introduction

The spatial distribution of some aquatic insects seems to respond to environmental parameters of significant influence, such as current, temperature, oxygen concentration, pH, substrate particle size, and food supply (Cummins & Lauff, 1969; Yalles-Satha et al., 2022).

The trophic function is one of the functional traits, representing a combination of physiological and compartmental traits. This function is essentialfor the growth and survival of living beings. The different functional feeding groups "FFG" of insects are distributed according to the characteristics of the environment (Chenchouni et al., 2015; Chafaa et al., 2019), in particular, the organic and inorganic substrate and the current velocity. Therefore, this study aims to analyze essentially the relationship of the FFG of aquatic insect communities with substrate type along the hydrographic network of Wadi El Harrach located in central northern Algeria.

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## 2 Materials and Methods

We selected ten sampling stations in the hydrographic network of Wadi El Harrach located in the center north of Algeria. Sampling monthly was carried out between March 2016 and February 2017. At each sampling station, we recorded physicochemical parameters using a multi-parameter analyzer type WTW340i in situ. We also estimated the substrate type and aquatic and riparian vegetation. On the other hand, the aquatic macroinvertebrates were collected using a Surber net and preserved in 5% formaldehyde. In the laboratory, the benthic macroinvertebrates were identified at the family and genus level using the keys of identification of Tachet et al. (2010). FFG of aquatic insects was based on Merritt and Cummins (1996).

## 3 Results

The total number of macroinvertebrates collected in this study is 8735 individuals. The insects represent 8587 individuals divided into 43 taxa.

A good physicochemical quality is described in sampling stations H1–H5. (Dissolved oxygen: 9.86 mg $L^{-1}$, Electrical Conductivity: 479 µS $cm^{-1}$). The aquatic vegetation is present in these sampling stations. As for the riparian vegetation, it is current and dense.

The sampling stations H6 and H7 have an average physicochemical quality (Dissolved oxygen: 6.74 and 5.12 mg $L^{-1}$, Electrical Conductivity: 1032 and 1328 µS $cm^{-1}$). In addition, these stations are characterized by the presence of aquatic vegetation and riparian vegetation that is less dense compared to previous sampling stations located upstream.

The last sampling stations located downstream H8–H10 are of poor physicochemical quality (Electrical Conductivity: 1952 µS $cm{-}^{1}$, Dissolved Oxygen: 1.28 mg $L^{-1}$). In addition, aquatic vegetation is absent, and riparian vegetation is shallow.

According to the functional feeding groups "FFG," 04 taxa were assigned to shredders, 04 to collector-filterers, 14 to collector-gatherers, 05 to scrapers, and 16 to predators. The distribution of FFG is based on three types of substrate: rock, gravel, and aquatic vegetation, which dominate between the upstream and downstream of Wadi El Harrach (Fig. 1).

## 4 Discussion

The Functional Feeding Groups distribution showed variation across habitats, especially a substrate type. The shredders are represented by 04 taxa and only 38 individuals

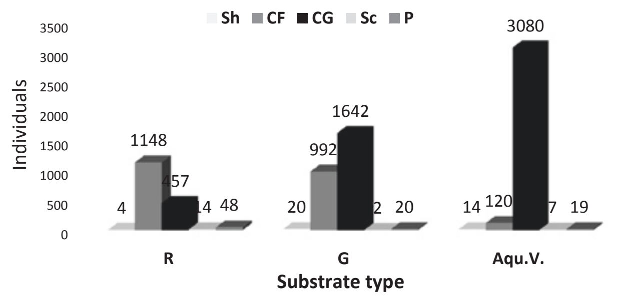


**Fig. 1** Functional feeding groups (FFG) were found for each substrate type. Legend: *Aqu.V* aquatic vegetation, *G* gravel, *R* rocks, *C.G.* collector-gatherers, *C.F.* collector-filterers, *Sc.* scrapers, *Sh.* shredders, *P* predators

and collected in gravel substrate and aquatic vegetation, essentially in H2, H3, and H4. According to Vannote et al. (1980), shredders are the predominant FFG upstream owing to their reliance on allochthonous resources falling from the riparian vegetation. The low presence of shredder is consistent with studies by Brasil et al. (2014) and Makaka et al. (2018). The scrapers represented by 05 taxa, mainly Heptageniidae, are collected essentially in rock substrate. According to Oliveira and Nessimian (2010), scrapers showed a higher relative proportion in rock substrates, where there are appropriate conditions for biofilm growth. This distribution of scrapers also corroborates with the study of Makaka et al. (2018). Collector-gatherers displayed a higher relative proportion in aquatic vegetation and gravel with 3080 and 1642 individuals of aquatic insects, respectively, and represented by 14 taxa. This functional feeding group was dominant in all sampling stations. This result corroborates those of Brasil et al. (2014). As for the collectors-filters were collected with four taxa in rock and gravel substrate and low collected in aquatic vegetation. According to Oliveira and Nessimian (2010), the collectors-filters were concentrated in rock and litter from the riffle.

The group of predators is composed of 16 taxa. It is represented essentially by Plecoptera, Odonata, Coleoptera, and Hemiptera but with only 87 individuals. The predators are the essential group in terms of taxonomic richness and are found in all types of substrate, essentially in rock. This presence in the variety of the different substrates is similar to that of Brasil et al. (2014). According to Vannote et al. (1980), the abundance of this group varies primarily in response to the availability of its prey.

The upstream is characterized by excellent physicochemical quality, heterogeneity of substrate, installation of aquatic vegetation (algae) on the rock substrate, and dense riparian vegetation. These characteristics participate in the structure of shredders. Shredders should dominate the upstream, given the abundant allochthnous resources from the overhanging riparian vegetation (Brasil et al., 2014).

The water quality deteriorates in midstream and downstream; the gravel substrate dominates; aquatic vegetation is absent, while riparian vegetation is low. The abundance of collectors downstream is the consequence of the action of the shredders, which was exercised further upstream. Shredders and collector-gatherers should thus co-dominate the headwaters, with the former giving way to the latter in midstream and downstream stream reaches as delicate particulate organic matter dominates the food resource (Vannote et al., 1980). As for the scrapers and predators, they are more evenly distributed between the different habitats. In this context, we show the importance of substrate type in the distribution of mesohabitat between upstream and downstream of Wadi El Harrach and subsequently in the installation of the different FFG. According to Oliveira and Nessimian (2010), the abundance and relative proportion of the FFG showed variation across habitats.

## 5 Conclusion

The different FFGs combine with all environmental metrics of habitat, such as substrate, aquatic and riparian vegetation, current velocity, and water quality. Our study suggests that substrate type influences the trophic structure of macroinvertebrate communities in Wadi El Harrach. Nevertheless, substrate appears as an essential factor affecting the FFG structure of macroinvertebrate communities. We state that the use of substrate type is insufficient to predict the FFG structure accurately and that the influence of other environmental factors, such as longitudinal distribution related to altitude, temperature, and hence to riparian vegetation changes and leaf litter decomposition, should be accounted for and detailed in others studies.

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