

Contribution to the knowledge of ecotones: impact of riverbank pollution on riparian communities in temporary environments in Eastern Morocco.

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Abstract. Riparian communities are made up of species that colonise the wet banks of different aquatic environments (ocean, river, torrent, water body, dayas) whatever their size and as long as they are being impounded. These are species that are highly dependent on their biotope, with very strict ecological and ethological requirements, and are vulnerable to any change or disturbance of the environment. Thus, depending on the type of contaminant, pollution can have different effects on this fauna: a lethal, repulsive, or attractive effect. The aim is to study the effect of pollution on the riparian community. We compare between the beetles fauna of banks of two hill dam reservoirs, one polluted and the other unpolluted. The study highlighted the attractive effect of pollution by domestic waste, particularly plastic bags, and other solid debris. Indeed, the latter, having the same physical characteristics (weight, size, thickness, etc.) as stones, leaves, and other microhabitats found in nature, have had the effect of attracting riparian species through the shelter, humidity, and shade they offer. **Keywords:** ecotone, temporary environments, riparian community, pollution, hill dams.

1 Introduction

The riparian species that colonise the wet banks of aquatic environments in general and temporary environments, in particular, are populated by a wide variety of species with unique physiological and ethological characteristics [1,2]. They are highly mobile species, capable of leaving the area as soon as conditions become unfavorable. They are capable of recolonising other areas very quickly [2]. Moreover, these species are very dependent on their biotope because they have very strict ecological and ethological requirements, which makes them very vulnerable. Spatio-temporal location of riparian communities is mainly determined by temperature, substrate humidity and seasonal variations [3]. Indeed, any change in physico-chemical or biological conditions can profoundly affect the structure of these populations. Thus, pollution can have very antagonistic effects on this fauna. It can have a lethal effect in the case of contamination by toxic products [4], a repulsive effect in the case of shoreline reworking [5], or an attractive effect in the case of household waste [4,6]. The objective of this study is to highlight the effect of pollution by domestic waste

such as plastic bags and solid debris on these particular communities.

2 Material and Methods

The Sidi Yahya hill dams (BCSYI & BCSYII) are located 2 km south-east of the city of Oujda (Eastern Morocco) (Figure 1). They are mainly intended to retain runoff water and water livestock. They have the same geographical location (34°39'N - 01°52'W) and similar physico-chemical characteristics. The water is fresh and has a neutral pH and the banks are of a clayey-silt nature with a neutral pH. The period of impoundment depends on rainfall, averaging 4 to 6 months (BCSYI) but can reach 8 months (BCSYII) in years of heavy rainfall. The banks of Sidi Yahya I hill dam (BCSYI) are not polluted, whereas those of the Sidi Yahya II dam (BCSYII) are polluted by all sorts of solid domestic waste, particularly plastic bags from a nearby urban dump. Monthly surveys were carried out from the time the water bodies were impounded until they dried up. The work was spread over three campaigns at the BCSYI (November 1993-March 1994; March-May 1998; January-May 1999) and two campaigns at the BCSYII (March-July 1998; December 1998-July 1999), a total of 13 months for

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each dam. The fauna sampling consisted of collecting all the fauna encountered on the banks during 1 hour

of active research [7] by direct visual hunting under stones, plant leashes, plastic bags, wood debris, etc.

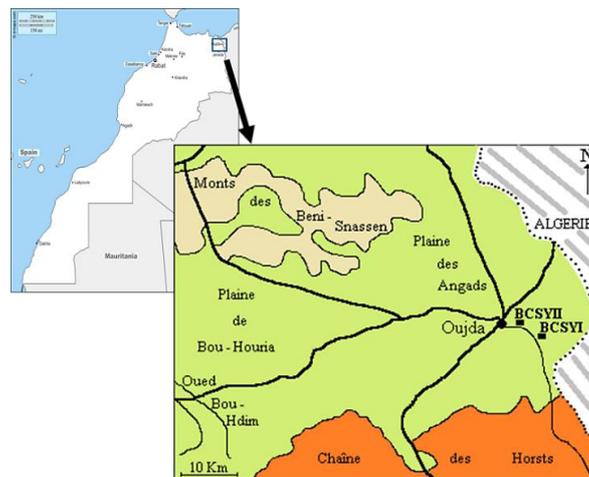


Fig.1. Geographical location of the surveyed stations.

In order to study the settlement structure of the banks of both dams, we used several parameters:

Shannon & Weaver's diversity index (H), which reflects the way in which individuals are distributed between different species [8].

$$H = 3.322 (\log Q - 1/Q \sum q_i \cdot \log q_i)$$

Q: total number of individuals in the sample.

qi: number of individuals of species i.

Theoretical diversity (Hmax), which gives an idea of the maximum diversity that can be found in an environment in which the species are equally distributed.

$$H_{max} = \log_2 S \text{ (in Bits)}$$

S: number of species in the sample.

Equitability (Eq.), which allows comparison of several stations with different richness.

$$Eq = H/H_{max} \text{ (in \%)}$$

The coefficient of stability (Cs), which makes it possible to evaluate the stability of the communities [9]. A low value of the coefficient indicates that there are minimal variations and that the factor studied is stable.

$$C_s = S | x_{it} - x_{it+1} | / N$$

xi_t: rank of species i at time t.

xi_{t+1}: rank of species i at time t+1.

N: total number of measurements.

3 Results

The population of the banks of BCSYI comprises 385 individuals divided between 61 taxa, 29 of

which are riparian and 32 terrestrial (Table 1). The terrestrial species are the most numerous, but the riparian species dominate in terms of numbers with 230 individuals (Figure 2 & 3).

The Caraboidea are the best represented group with 30 taxa and 196 individuals followed by the Staphylinidae with 9 taxa and 119 individuals (table 1).

Table 1. Richness and abundance of the banks of the Sidi Yahya dams (BCSYI and BCSYII)

	Wealth		Abundance	
	BCSYI	BCSYII	BCSYI	BCSYII
Carabidae	30	19	196	956
Staphylinidae	9	12	119	244
Scarabaeidae	7	3	43	38
Curculionidae	5	2	8	2
Tenebrionidae	5	4	11	4
Chrysomelidae	4	0	7	0
Elateridae	1	1	1	1
Anthicidae	0	1	0	2
Dytiscidae	0	1	0	1
Hydrophilidae	0	3	0	3
Corixidae	0	1	0	1
Naucoridae	0	1	0	4
Total	61	48	385	1256

On the other hand, the BCSYII population has a relatively low richness compared to the BCSYI, only 48 species were collected (Table 1, Figure 2) but the abundance is much higher with 1256 individuals (Table 1).

It is the most populated station in eastern Morocco with an average abundance of 85 individuals per sample [10]. Riparian taxa dominate both in terms of richness (26 taxa) and abundance (1169 individuals) (Figure 2 & 3).

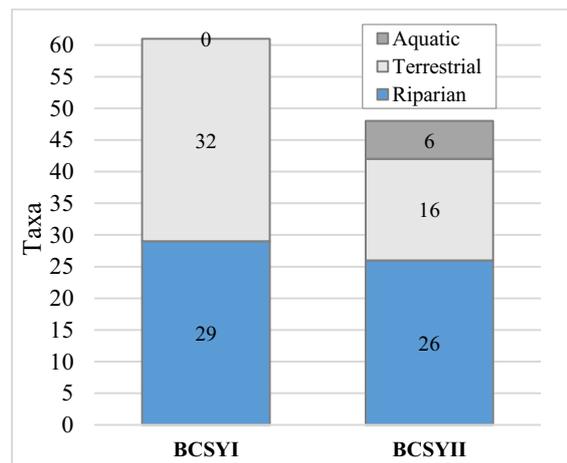


Fig. 2. Richness of taxa collected on the banks of the BCSYI and BCSYII hill dams according to ecological type (riparian, terrestrial, aquatic)

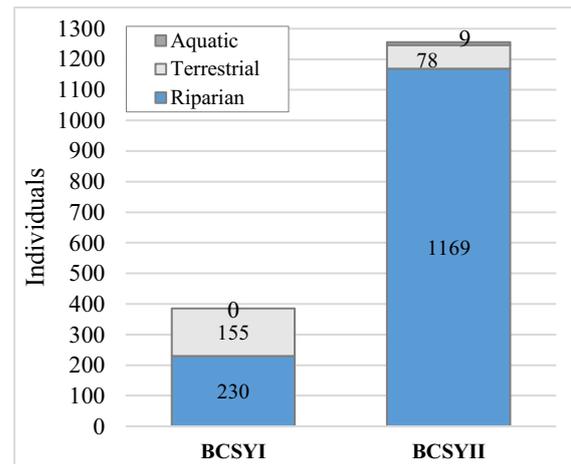


Fig. 3. Abundance of taxa collected on the banks of the BCSYI and BCSYII hill dams by ecological type (riparian, terrestrial, aquatic).

The most important systematic groups in abundance and richness are the Carabidea with 19 species and 956 individuals and the Staphylinidae with 12 species and 244 individuals. Species of riparian origin are either accidental or incidental. For the BCSYII dam, on the other hand, the majority of constant, accessory, and accidental species are riparian, and it is the species of terrestrial origin that are sporadics (Table 2).

Table 2. The proportion of constant, incidental, accidental, and sporadic species in BCSYI and BCSYII stations and the predominant ecological type (Ecol.) for each species category (T: terrestrial and R: riparian).

	Constant (F ^a >50%)		Accessories (50%>F ^a >25%)		Accidental (25%>F ^a >10%)		Sporadic (F ^a >10%)	
	%	ecol.	%	ecol.	%	ecol.	%	ecol.
BCSYI	1,5%	T	9,5%	R	28%	R	61%	T
BCSYII	9,3%	R	9,3%	R	20,9%	R	60,5%	T

^a F = number of samples where the species is present out of the total number of samples in %.

In addition, on this same dam, we note the presence of four species with a high number of individuals, which together account for 954 individuals, nearly 76% of the total population.

These are the carabid beetles *Bembidion maculatum* (421 individuals), *Bembidion varium* (293 individuals), *Bembidion hummleri hummleri* (127 individuals) and the staphyline *Platystethus cornutus* (113 individuals), all of them riparian.

This results in a low value of equitability (52.6%) indicating an unbalanced and poorly diversified population (2.9 bits) compared with the population of the BCSYI dam, which is better balanced

(equitability: 76.8%) and more diversified (4.6 bits) (Table 3).

Table 3. Diversity H, Maximum Diversity Hmax, Equitability Eq and Coefficient of Stability Cs.

	H (bits)	Hmax (bits)	Eq (%)	Cs
BCSYI	4,6	6,0	76,8%	1,6
BCSYII	2,9	5,4	52,6%	0,98

Nevertheless, the BCSYII dam population has a stability coefficient Cs = 0.98, which indicates a more stable population than the BCSYI dam. Thus, the latter has species with abundances that vary from one sample to another, unlike the former.

4 Discussion

Solid domestic waste has the same physical characteristics (weight, size, thickness, etc.) as some microhabitats found in nature. Indeed, plastic bags are comparable to leaves and various other debris are comparable to stones [6]. They attract riparian species by providing shelter, moisture, and shade. The presence of this type of pollutant on the banks of a hill dam (BCSYII) causes a change in composition and structure of its fauna compared to a close station with the same physico-chemical characteristics (BCSYI) but without waste. Thus, we encountered more species of riparian origin and aquatic species on the polluted banks. This contingent of species is present regularly on these banks with abundances varying very little from one sample to another. This indicates a more stable population compared to that on the banks of the BCSYI dam (unpolluted), which remains more diversified and more balanced.

5 Conclusion

The presence of household waste on the banks of water bodies causes a quantitative and qualitative change in the fauna. The banks become more attractive to species with strict moisture requirements, such as riparian and aquatic species, due to the presence of more shelters and especially wetlands favoured by plastic bags. Therefore, they have a repellent effect on species of terrestrial origin. The fauna is less rich and diversified but very abundant. The population is unbalanced, with only a few species, all of which are riparian, dominating the population in terms of abundance. On the other hand, the abundance remains constant from one sample to the next, which gives this population a certain stability.

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