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Araştırma

IMPACT OF SOIL QUALITY ON THE DISTRIBUTION OF TERRESTRIAL ISOPODS IN SOME TUNISIAN WETLANDS

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Abstract: No studies in Tunisia have focusing on an analysis of oniscidean diversity in wetlands. To improve our knowledge on the species occupying this type of habitat, field work was conducted during spring 2008 in 18 wetlands (3 dams, 4 hill reservoirs, 7 lagoons, 2 sebkhas and 2 rivers) located in the north of the Tunisian dorsal. Isopods were collected by hand each time with respect to the same sampling effort. At the laboratory, Isopods are identified, counted and sexed. Physico-chemical analyses were performed from soil sampled in each site. The results reveal the presence of 19 terrestrial isopods species belonging to 10 families. *Chaetophiloscia cellaria* and *Porcellio laevis* are the most abundant species; their relative abundance is respectively equal to 29.5 and 23.4 %. The species richness varied from 8 in both lagoons of Ghar El Meleh and Bizerte to 1 in some hill reservoirs. *Chaetophiloscia cellaria, Leptotrichus panzeri, Porcellio variabilis* and *Porcellio laevis* tolerate changes in salinity up to 35.4 g/kg, whereas others, such as *Armadillidium sulcatum* and *Armadillo officinalis*, were collected in stations where soil salinity does not exceed 8.5 g/kg. Among environmental factors, this study shows the effect of soil salinity on the distribution of terrestrial isopods. Other factors, such as relative humidity, conductivity and calcium content of the soil, will be discussed in order to define the preferendum of each species.
Key Words: Distribution, Terrestrial isopod, Wetland, Soil salinity, pH value

1. INTRODUCTION

Wetlands are of a great importance in conservation biology. In this particular environment, considered among the most biologically diverse and productive ecosystems, human activities (urban growth, driveways, pollution…) induce wetland degradation and the loss of biodiversity. Recently, different authors proposed new methods, based on soil microarthropods, in order to evaluate the environmental quality. Indeed, many factors (salinity, humidity, temperature) influence the species diversity and the number of terrestrial isopods. For example, Van Straalen and Verhoef (1997) developed a soil pH indicator system based on soil pH preferences of collembolans, mites and woodlice.

In Tunisia, several publications on terrestrial isopods have been available in the last decades. These studies were performed on the systematic, biogeography and the reproduction of many species such as *Porcellio variabilis* (Medini et al. 2000), *Porcellio lamellatus* (Khemaissia & Nasri-Ammar, 2008, 2010), *Porcellionides pruinosus* (Achouri & Charfi-Cheikhrouha, 2001, 2005, Achouri et al. 2003), *Porcellionides sexfasciatus* (Achouri & Charfi-Cheikhrouha, 2001, 2002, 2005) , *Hemilepistus reaumuri* (Kacem & Rezig, 1995; Nasri et al. 1996) , *Armadillidium pelagicum* (Hamaied et al. 2004 ; Hamaied & Charfi-Cheikhrouha, 2004). However, the terrestrial isopod communities inhabiting the Tunisian wetlands have not received any attention. The main aim of this study is to improve our knowledge on the species occupying this type of habitat and to collect specimens from as many habitats as possible, taking in account the impact of soil quality on their distribution.

2. MATERIAL AND METHODS

2.1. Sampling Method

Field work was done in spring 2008 which is the main activity season of isopods in Tunisia. Terrestrial isopods were collected by hand each time with respect to the same sampling effort. During collecting, the vegetation present, the humidity and the air temperature were also noted for further evaluations. At the laboratory, Isopods were identified with the help of the works from Vandel (1960, 1962), Medini-Bouaziz, (2002) and Hamaied, (2008) then counted and sexed. Physico-chemical analyses were performed from soil sampled in each site.

2.2. Sampling Sites

Eighteen wetlands located in the north of the Tunisia were studied: (3 dams, 4 hill reservoirs, 7 lagoons, 2 sebkhas and 2 rivers) (Table 1).

2.3Data Analysis

Different indices estimating the diversity in the studied biotopes were used:

- The abundance of individual species A corresponding to the total number of individuals gathered in a particular biotope.
- Diversity was measured using the Shannon- Weiner index H' and the Pielou's evenness index (J') was estimated to analyze the evenness of the community

$$H' = - \sum ((Ni/N)*Log2 (Ni/N)) \quad (1)$$

$$J' = H'/\log_2 S \quad (2)$$

Where S = the total number of species in the sample; Ni = individual number of species (i); N = total individual number of populating.

3. RESULTS AND DISCUSSION

During the sampling we collected 1232 terrestrial isopods. We identify 19 species belonging to 10 families. The lagoons were the richest in isopod specimens (64.8 % out of the total isopods found in 7 sites), whereas the lowest diversity values

were observed for hill reservoirs (5.9 %). The dams, the sebkhas and the rivers contained nearly the similar number of isopods specimens.

Most of terrestrial isopods were *Chaetophiloscia cellaria* (relative abundance is equal to 29.5 %), *Porcellio laevis* (23,5 %) and *Porcellio variabilis* (11,1 %). These three species have the highest regional distribution value; *Chaetophiloscia cellaria* came up in 9 (50 %), *Porcellio laevis* in 8 (44.5 %) and *Porcellio variabilis* in 11 (61.1 %) of the 18 wetlands sites. However, the remaining species were found occasionally in a few sites (Table 2).

Clear differences were seen between study sites both for species diversity and the number of specimens (Figure 1):

- In the lagoons, 16 species were sampled; among them 2 species were relatively more abundant: *Chaetophiloscia cellaria* (relative abundance is equal to 36.2 %) and *Porcellio laevis* (31.9 %).
- In the hill reservoirs, only 4 species were collected, among them *Armadillidium pelagicum* was the most abundant (65.8 %).
- In the dams, 6 species were found among them, 3 species were abundant: *Armadillidium pelagicum* (27.9 %), *Armadillidium sulcatum* (21.7 %) and *Porcellio variabilis* (27.1 %).
- In the sebkhas, 9 species were sampled among them *Porcellio laevis* (19.6 %), *Ligia italica* (23.4 %) and *Armadillidium granulatum* (21.5 %) were the most abundant.
- In the rivers studied, 6 species were collected among them two species were abundant: *Chaetophiloscia cellaria* (55.4 %) and *Porcellio variabilis* (37.1 %).

Distribution analysis in the different studied biotopes showed that P*orcellio variabilis* was collected whatever the type of the wetland. However, other species such as, *Armadillidium granulatum* and *Armadillidium tunisiense* occurred only in the sebkhas. Shannon indices calculated ranged between 2.79 to 1.4. The highest diversity was in the sebkhas, followed by lagoons (2.54) and dams (2.25). Pielou's evenness index (J') varied from 0.69 (in hill reservoirs) to 2.24 (in lagoons) (Table 3).

Community similarity estimated by the Bray-Curtis index (based on species composition) revealed that the highest similarity was found between the dams and the hill reservoirs (74.8 %) which are two closed biotopes. The value of Bray-Curtis index is the lowest between hill reservoirs and lagoons then between hill reservoirs and sebkhas (13.8 and 13.9 % respectively) (Figure 2).

Table 1. List of sampling sites

Type of wetlands	Station	Code	Altitude-latitude
Dam	El Fartout	D. Fart	N 37°10'03.1" E010°09'57.7"
	Lebna	D. Leb	N 36°44'26.8" E010°55'27.9"
	Oued El Hajar	D. O El H	N 36°51'08.4" E011°01'01.6"
River	Lebna	R. Leb	N 36°39'13.8" E010°54'31.3"
	Tinja (Korsi)	R. Tj	N 37°11'12.5" E009°46'52.3"
Lagoon	Ghar El Meleh S1	Lg. GEM 1	N 37°10'03.1" E010°09'57.7"
	Ghar El Meleh S2	Lg. GEM 2	N 37°10'04.7" E010°11'40"
	Ghar El Meleh S3	Lg. GEM 3	N 37°10'09.4" E010°13'12.6"
	Sidi Ali Makki	Lg. SAM	N 37°09'50.7" E010°14'45.1"
	Korba	Lg. Kor	N 36°38'12.9" E010°54'11.9"
	Tazarka	Lg. Taz	N 36°32'20.3" E010°50'38.7"
	Bizerte	Lg. Biz	N 37°13'8" E009°55'1"
Sebkha	El Wafi	S. El W	N 37°10'12.6" E010°12'6"
	El Kalbia	S. El Kal	N 35°54'25.2" E010°17'08.6"
Hill reservoir	El Morra	Hr. Mor	N 37°05'53.4" E009°59'08.8"
	El Basbassia	Hr. Bas	N 37°04'07.1" E009°55'19.1"
	El Akkari	Hr. El Ak	N 37°04'15.1" E009°55'47.1"
	El Hanaya	Hr. El Han	N 37°04'11.1" E009°55'34.1"

Table 2. Frequency of occurrence of the species

The species	Frequency of occurrence
Porcellio variabilis	11
Chaetophiloscia cellaria	9
Porcelio laevis	8
Armadillidium pelagicum	6
Chaetophiloscia elongata	4
Porcellionides pruinosus	4
Leptotrichus panzeri	3
Armadillidium vulgare	3
Armadillo officinalis	3
Armadillidium sulcatum	3
Porcellionides sexfasciatus	2
Tylos europaeus	2
Ligia italica	2
Chaetophiloscia sicula	2
Porcellio lamellatus	2
Armadillidium tunisiense	1
Armadillidium granulatum	1
Armadilloniscus littoralis	1
Halophiloscia sp.	1

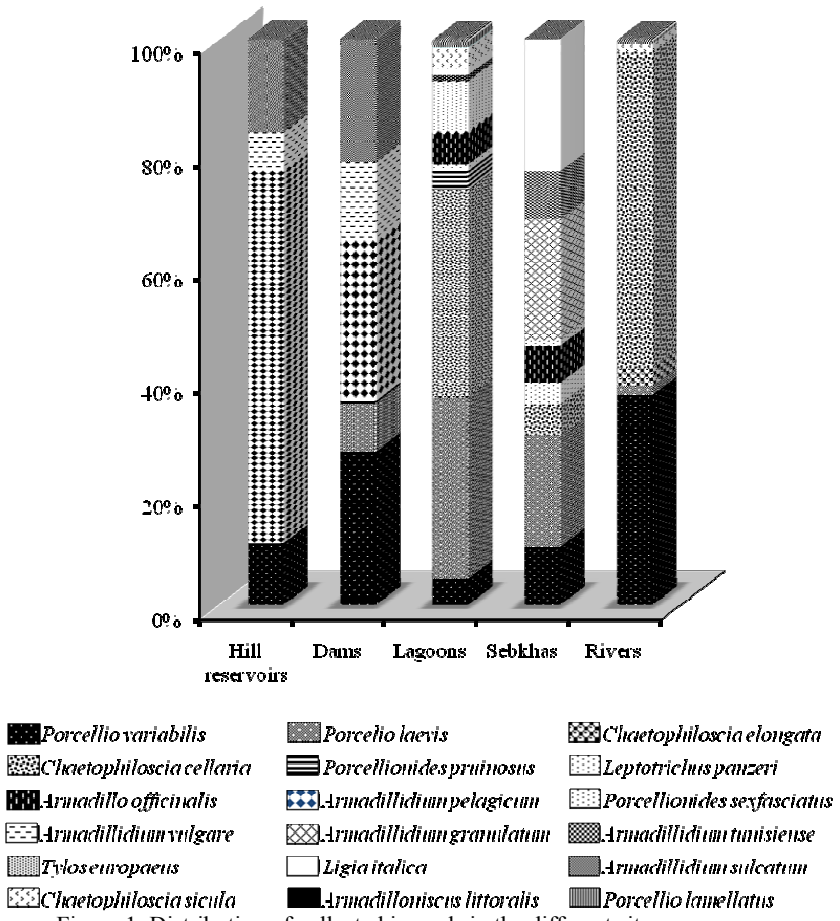

Figure 1. Distribution of collected isopods in the different sites

Table 3. Species diversity in the studied biotopes; H', Shannon Wiener index ; J', Pieloud eveness index

	Number of specimens collected	H'	J'
Lagoons	799	2.54	2.24
Dams	129	2.25	1.02
Rivers	124	1.4	1.03
Sebkhas	107	2.79	1.71
Hill reservoirs	73	1.44	0.69
Total	1232		

Terrestrial isopods were collected in soil having salinity between 0.9 and 35.4 g/kg. The maximum species richness (8 species) was observed for both stations; Lg. Biz and Lg. GEM2 with salinity respectively equal to 34 and 7.8 g / kg. The distribution of terrestrial isopods on the basis of increased salinity of the soil showed that the degree of tolerance varied among species. Indeed, individuals of *Chaetophiloscia cellaria* and *Porcellio laevis* had a wide tolerance up to 35.4g / kg. Other species, such as, *Armadillidium granulatum* and *Armadillo officinalis* were found at stations with low salinity which did not exceed 8.5 g / kg. Concerning the species *Armadillidium tunisiense* its distribution was limited to stations with lower salinity equal to 0.9g / kg (Fig. 3).

According to our field data, it seems that *Chaetophiloscia cellaria* and *Porcellio laevis* tolerate a soil acidity that ranges from 8.02 to 9.43 (Figure 4).

Based on the present study, isopods are not evenly distributed among the various wetlands; they varied in number of species as well as in number of individuals. It has been shown that lagoons are the most diverse habitat. In fact, comparing with other studies done on isopod diversity in lagoons, we show that our sites are even diverse (eight species in Lg. Biz and Lg. GEM2) than others lagoons in the world. It's the case of the Ria Farmosa lagoon where only four species coexist (Dias et al. 2005). The low number of species observed in hill reservoirs, in rivers and in dams could be explained by the human activity, especially the agricultural practices or by the fact that they represent a closed area. For exemple, in carabids, it has been shown that species diversity is higher in the open ecosystems than in forest areas (Bedford & Usher, 1994). *Chaetophiloscia cellaria*, a species with a wide Mediterranean distribution (Vilisics & Lapange, 2005) and *Porcellio laevis*, a widespread species in Tunisia (Medini-Bou Aziz, 2002), are the most abundant species. From these data, it was apparent that the difference in the distribution of isopods depended on the nature of the habitat which is influenced by the soil quality. Van Straalen & Verhoef (1997) showed that arthropods (Collembola, Oribatida and isopods) have the tendencies to settle in a gradient of soil pH from 2 to 9. According to our field data, *Chaetophiloscia cellaria*, *Armadillidium vulgare*, *Armadillidium pelagicum*, *Porcellio variabilis* and *Porcellio laevis* tolerate a large variation of soil pH.

4. CONCLUSION

This preliminary study shows that species richness and isopod communities' structure is very important in wetlands. In these areas, changes of environmental factors such as salinity or pH value have an effect on the distribution of terrestrial isopods. These arthropods are used as bio-indicators and can detect any changes affecting the ecological quality of the environments. Other parameters such as levels of soil calcium, potassium and magnesium are now measured in order to assess the preferendum of each species collected.

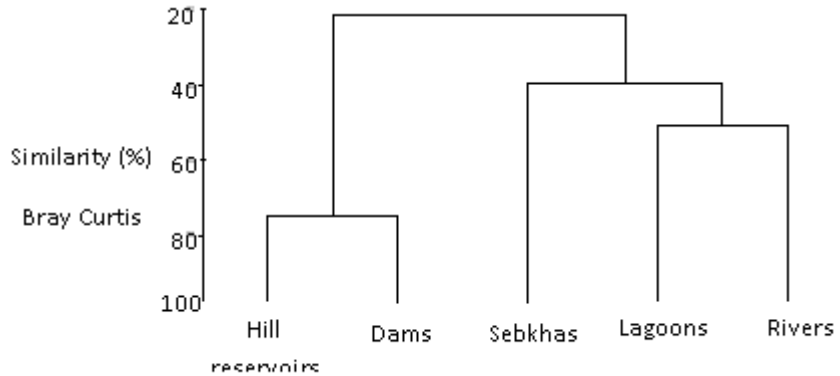

Figure 2. Clustering of sampling sites based on species diversity

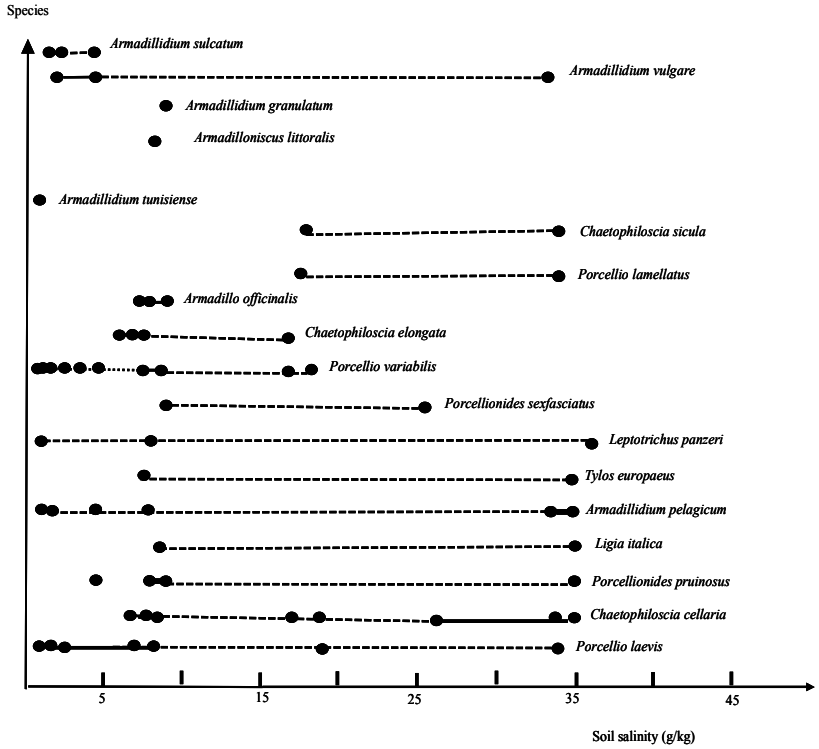

Figure 3. Tolerance of Terrestrial Isopods to changes in soil salinity

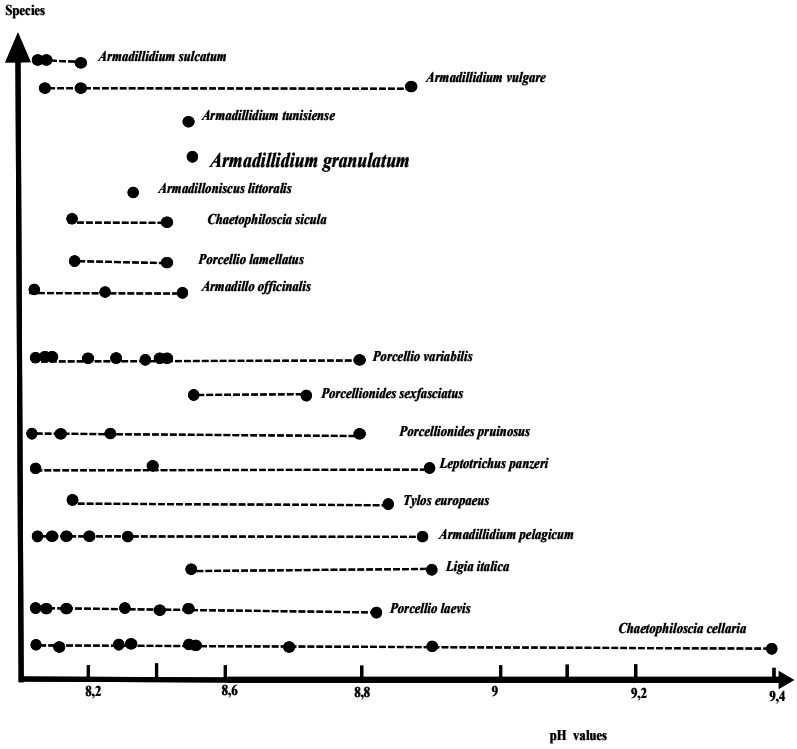

Figure 4. Tolerance of Terrestrial Isopods to changes in soil pH

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