The rotifer communities seasonality from Sfântu Gheorghe branch (Danube Delta)

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Abstract. Many studies pointed out that the rotifers species richness and abundance from river systems was higher than other zooplankton groups, despite unfavourable conditions. In our study we follow the seasonally rotifer communities dynamics in different types of areas of Sfântu Gheorghe branch (Danube Delta, Romania). The results showed both spatial and temporal variation of the species composition and abundance. Typically, the complex structure of river zooplankton is due to the migration of non-indigenous species from the stagnant waters of permanent or temporary floodplain. In our case, 37 out of 83 total species were assessed as accidental in the rotifer community. The seasonal abundance ranged between 0.02-31.84 ind L^{-1}. The dominant rotifer species belonged to the *Keratella, Synchaeta, Asplanchna* and *Brachionus* genus. The other species contribute with small values to the abundance. The K dominance curves emphasis a seasonal resemblance of the diversity and abundance of the three areas, depending on the season. The MDS analysis and Bray Curtis similarity confirmed a high seasonally resemblance of the rotifers of the tree areas of the branch. Also the MDS analysis revealed from upstream to the downstream differences of branch in terms of the rotifers abundance.
Key Words: abundances, composition, diversity, lotic systems.

Introduction. Although the rotifers can be found in almost any aquatic ecosystem, the habitat features are important. Therefore, the rotifer populations differ significantly between lotic and lentic ecosystems, even from one area to another of the same ecosystem (Wallace & Snell 2010). The stream zooplankton is difficult to study because of the dynamics that characterize these ecosystems both, in the physical-chemical parameters and biota (Wahl et al 2008; Reckendorfer et al 1999). Also, the delimitation of the boundaries of such system has some peculiarities raising questions if is one or a complex of ecosystems.

Danube is one of the most important rivers of Europe and the subject of many studies (Baranyi et al 2002; Reckendorfer et al 1999; Vadadi-Fulop et al 2009). Nevertheless, the ecology of the river branches is little known. At the mouth to the Black Sea, the Danube splits in three branches (Chilia, Sulina and Sfântu Gheorghe) forming the Danube Delta (Biosphere Reserve). The branches of Danube, present some hydro-geomorphological differences comparing with the other areas of Danube, especially hereby of the meanders. These meanders have slower water flow and sedimentation processes more intense than in other areas, that favour the development of planktonic communities (Strechie Sliwinski et al 2008; Popa 1997).

The entire length of its course the Danube was undergone, in different periods of time, to many human impacts, especially by hydro-technical works. In the arms the most significant activities along the Danube branches were the cut off of meanders and canals construction in order to facilitate the navigation (Giosan et al 1997; Romanescu 2013; Baranyi et al 2002).

The temporal taxonomical composition and abundance of the rotifer communities assessment is important to understand the undergoing ecological processes (Zedler & Kercher 2005).

The objectives of the present paper were to assess the species composition and abundance of the rotifer communities in different areas of the Sfântu Gheorghe branch and to analyse the seasonal variation.

Materials and Methods. The Sfântu Gheorghe branch starts from Sfântu Gheorghe Ceatal (Danube River) at 108.8 Km, with a looped stream (with 10 meanders) kept in natural form until 1984 (Panin 2009). Natural riverbed has length of about 108 km, widths of 150-550 m and 3-27 m thalweg depths below local low-water line. During the 1980s, the branch as the other two Danube branches, were undergone course modifications, for navigation facilitating. One of the important activities was cutting off

the major meanders and creating canals with 7-8 m depth and 75-100 m width. As a result of these changes, the route was shortened by 32 kilometres (Popa 1997) and new hydrological processes appeared. Watercourse flow modifications on the Danube arms affected the distribution of water and sediments among them. Nowadays, Sfântu Gheorghe branch presents three types of areas: natural sectors, sectioned meanders and canals.

The study was conducted between 2008 and 2010 in different sections of Sfântu Gheorghe branch with seasonal sampling (spring, summer and autumn). Seven sampling points were established over the water course, in natural sectors (stations 1, 4 and 7), in meanders (stations 2 and 5) and in canals (stations 3 and 6) (Figure 1). The sampling points were positioned in order to reflect the heterogeneity of the river branch, with medial and littoral sampling points, resulting in a total of 126 samples.

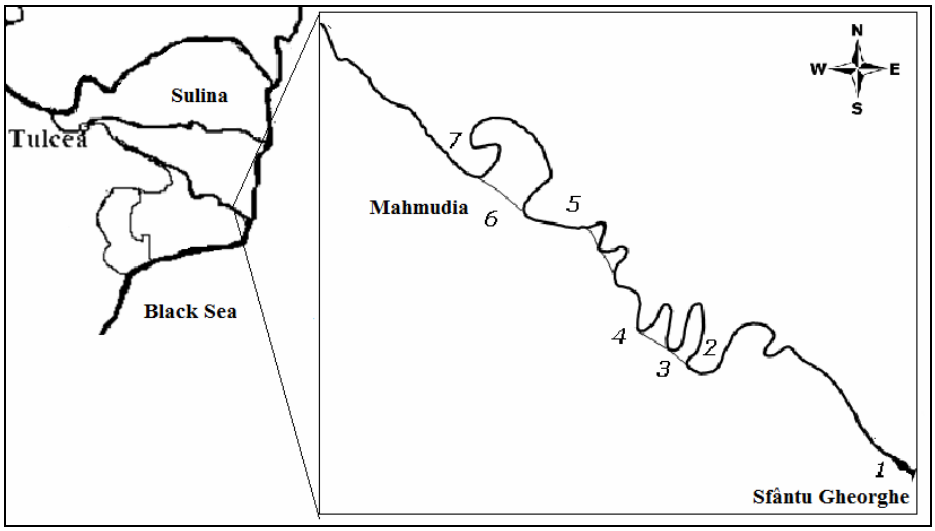

Figure 1. Sfântu Gheorghe branch with the sampling points.

The zooplankton samples were taken seasonally (at spring, summer and autumn), on water column with a Patalas Schindler plankton trap. Fifty (50) L were filtered through plankton net mesh with 65 µm Ø and preserved in 4% formaldehyde. Species identification was made using a Zeiss inverted microscope and some references (Rudescu 1960; Voight 1956). Simultaneously with the taxonomic identification the counting of individuals was done. The density was calculated by multiplying the obtained values with a resulted coefficient by the amount of filtered litters and the volume of the sample and subsample. The density was expressed in number of individuals per litter (ind L^{-1}).

For statistical data processing Biodiversity Pro (McAleece et al 1997) and XLSTAT software were used.

In order to obtain a graphical representation of the diversity differences among seasons and areas, based on species abundance, K-dominance analysis was used (Warwick et al 1990; Warwick & Clarke 1991; Warwick 1986; Warwick et al 1987).

The relative similarity among the areas and seasons was assessed by Bray-Curtis dendrogram. The method stems from the fact that there is no limit in a predetermined number clusters and trees can vary in size depending on the complexity of the variables (Legendre & Legendre 1998).

For getting an overview of the abundance distribution in the three types of areas and seasons, multidimensional scaling (MDS) analysis was used. MDS ordination creates a graph, based on a similarity or distance matrix which highlights important issues that cannot be observed (Harris et al 2000).

Results and Discussions. In the study period, 83 rotifers species were recorded which showed seasonal and spatial variations. The meanders (63 species) and natural sectors (55 species) represented the favorable areas for rotifers development comparable with canals (45 species).

In natural sectors, most species were found during the spring (30 species) and summer (34 species), while in autumn the number of species decreases by 30%.

In meanders, the seasonal species richness was higher than in all three periods in natural sectors. In the three-years of study species richness indicates 30 species in spring and their number increase to 36 species in summer. In autumn the meanders differ than other two types of ecosystems, presenting a large number of species (31 species). The seasonal dynamics analysis emphasis that few species are typical to autumn, most of them were found in the summer and, due to the favorable conditions were maintained in autumn.

The canals presented a lower number of species in all the three seasons, comparing with natural areas of the branch. Twenty four (24) species were identified in spring, 25 species in summer and 21 in autumn.

The rotifers spatial and temporal variability can be considered the response mechanisms to environment changes (Marcus 2004). In many studies in Danube or other large rivers, the rotifer communities were mentioned as dominant zooplankton group in terms of species richness and abundance. Generally, the rotifers abundance in Sfântu Gheorghe branch was modest (monthly average 87 indv. L^{-1}, during 1981-1992) comparing with close hydrological network of Danube Delta (141 indv.L^{-1}, during 1989-2004) (Zinevici & Parpală 2007).

During our studies, the highest abundances were reached in summer, 31.84 indv. L^{-1} (in canals) and 31.79 indv. L^{-1} (in natural sectors), while the fall represented a strong decrease period (0.02 indv. L^{-1} in canals).

Due to the short generation time and high reproduction rate, rotifers can reach high densities than microcrustaceans (Pourriot et al 1982; Reckendorfer et al 1999; Schöll & Kiss 2008; Winner 1975). However, their number depends on several key environmental factors.

The zooplankton development is advantaged by the areas with following hydrological features: low flow rates ≤ 0.4 m^{-1}, decreased residence time, low turbidity (Basu & Pick 1997; Wahl et al 2008; Pollard et al 1998). In Sfântu Gheorghe branch, these conditions are especially characteristic to the meanders and to lesser extent the natural sectors. The River Danube course (2857 km) is divided into three sub-regions: the upper basin, the middle basin and the lower basin (including the Danube Delta). The Danube water flow velocity gradually decreases from upper basin (2.2- 2.5 m sec^{-1}), to around half values in the middle section and between 0.98 and 0.78 m in the last one (www.icpdr.org; Strechie-Sliwinski et al 2008).

In the Sfântu Gheorghe branch, at the Ceatal point, 0.8 m sec^{-1} was recorded and the water velocity values varied among natural areas (average value = 0.58 m sec^{-1}) and new created canals (average value = 0.68 m sec^{-1}). Following to hydrotechnical engineering by cutting-off the meanders, the flow velocity in meanders can reach 0.09 m sec^{-1} (Popa 1997; Strechie-Sliwinski et al 2008).

These water aspects depend by many factors, especially by the hydrological regime, the depth of the section and the meanders sinuosity (Whipple 2004; Charlton 2008).

Rotifers are cosmopolitan organisms, most species being recognized as eurytherm type (Wallace 2002). In our study 35 rotifer species were found in the most part of the year and also, 18 species preferred the spring season, 18 species the summer and 12 species the autumn.

The lotic systems cannot be characterised by heterogeneity and stability similar with the lentic systems, especially at the plankton level, where many species are non-indigenous imported from proximate sources (Dickerson et al 2010; Saunders & Lewis 1989). In our case, 37 out of 83 total species were assessed as accidental in the rotifer community.

Using the multidimensional scaling diagram MDS of the rotifers abundance distribution along the branch, revealed from upstream to downstream some differences. It can be noted that the arm extremes are positioned differently than the rest of sampling points (Figure 2). Also, it can be observed a close resemblance of the meanders sampling points (stations 2 and 5) and station 4 of natural sectors, reflecting intermediate features between these areas. Instead, the canals stations (3 and 6) are located at a greater distance from each other, defining different characteristics from a canal to the other.

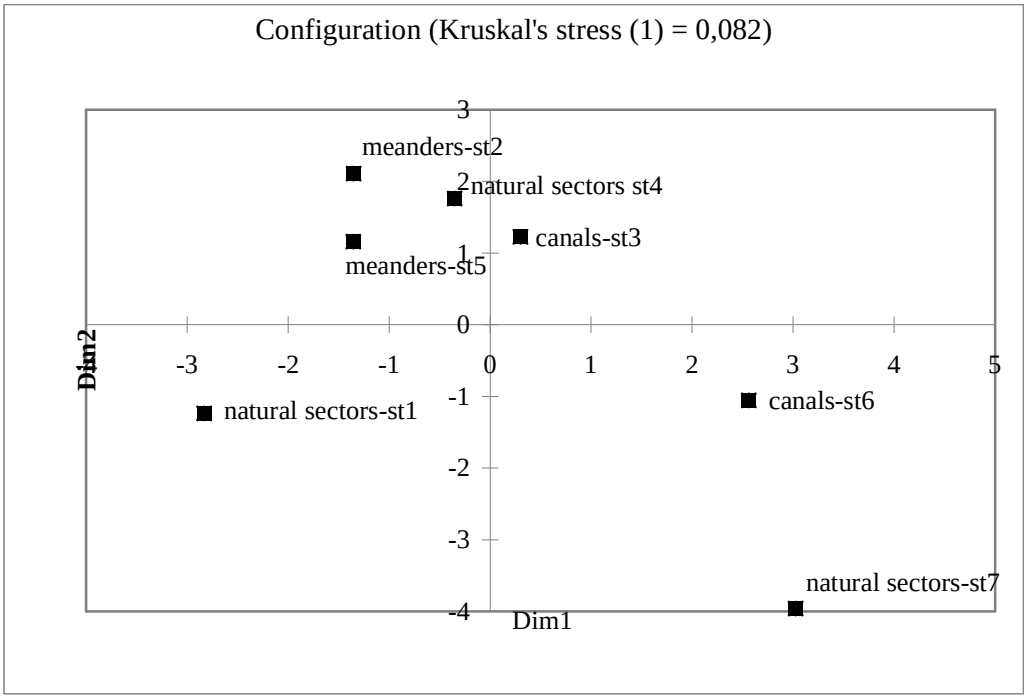

Figure 2. The MDS distribution of sampling stations rotifers abundance.

The conditions of the lotic ecosystems do not favor these organisms development, known as been sensitive to flow speed, high load of suspended particles in water, the volume of water. So within the rotifers populations only some species can adapt and dominate in these environments.

In spring, *Keratella quadrata* (Müller, 1786) and *Synchaeta oblonga* (Ehrenberg, 1832) were the dominant species, representing together around 50% of total rotifers abundance, from all three areas of branch. In natural sectors and meanders, *Keratella cochlearis* (Gösse, 1951) follows with 13% of abundance and in canals *Asplanchna priodonta* (Gösse, 1950) 14.68%. In summer, beside of *Brachionus calyciflorus dorcas* (51.21% - natural sectors; 41.15% - meanders, 48.32% -canals), the second dominant species varied from one area to another with about 20 % their income in abundance.

Synchaeta oblonga, in autumn, became again the most abundant species in natural sectors (77.28%) and canals (73.27%), while in meanders *Brachionus calyciflorus dorcas* (Gösse, 1951) (42.62%) was found. In smaller percentages species of *Keratella* and *Asplanchna* genus were assessed. These species were many times noticed as dominant rotifers in Danube or in other large rivers. The others species contribute with small values in abundance on entire study (Reckendorfer et al 1999; Keckeis et al 2003; Schöll & Kiss 2008; Chick et al 2010; Baranyi et al 2002).

K-dominance analysis (Figure 3) highlights the highest diversity in spring and summer, especially in meanders and natural sectors and the lowest in autumn, in canals and natural sectors. Also, it can be observed a seasonal assembled of the curves, which means a diversity and abundance resemblance of the three areas, depending on the season.

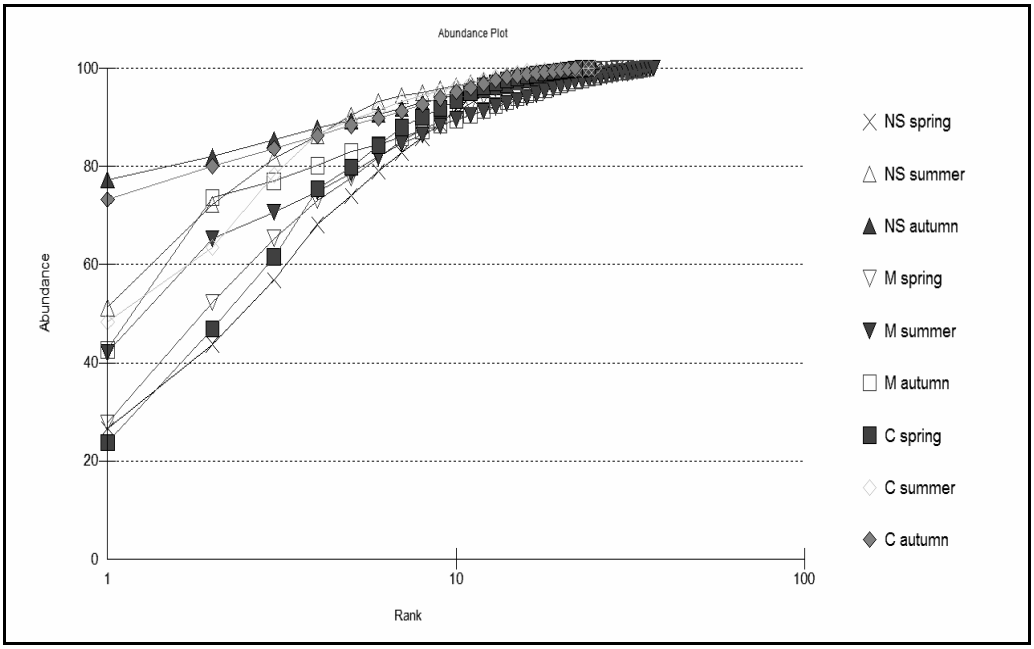

Figure 3. K-dominance of rotifer curves based on pooled sample abundances.

This fact was confirmed by MDS distribution (Figure 4), emphasizing a clear seasonal grouping ($p = 0.05$, $F_{8,729} = 1.897$) and by Bray Curtis single linkage analysis, which point out especially a high similarity between meanders and canals, in spring (89.22 %) and natural sectors and canals, in summer (74.99 %) (Table 1).

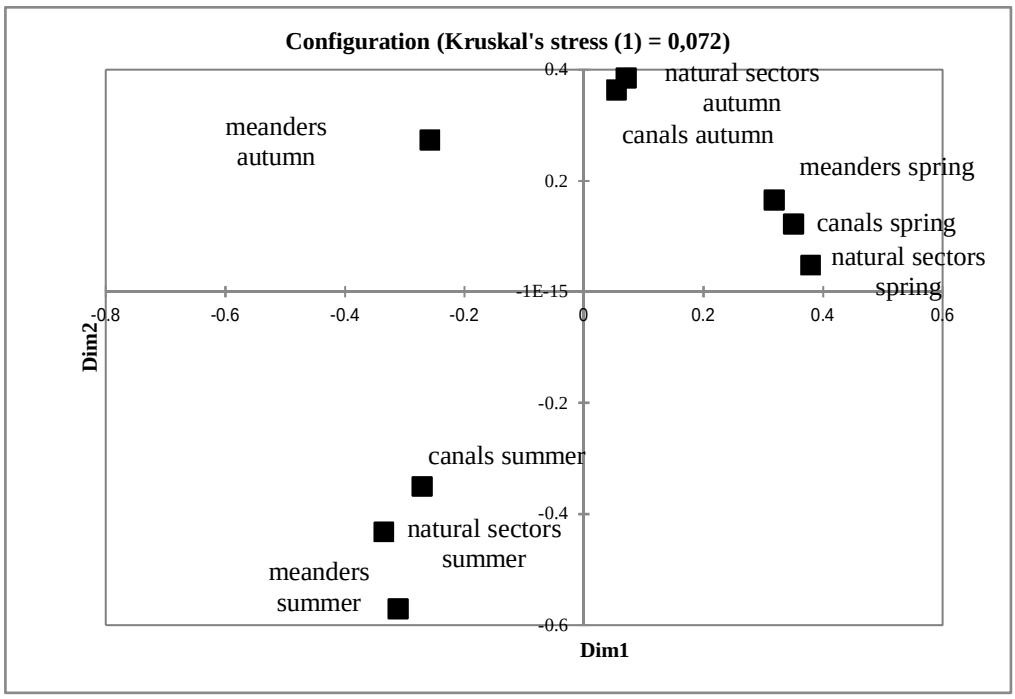

Figure 4. Multidimensional MDS of rotifers seasonal abundance.

Table 1

Similarity matrix of the Bray Curtis single linkage of the rotifer communities abundance (NS - natural sectors, M - meanders, C - canals; sp. – spring; sm. – summer; au. – autumn)

	NS sp.	*NS sm.*	*NS au.*	*M sp.*	*M sm.*	*M au.*	*C ap.*	*C sm.*	*C au.*
NS sp.	-	16.76	30.07	70.17	19.63	18.33	69.69	16.02	36.40
NS sm.	-	-	9.42	13.89	42.84	10.99	15.02	74.99	10.84
NS au.	-	-	-	19.46	4.55	41.40	18.69	7.95	71.88
M sp.	-	-	-	-	11.88	14.43	89.22	24.35	26.71
M sm.	-	-	-	-	-	12.19	12.33	30.29	6.80
M au.	-	-	-	-	-	-	15.77	6.94	41.74
C sp.	-	-	-	-	-	-	-	22.92	25.96
C sm.	-	-	-	-	-	-	-	-	11.33
C au.	-	-	-	-	-	-	-	-	-

Conclusions. The study shows modest values of the rotifers species richness and abundance, characteristic to the large rivers. Eighty three (83) rotifer species were recorded during the study with average abundance ranged between 0.02-31.84 indv.L^{-1}. Also, it was noticed a seasonally resemblance of the three areas. The numerical dominant rotifers species belonged to the *Keratella, Synchaeta Asplanchna, Brachionus* genus, while the other species contribute with small values in abundance. The Sfântu Gheorghe branch enivronmental conditions influenced the diversity mainly through the number of species and secondary through their abundance.

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