Fauna composition of water beetles (Coleoptera: Adephaga) in seven water environments in the municipality of Gramado, RS, Brazil.

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ABSTRACT: Fauna composition of water beetles (Coleoptera: Hydradephaga) in seven water environments in the municipality of Gramado, RS, Brazil. **The collections were made from December 1998 to December 1999 in 106 sampling points of seven different environments (wetlands, ponds, pools, reservoirs, temporary wetlands, streams and rivers) in the municipality of Gramado, Rio Grande do Sul State, Brazil. A total of 7,235 specimens of beetles were collected, belonging to 73 species distributed among the Dytiscidae, Gyrinidae, Haliplidae and Noteridae (Hydradephaga). The most suitable environments for the fauna were wetlands, ponds and temporary wetlands. Fauna in streams and rivers were reduced and quite distinct from those found in other environments. Most species were rarely or occasionally present, and in most cases the dominant species were the most abundant and frequent in all environments.**
Key-words: **fauna composition, water beetles, Hydradephaga, Brazil.**

RESUMO: Composição faunística de coleópteros aquáticos (Coleoptera: Hydradephaga) em sete tipos de ambientes aquáticos no município de Gramado, RS, Brasil. **O presente trabalho foi realizado no período de Dezembro de 1998 a dezembro de 1999 em 106 pontos de amostragem de sete tipos de ambientes (banhados, lagoas, poças, lagos, alagados, arroios e rios) do município de Gramado, Rio Grande do Sul, Brasil. Foram capturados 7.235 exemplares de coleópteros de 73 espécies das famílias Dytiscidae, Gyrinidae, Haliplidae e Noteridae (Hydradephaga). Os ambientes mais favoráveis a esta fauna foram banhados, lagoas e alagados. Por outro lado, arroios e rios participaram com uma fauna reduzida e muito distinta dos demais ambientes. A grande maioria das espécies teve presença ocasional ou esporádica, sendo que as espécies predominantes foram, em grande parte as mais abundantes e frequentes nos diferentes ambientes.**
Palavras-chave: **composição faunística, coleópteros aquáticos, Hydradephaga, Brasil.**

Introduction

The representatives of Hydradephaga are usual lentic water inhabitants, especially common in wetlands with abundant vegetation and temporary pools with little volume of water. However, they can be found in lotic environments, mainly on the banks of small streams, where species of *Gyretes* Brullé and *Gyrinus* Müller (Gyrinidae) are visualized with certain facility.

Some of these beetles are active swimmers. They frequent large volumes of water and are more abundant in deep waters. Others, mainly larvae or species that live on aquatic plants, are more common at the sides of wetlands or in shallow pools.

Most hydradephagous beetles show a great capacity to colonise or re-colonise habitats due to their ability to fly. Therefore, when an environment becomes inadequate, either due to water temporality or pollution, they can leave it and search for a new habitat. Furthermore, concrete environments - such as pools by the banks of great rivers with a very strict ecological valence - may hold characteristic species. Study of these

organisms may thus help us to understand the operation and dynamics of these water systems.

Studies about benthonic fauna in Brazil, e.g. Nessimian (1995), do not specify genus or species of beetles. To date, there are few works about the ecology of this fauna. Benetti et al. (1998) presented data about the habitat, richness and abundance of collected genera a study of the fauna of aquatic beetles in southern Brazil. Ferreira Jr. (1993; 1995) contributed some data about the habitat in descriptions of larval stages of *Megadytes* Sharp. A more complete work is that of Ferreira Jr. et al. (1998) which studied aquatic beetles fauna in the Restinga de Maricá, RJ, and relates the fauna with environmental parameters and plant composition of the habitats.

The municipality of Gramado as yet has few or no altered natural environments, although the degradation of hydric springs has increased progressively in recent years, mainly as the result of organic waste disposal. The present study reflects the quality of the water environments in the municipality and emphasizes the need for preservation, not only for the maintenance of the quality of the water but also of the aquatic biodiversity.

Material and methods

This study was carried out at 106 survey sites in the municipality of Gramado, from December 1998 to December 1999. This study allowed us to search the largest possible number of species within the territory.

The area was divided into quadrants of 4 Km^2 for a faithful sampling of the area, obtaining 80 quadrants approximately, including outlying regions. To select survey sites, attempts were made to sample at least one point in each quadrant. Efforts were also made to collect samples in points with different environmental characteristics, such as pools, deep pools, or streams.

Insects were collected throughout the year as the climatic conditions were favourable, despite the fact that winter temperatures are usually low. Another factor favouring the presence of species was the balanced distribution of precipitation over the year. However, water levels in wetlands and streams fluctuated and a lack of water was observed at times in some habitats such as pools and temporary wetlands.

Samples were collected with an entomological water net (frame 30 cm diameter, 60 cm deep, mesh 0.1 mm). A manual strainer (10 cm diameter, mesh 0.05 mm) was used as an auxiliary instrument for deep pools.

In wetlands, including those of a temporary nature, attempts were made to collect samples from all or most areas: from the shore, the centre, in vegetation and in the substrate. In ponds and reservoirs the sampling was done at the sides, next to the vegetation. In pools of temporary character and small extension, samples were captured by net or manual strainer. Captures in streams and rivers were carried out on the banks, raking the vegetation and in the middle, moving stones and in vegetation such as mosses and algae fixed to the bottom. Captured imagoes in all the samplings were immediately stored in 70% alcohol.

For each survey site, the following parameters were recorded:

* Depth of the body of water

The maximum depth was used for this parameter. A: Shallow: from 0 to 30 cm; B: Medium deep: from 30 cm to 1 meter; C: Deep: more than 1 meter

* Character (permanence of the water):

T: Temporary habitat; P: Permanent habitat.

* Water velocity

ES: Stagnant waters, of lentic facies; CO: Running water, of lotic facies.

* Dominant substrate: LO: mud; AR: sand; GR.: gravel; RO: rock.

* Dominant macrophytes: AL: algae; BR: bryophytes; FS: submerged phanerogams; FF: floating phanerogams; GR.: terrestrial grass ; AU: absent.

* Type of environment:

1: wetlands; 2: ponds; 3: reservoirs; 4: pool; 5: temporary wetlands; 6: stream; 7: river.

The 106 survey sites in the studied area were classified according to the mentioned parameters. Seven different types of aquatic bodies of water were therefore investigated.

The lotic environments were divided into streams and rivers, taking into account order, width, and depth. Small bodies of water of up to 5 meters wide, little depth - rarely reaching one meter - were considered streams. Rivers were those of over 5 meters wide, and greater depth - sometimes-surpassing 3 meters.

Due to their great diversity, stagnant waters are difficult to classify. According to Lacroix (1992), the criteria normally used are the aspect, depth and extension, but many other factors may influence the characteristics of the body of water. In the present study, five environments were defined on the basis of the characteristics analysed: pools, temporary wetlands, wetlands, ponds and reservoirs. Tab. I shows the relation of the survey sites in the municipality with the analysed parameters and the classification into environment type.

The species considered "dominant" were those present in 50% or more of the captures each environment and/or whose number was equal to or above the total number of species in each capture.

The other species present in the environments were considered of occasional or sporadic presence. "Occasional" species were those found in a determined environment at a frequency of between 5 and 50% and their presence was never more than half the number of hydradephagous samples captured. Those which were not present in a determined ecosystem at a frequency above 5% were considered "sporadic". The similarity between the considered types of environments was also analysed , based on the total fauna composition of each. Jaccard's coefficient was used to calculate affinity, and the data matrix was made from the presence or absence of the species in each type of environment, i.e. binary matrix.

Table I: Environmental parameters from sites of survey (A: Shallow, B: Medium deep, C: Deep; T: Temporary habitat, P: Permanent habitat; ES: Stagnant waters, CO: Running water; LO: mud, AR: sand, GR: gravel, RO: rock; AL: algae, BR: bryophytes, FS: submerged phanerogams, FF: floating phanerogams, GR.: terrestrial grass, AU: absent; 1: wetlands, 2: ponds, 3: reservoirs, 4: pool, 5: temporary wetlands, 6: stream, 7: river).

Site	Depth	Character	Velocity	Substrate	Macrophyte	Type
1	C	P	ES	LO	FS/FF	2
2	B	P	ES	LO	FS	1
3	A	T	ES	LO	AL	4
4	B	P	ES	LO	FS	1
5	A	T	ES	LO	GR	5
6	C	P	ES	LO	AL	3
7	A	P	ES	LO	AL/FS	1
8	C	P	ES	LO	FS	2
9	C	P	ES	LO	FS	2
10	C	P	ES	LO	FS/FF	2
11	B	P	ES	LO	FS	1
12	B	P	ES	LO	FS	1
13	A	T	ES	LO	GR	5
14	A	T	ES	GR	AU	4
15	A	T	ES	GR	AL	4
16	A	T	ES	GR	FS	4
17	B	P	ES	LO/RO	FS	1
18	B	P	ES	LO	AL	1
19	C	P	ES	LO	FS	2
20	C	P	ES	LO	FS	2
21	B	P	ES	LO	AL	1

Table I Cont.

Site	Depth	Character	Velocity	Substrate	Macrophyte	Type
22	B	P	ES	LO	FS	1
23	B	P	ES	LO	AL/FS	1
24	A	P	CO	AR/GR	AU	6
24	A	P	CO	AR/GR	AU	6
25	B	T	ES	LO	FS	5
26	C	P	ES	LO	AL	3
27	A	T	ES	LO/RO	GR	5
28	A	T	ES	GR	AL	4
29	B	P	CO	AR/GR	AU	6
30	B	P	ES	LO	FS	1
31	B	P	ES	LO	FF	2
32	C	P	ES	LO	FS	3
33	C	P	ES	LO/RO	FS	3
34	A	T	ES	LO	GR	5
35	B	P	ES	LO	FS/FF	1
36	A	T	ES	GR	AL/FS	4
37	A	T	ES	LO	FS	4
38	C	P	ES	LO/GR	FS	3
39	C	P	ES	LO	AL/FS	2
40	A	T	ES	LO	FS/GR	5
41	C	P	ES	GR	AL	2
42	C	P	ES	LO	FS	3
43	C	P	ES	LO	FS	2
44	C	P	ES	LO	FS	2
45	A	T	ES	LO	GR	5
46	C	P	ES	LO	FS	2
47	A	T	ES	LO	AL	5
48	C	P	ES	LO	FS	2
49	B	P	CO	AR/GR	BR	6
50	C	P	ES	LO	FS	2
51	C	P	ES	LO	AL	2
52	C	P	ES	LO	AU	3
53	A	P	CO	AR/GR	AU	6
54	C	P	ES	LO	FS	2
55	C	P	ES	LO	FF	2
56	C	P	ES	LO	FS	2
57	C	P	CO	AR	AU	7
58	B	T	ES	LO	GR	5
59	B	T	ES	LO	FS	5
60	B	P	ES	LO	FS	1
61	C	P	ES	LO	AL	3
62	C	P	CO	AR/GR	AU	7
63	C	P	ES	LO	AL/FS	2
64	B	P	CO	AR	AU	6
65	B	P	ES	LO	FS	1
66	C	P	ES	LO	AL	3
67	B	P	CO	AR	BR	6
68	C	P	ES	LO/GR	AL	2
69	B	P	ES	LO	FS	1
70	C	P	ES	LO	FS/FF	2
71	B	P	ES	LO	FS	1
72	B	P	ES	LO	FS	1
73	C	P	ES	LO	FS/FF	2
74	C	P	ES	LO	FS	2
75	C	P	ES	LO	FS	2

Table I Cont.

Site	Depth	Character	Velocity	Substrate	Macrophyte	Type
76	B	P	ES	AR	AL/BR	1
77	C	P	ES	LO	FS	2
78	B	P	ES	LO	FS	1
79	A	T	ES	LO	GR	5
80	C	P	ES	LO/RO	FS	2
81	B	T	ES	LO	FS	5
82	C	P	CO	AR	BR/FS	6
83	B	P	CO	AR/GR	FS	6
84	C	P	ES	LO	AL	3
85	C	P	ES	LO	FS	2
86	C	P	ES	LO/RO	FS	3
87	B	P	CO	AR/GR	AU	6
88	C	P	ES	LO	FS/FF	2
89	A	T	ES	LO	AL/BR	5
90	A	T	ES	LO	FS/GR	5
91	C	P	ES	LO	FS	2
92	B	P	CO	AR/GR	BR	7
93	C	P	ES	LO/RO	AL	3
94	C	P	CO	AR	AU	7
95	A	P	CO	AR/GR	BR	6
96	B	P	ES	LO	AL	1
97	A	T	ES	LO	GR	5
98	B	P	ES	LO	FS	1
99	C	P	CO	AR/RO	AU	7
100	B	P	CO	AR/GR	AU	6
101	C	P	ES	LO	AL	3
102	C	P	ES	LO	FS	2
103	A	T	ES	LO	FS/GR	5
104	B	T	ES	LO	AL/FS	5
105	A	T	ES	LO	AU	4
106	A	T	ES	RO	AU	4

Results and discussion

The predominant water environments in the studied territory were wetlands, ponds and streams. The great majority of the habitats of lentic facies presented muddy substratum and the predominant vegetation consisted of submerged phanerogams or algae. Floating phanerogams were also common in ponds. Wetlands, ponds and temporary wetlands presented abundant vegetation - marginal in ponds and extensive in the case of wetlands and temporary wetlands. Reservoirs and pools had little or no vegetation. In streams and rivers the predominant substrata were sand or boulders. Vegetation was absent or consisted of mosses in the region of current and submerged terrestrial plants in the margins.

The shallowest waters (less than 30 cm) were observed in temporary environments (pools and temporary wetlands) . The wetlands presented a maximum depth of 30 cm to 1 meter, approximately, ponds and reservoirs, were always over 1 meter deep. As concerns the origin of lentic environments, wetlands and ponds are natural and permanent ; pools and temporary wetlands, natural and temporary; and reservoirs are artificial. There are no naturally formed lakes in the study area.

According to Odum (1988), the organisms of a community do not play equally important roles in a particular ecosystem. Some species or groups of species in a community exert more influence than others and are considered dominant. The predominance of one species in a certain habitat is related to its frequency – the number of times the species appears in the total number of captures -, and its abundance - number of individuals of the species with relation to the total. In a study on the fauna of macro-invertebrates in tropical lotic environments, Kikuchi et al. (1998) considered those with a frequency of 50% or more as dominant groups, and affirmed that this is an important datum in the analysis of the composition of a habitat. This was reaffirmed by Santos et al. (1998) for lentic environments.

In order to determine the participation of a species in an environment we must consider the group that is analysed, in this case the community of adephagous beetles. Dominance of a species includes many factors, not only their presence or abundance. In this study, the most frequent were considered "dominant" in relation to the total faunistic composition. In Tab. II, the captured species in each environment are listed and classified according to category of frequency.

Table II: Species present in the area of study, for type of environmental (1: wetlands; 2: ponds; 3: reservoirs; 4: pool; 5: temporary wetlands; 6: stream; 7: river), classified for frequency in: D: dominant; O: occasional and E: sporadic.

Family	Specie	1	2	3	4	5	6
Haliplidae	***Haliplus thoracicus***	**E**	**E**			**E**	
Gyrinidae	***Gyrinus chalybaeus***	**O**	**O**	**D**			**D**
	G. gibbus		**E**				
	G. ovatus	**O**	**O**	**D**		**E**	**D**
	G. violaceus						**O**
	Gyretes brunnescens						**O**
	G. dorsalis						**O**
	G. levis australis						
	G. tarsalis chapadensis						
Noteridae	***Hydrocanthus debilis***	**O**	**O**				
	H. paraguayensis	**D**	**D**	**O**		**O**	
	H. sharpi		**O**				
	H. socius	**D**	**D**	**O**		**O**	
	Suphisellus bruchi	**E**	**O**			**E**	
	S. nigrinus	**D**	**D**			**O**	
	S. obesus		**E**				
	S. ovatus	**D**	**O**			**O**	
	S. phenax	**O**	**O**			**O**	
	S. pinguiculus	**O**	**O**			**E**	
	S. remator	**D**	**D**	**O**		**O**	
	S. rufipes	**D**	**D**	**O**	**E**	**D**	
	S. subsignatus	**D**	**D**	**E**		**D**	
	***Suphisellus* sp1**	**O**	**E**			**O**	
	***Suphisellus* sp2**	**O**	**O**	**E**		**E**	
	Mesonoterus laevicollis	**E**	**E**				
	Pronoterus punctipennis	**E**	**E**				
	Suphis notaticollis		**E**				
Dytiscidae	***Anodocheilus maculatus***	**D**	**D**		**O**	**D**	
	Bidessonotus truncatus	**O**	**O**			**O**	
	Brachyvatus acuminatus		**E**				
	Hemibisessus plaumanni	**O**	**E**			**E**	
	Liodessus affinis	**D**	**D**	**O**	**D**	**D**	
	Neobidessus curticornis	**E**	**E**	**E**	**E**		
	N. trilineatus	**E**				**E**	
	Amarodytes duponti				**E**		
	Laccornellus lugubris	**E**				**E**	
	Hydrovatus caraibus	**O**	**O**				
	Desmopachria nitida	**D**	**D**		**O**	**D**	
	D. concolor	**E**	**E**				
	D. aureus	**E**	**E**		**O**	**E**	
	D. ferrugata	**O**	**O**			**E**	
	D. fossulata		**E**				
	Celina aculeata	**O**	**D**	**E**		**O**	
	C. punctata		**E**				
	C. vitticollis	**O**	**D**	**E**		**O**	
	Derovatellus lentus		**E**				
	Macrovatellus marginalis	**O**	**O**			**E**	
	***Laccodytes* sp**	**E**					
	Laccophilus obliquatus	**D**	**O**	**O**		**E**	

Table II Cont.

Family	Specie	1	2	3	4	5	6
	L. ovatus	D	D	E	E	O	E
	L. paraguensis	O	O				E
	L. tarsalis	D	D	O	E	D	E
	***Laccophilus* sp1**	O	E	E			
	***Laccophilus* sp2**				O		O
	Copelatus bacillifer	E					
	C. coelatipennis	E	E				
	C. incognitus		E		E	E	
	C. longicornis	E	E		E	E	
	C. silvestrii		E		D	E	
	Rhantus calidus	D	D	D	O	D	
	R. duponti	E	O		D	O	
	R. limbatus	E	O				
	R. signatus signatus	D	D			O	
	Lancetes marginatus			E			
	Thermonectus marginegutathus	D	D	E		D	
	T. succinctus	O	O		E		
	Megadytes carcharias	E	O				
	M. fraternus		E				
	M. laevigatus	E					
	M. latus	O	D				E
	M. marginithorax		E				
	Hydaticus palliatus	E	O	E	O	E	
	H. tuyuensis	E					

Some species were dominant in different environments, as in the case of *Liodessus affinis* and *Rhantus calidus,* dominant in four environments. This indicates that these species are well-adapted to survive in environments with different ecological conditions. For this reason, they have the potential to dominate many other species, occupying diverse habitats with a wide ecological niche. These two species have an extensive geographic distribution ranging from the U.S.A. and Canada to Patagonia, reinforcing the tendency to affirm that they are very adaptable species, occurring in habitats with particularly divergent conditions.

The less frequent species generally showed a sporadic occurrence in most habitats, a great number of them being rare species. A total of 10 species were recorded in only one capture. Most of them had a restricted geographic distribution with few records from at other places. Some species, like *Gyrinus violaceus* and *Hydrocanthus sharpi*, were found in only one type of environment. However, as their frequency was not low, they are not considered rare species. This means that they are species with precise ecologic requirements found in a definite habitat such as ponds for *H.sharpi* or streams for *G.violaceus*.

Tab. III shows the number of captured species in each lentic environment in the study area, distributed in categories according to frequency and total frequency of species for each habitat in respect to the total. Because of their low numbers, species captured in lotic environments were not included in this analysis.

The data obtained for wetlands and ponds show that there is a certain balance between occasional and sporadic species regarding their participation in the total faunistic

Table III: Species predominants, occasionals and sporadics and frequency (%)in lentic environment.

Type of environment	dominant	occasional	sporadic	total	frequency
Wetlands	16	18	19	53	72,6
Ponds	17	20	22	59	80,82
Lakes and dams	3	8	10	21	28,76
Pools	3	6	8	17	23,28
Temporary wetlands	8	13	16	37	50,68

composition, with a slight predominance of sporadic species. These habitats are therefore stable as concerns the community of hydradephagous beetles, and there is a well-established and well-organised community, without a great predominance regarding number of species of a determined category of frequency. Santos et al. (1998) analysed the benthonic fauna of five lakes and considered that the most structured community was that which presented the lowest frequency of the dominant group, while having the highest number of taxons.

In other habitats, the fauna is not completely established or constant, either due to environmental conditions (periodicity of water) or anthropic (artificial) influence. Such communities are less balanced as regards participation of dominant, occasional, or sporadic species. The low number of dominant species captured with a high frequency indicates that very few species exert a greater predominance in relation to others. In time, and if the environment stabilises, a certain balance will likely appear between these categories of frequencies.

Wetlands and ponds, besides presenting a more balanced fauna, were the environments that presented the greatest fauna richness, with 53 and 59 species respectively, corresponding to over 70% of the total species (73). These more stable habitats are well conserved on the whole.

Fig. 1 reflects the degree of affinity between the seven types of sampled environments in the studied area. It can be seen that the environments that presented greater affinity were "wetlands" and "ponds", with 43 coincident species. Despite the differences in depth, the similarity between these types of environment may account for this affinity, especially regarding the presence of abundant marginal vegetation. These natural environments are also more stable in relation to the others. The results demonstrate that the vegetation factor is more important than depth; however, there are marked differences and many species have a more limited distribution, needing a great volume of water.

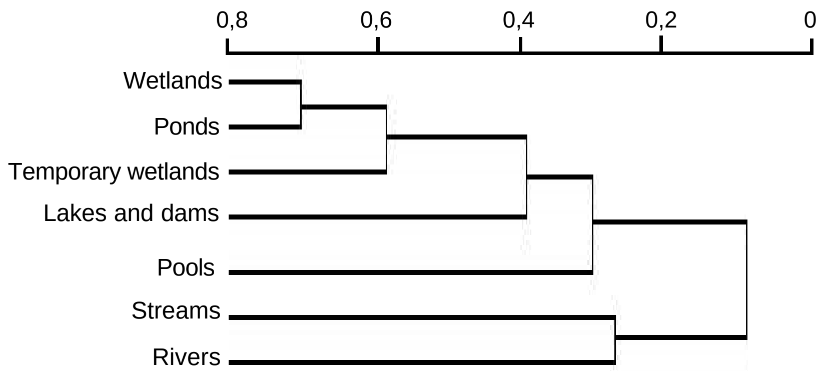

Figure 1: Fauna similarity between the considered type of environments.

With a similar fauna composition to wetlands and ponds are the temporary wetlands. Not unlike pools, they differ mainly in the temporary nature of the water, which affects the presence or absence of some species. However, it is the "aquatic vegetation" factor where the two are most similar. Extensive plant cover is a determining factor for presence and permanence (though temporal), of many species. According to Margalef (1983), when the macrophyte community finds favourable conditions, the environment in many lakes becomes more productive and numbers of niches and species increase. Santos et al. (1998) observed that habitat margins present greater richness in species than bottoms; likely because vegetation at the margins is abundant, while that at the bottom it is different and poorer.

Reservoirs showed a low affinity to wetlands and pools. The main factor was the absence or scarcity of aquatic macrophytes and the instability of these environments, artificially formed.

"Pools" were the environments of lentic facies that presented the least fauna affinity with the others. These environments are quite different from those previously mentioned, specially concerning their temporary character, great instability, small extension and very low depth, factors that limit excessively the presence of most species. These factors associated to the almost total absence of vegetation account for the fauna of pools being quite different from the others. Williams (1985) emphasizes that even though they are unstable, temporary water masses are an important resource for the study of ecological succession and adaptive strategies.

Finally, with a fauna composition which differs greatly in comparison lentic environments are the "streams" and "rivers". Only seven species were present in lotic environments. A great number of factors contribute to the differences between lentic fauna and the running water fauna. However, flowing water with a permanent stream velocity, although often low, together with a different plant composition, are clearly the main factors that cause the low affinity between the hydradephagous fauna of lotic and lentic environments. In agreement with Hynes (1970), the current is the most significant characteristic of streams and rivers. Fauna living in the high current region is well adapted and differs considerably from the fauna of lentic environments. Benetti et al. (1998) emphasize the presence of *Gyretes* and *Gyrinus* (Gyrinidae), *Laccophilus* and *Megadytes* (Dytiscidae), confirming that these genera are more frequent in lotic environments, as is also observed in this work.

The streams and rivers also showed a low affinity to each other in the studied area. Specificity of the fauna in rivers was high; only species of Gyrinidae, mainly of the genus *Gyretes*, were recorded. In contrast, species of Dytiscidae were also recorded in streams. However, due to the low number of species present in rivers we were unable to perform a reliable analysis of these data to determine the similarity regarding hydradephagous fauna in streams and rivers.

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