

BENTHIC MACROINVERTEBRATES OF THE HEAD-WATERS OF RIVER SÃO FRANCISCO (NATIONAL PARK OF SERRA DA CANASTRA, BRAZIL)

NICOLAE GĂLDEAN, MARCOS CALLISTO,
FRANCISCO A. R. BARBOSA

Abstract

National Park Serra da Canastra (Minas Gerais State, Brazil) preserved life conditions very close to those from the very beginning. The quality of the waters from the upper flow of the river São Francisco was established studying the benthic macroinvertebrates.

Résumé

Le Parc National Serra da Canastra (l'Etat Minas Gerais, Brésil) a conservé les conditions de vie très proche de celles initiales. La qualité des eaux du cours supérieur de la rivière São Francisco a été évaluée par l'étude des macroinvertébrés benthiques.

Keywords: conservation of lotic ecosystems, trophic resources, strategies

INTRODUCTION

Preservation areas (e.g. parks, natural reserves, etc) are of paramount importance as reference sites, particularly for the biological diversity conservation since they are probably the only areas where species and processes have chances of not being severely disturbed, thus maintaining approximately original conditions. However, in the case of Brazil, the majority of these protected areas still need basic information concerning their biota and processes. In the particular case of the State of Minas Gerais the situation is not different since the majority of the protected areas have not been studied yet in order to provide the necessary information for their management. This is the case of the Serra da Canastra National Park situated in the southeastern part of the state ($46^{\circ}15'$ - $47^{\circ}00'W$, $20^{\circ}00'$ - $20^{\circ}30'S$), with an area of 71,525 ha in a zone of moderately humid

subtropical climate (Cwb of Kopen) at an altitude ranging between 1,300-1,700 m above sea level, annual mean temperatures of 14-21°C, with dystrophic latosols yellow-red and a predominant vegetation of cerrados (up to 800 m) and altitudinal fields (campos rupestres) on top of a stony surface (800-1,700 m).

This Park is particularly important for its characteristic flora and fauna and mainly for the fact that within its boundary lies the sources of the São Francisco river, the most important watershed of the south-eastern Brazil.

In order to obtain basic information on the quality of the waters and the aquatic communities of this river, a first assessment of the physico-chemical characteristics of the waters and the first evaluation of the structure of the macroinvertebrate communities was performed in July 1997, aiming to provide basic data for the conservation and management of the natural communities which can be used in the definition of a management plan of the Park.

This first assessment of the water quality of the head-waters of river São Francisco was based on the analyses of the benthic macroinvertebrates which can be used as monitoring tools of the general conditions of the studied sites.

In this study besides the evaluation of the richness of the benthic communities it was also assessed its capacity and strategies of using the available trophic resources.

It must be pointed out that these data constitute the first records for the area.

The studied area

Six sampling points were chosen along the first 20 Km of the river from which 5 are within the Park and 1 was located just outside its limit, in an area under mining activities. The general characteristics of each sampling point are as follows:

Point 1. Flooded area of approximately 1 ha possessing mainly grassland. The stream's bed is formed mainly by stones showing a layer of filamentous algae, gravel and moss clumps near the banks.

Point 2. Small lake approximately 300 m downstream with a stony-gravel river bed covered with fine sediments (mud) and algae, presence of aquatic macrophytes.

Point 3. Area showing remarkable* diversity of habitats (stones, boulders, gravel, sand and fine detritus) 10 Km downstream.

Point 4. Located 50 meters below point 3 in an area of high currents (rapids) with a stony river bed showing the presence of algae between the gravel.

Point 5. Located just below Casca d'Anta fall possessing a stony river bed and also showing the presence of sand, deposits of leaves and fine detritus in between.

Point 6. Located outside the Park in an area where mining activities are relatively intense. The river bed is mainly formed of boulders also showing the presence of mosses, detritus and algae.

MATERIAL AND METHODS

Water samples were taken from the sub-surface of each point and in situ measurement of temperature, pH, dissolved oxygen, electrical conductivity and total alkalinity were conducted in order to assess the water quality.

The benthic community was sampled by hand net at each point and the collected material was fixed with formalin. After sorted and identified under stereomicroscopic in the laboratory it was preserved in alcohol solution (70%) and registered in the limnological collection of the Laboratory of Limnology/Ecology of Benthos of the Institute of Biological Sciences of the Federal University of Minas Gerais.

For each taxonomic group (Plecoptera, Ephemeroptera, Trichoptera and Diptera, Chironomidae) there were taken into account the trophic necessities (based on laboratory analyses, field observations and the literature according to Wiederholm, 1983; Merritt & Cummins, 1988; McCafferty, 1991; Epler, 1995; Pescador, 1997), considering its taxonomic composition, dominance and genera richness.

RESULTS AND DISCUSSIONS

The water quality

The water temperature among the sampling points ranged between 13.4°C (Station 5) and 17.8°C (Station 6); the studied waters are predominantly acidic (pH ranging between 4.52 and 6.84), well oxygenated (> 8 mg/l) and poor in nutrient content (electrical conductivities between 1.58 and 12.56). Among the sampling points the point 6 (Ponte do Emílio) is particularly distinct probably reflecting the mining activities prevailing in the area, as suggested for example by the high electrical conductivity. The waters within the Park (Stations 1 to 5) represent waters of excellent quality while Station 6 shows already some degree of impacts reflecting human activities mainly mining.

Taxonomic composition of the benthic macroinvertebrate communities (Tab. 1)

Table 1

List of the identified taxa						
Taxa	# 1	# 2	# 3	# 4	# 5	# 6
Turbelaria		***		*		*
Nematoda			**	*		
Oligochaeta			***	**	*	
Hirudinea			*			
Hydracarina			*			
Plecoptera						
Perlidae		*	**	*	**	**
Gripopterygidae					*	
Ephemeroptera						
Baetidae						
<i>Baetis</i>						**
<i>Cloeodes</i>		***	***	***	***	***
<i>Baetodes</i>				***	*	
Leptophlebiidae						
<i>Masartella</i>		***	***	***	*	
<i>Farrodes</i>		***			*	*
<i>Homoithraulus</i>			**			
<i>Hermanella</i>						*
<i>Hylister</i>						*
Tricorythidae	**	**				***
Odonata	**					**
Heteroptera	**	**				
Megaloptera			*		*	**
Coleoptera						
Elmidae			***	**		***
Psephenidae		*			*	
Trichoptera						
Hydrobiosidae			*	*		*
Hydroptilidae						
<i>Ochrotrichia</i>		**	**			
<i>Oxyethira</i>	**					
Hydropsychidae						
<i>Smicridea</i>			***		***	
Helicopsychidae						
<i>Helicopsyche</i>	**	**				
<i>Cochliopsyche</i>					***	
Polycentropodidae			*			

Table 1 (continued)

Taxa	# 1	# 2	# 3	# 4	# 5	# 6
Philopotamidae			***			
Leptoceridae			**		***	
Lepidoptera			***	***		
Diptera						
Ceratopogonidae			*		*	
Tipulidae			*			
Simuliidae				***	*	***
Blephariceridae					**	
Chironomidae						
Orthoclaadiinae						
<i>Cricotopus</i>	***	***	***	***	**	***
<i>Corynoneura</i>	*		*		*	*
<i>Nanocladius</i>			*		*	*
<i>Thienemanniella</i>	*	*	**	*	*	**
Tanypodinae						
<i>Ablabesmyia</i>	**	**	*	*	*	**
<i>Alotanypus</i>				*	*	
<i>Larsia</i>	**				*	*
<i>Tanypus</i>	**	**	**	*	*	*
Chironominae						
<i>Beardius</i>			**	*		
<i>Cryptochironomus</i>				*	*	
<i>Goeldichironomus xiborena</i>					*	
<i>Goeldichironomus</i> sp.1			*	*		*
<i>Harnischia</i> (?)			*		*	
<i>Parachironomus</i>		*		*		*
<i>Polypedilum</i>		*	**	*	*	**
<i>Stenochironomus</i>					*	
<i>Nimbocera</i>	*	*		*	*	
<i>Rheotanytarsus</i>			***		*	
Tanytarsini genera varia	*	*	*	*	*	***

* rare

** common

*** abundant

The benthic composition at station 1 is rather poor, composed mainly of Odonata-Zygoptera, Ephemeroptera-Baetidae (e.g. *Cloeodes*) and Tricorythidae, Heteroptera (*Limnocoris*), Trichoptera-Hydroptilidae (*Oxyethira*) and Helicopsychidae, Diptera-Chironomidae (*Cricotopus* and some carnivorous genera e.g. *Ablasbesmyia*, *Larsia* and *Tanypus*).

It is very likely that this community is influenced by the presence of an algae layer on the surface of the water which can cause an increase of the water temperature during the day and decreasing of the dissolved oxygen during the night hours.

At Station 2 the benthic fauna seems to be concentrated within the layer of filamentous algae on top of the stones, being composed by Plecoptera Perlidae, Ephemeroptera Baetidae (*Cloeodes*), Leptophlebiidae (*Masartella* and *Farrodes*), Coleoptera Psephenidae, Heteroptera, Trichoptera Hydroptilidae (*Ochrotrichia*, many pupal cases fixed on the algae), Helicopsychidae (*Helicopsyche*) and Leptoceridae, Diptera Chironomidae (*Polypedilum* and *Parachironomus*).

At Station 3 most of the stones are covered with moss and fine detritus, which represent the main trophic resources for numerous oligochaets. The community is particularly rich in Turbellaria (mainly the carnivorous groups), Nematoda, Hirudinea, Hydracarina, Ephemeroptera Baetidae (mainly *Cloeodes* group), Leptophlebiidae (*Masartella*) and Tricorythidae, Coleoptera Elmidae, Megaloptera, Trichoptera Polycentropodidae, Hydrobiosidae and Hydropsychidae, Lepidoptera, Diptera Tipulidae, Ceratopogonidae and Chironomidae (*Rheotanytarsus*, *Thienemanniella* and *Tanypus*).

On the other hand, the community found within the layer of algae on the top of the stones has a different structure, also occurring many Oligochaeta and Turbellaria although the number of Trichoptera Hydropsychidae and Diptera Simuliidae is high. The Ephemeroptera are not so abundant and there are many Coleoptera Elmidae and Lepidoptera. The predominant chironomids were *Cricotopus*, *Thienemanniella*, *Beardius*, *Polypedilum* and *Rheotanytarsus*.

Station 4 is characterized by the presence of rapids and among the stones in the river bed there are deposits of algae with Diptera Simuliidae and pupal cases of Lepidoptera. The community is dominated by the larvae of Diptera Simuliidae (over 800 individuals per sample). The surfaces of Lepidoptera's pupal cases are covered by a layer of very fine detritus available for Chironomidae (*Cricotopus*, *Beardius*, *Goeldichironomus*, *Polypedilum*, *Cryptochironomus*, *Parachironomus*, Tanytarsini genera varia and *Thienemanniella*). This very specialized habitat is determined by

the Lepidoptera and Simuliidae (similar to those created by the Hydropsychidae larvae). There are many Ephemeroptera Baetidae (*Baetodes* and *Cloeodes*), Plecoptera Perlidae, Coleoptera Elmidae, Trichoptera Hydropsychidae, Diptera Ceratopogonidae. The last two are the main carnivorous groups. Nematoda, Turbellaria and Oligochaeta were present in low densities.

This first part (14 Km of low declivity) of river São Francisco is separated by the rest by a big waterfall (200 meters high) named Casca d'Anta which can constitute an ecological barrier for the distribution of some benthic groups.

Station 5, located just below this water fall reflects this ecological barriers since its benthic fauna is composed mainly by Plecoptera Gripopterygidae, Trichoptera Helicopsychidae, genus *Cochliopsyche* (abundant) and Diptera Blephariceridae. The community contains also Plecoptera Perlidae, Ephemeroptera Baetidae (*Baetodes* and *Cloeodes*), Leptophlebiidae (*Farrodes* and *Masartella*). There are still present: Trichoptera Hydropsychidae (numerous), Leptoceridae (*Grumichella*), Odontoceridae, Coleoptera Psephenidae, Megaloptera, Diptera Ceratopogonidae and Chironomidae, this last family showing the highest number of genera within the area (*Cricotopus*, *Corynoneura*, *Nanocladius*, *Thienemanniella*, *Ablabesmyia*, *Tanypus*, *Larsia*, *Alotanypus*, *Beardius*, *Goeldichironomus xiborena*, *Polypedilum*, *Stenochironomus*, *Harnischia*, *Cryptochironomus*, *Rheotanytarsus*, *Nimbocera* and *Tanytarsini* genera varia).

At Station 6, despite the impacts from the mining activities, the community is relatively rich: Plecoptera Perlidae, Ephemeroptera Baetidae (*Baetis* and *Cloeodes*), Leptophlebiidae (group *Hermanella-Hylister*), Megaloptera, Odonata, Coleoptera, Trichoptera Hydropsychidae (numerous) and Hydroptilidae, Diptera Simuliidae and Chironomidae (*Cricotopus*, *Tanytarsini* genera varia, *Thienemanniella*, *Polypedilum*, *Ablabesmyia* dominated and a few specimens of *Goeldichironomus*, *Parachironomus*, *Nanocladius*, *Corynoneura*, *Tanypus* and *Larsia*).

The significance of the benthic macroinvertebrates for the water quality of river São Francisco

General conditions in the area of Serra da Canastra National Park are excellent, judged by the low impact of tourism (6,000 people per year) not existing any other factors acting and controlling the terrestrial and aquatic ecosystems with the exception of the presence of fire which seems to be a major factor capable of influencing the ecosystems in the area. So, as a

consequence of the inputs of nutrients (mainly N and P) as an indirect effect of the fires, a tendency of eutrophication is evident through the analysis of the composition of the benthic community.

So, in the wetland formed by the springs (sampling point 1), the main consumers of the filamentous algae are chironomids (*Cricotopus*); in sampling point 2 the diversity of the benthic community is higher and the main trophic resources are filamentous algae (used by *Cricotopus*), fine detritus and perifiton, and the main grazers are Ephemeroptera (some Leptophlebiidae) and Chironomidae (*Beardius*). The larvae of *Cloeodes*, *Polypedilum* and *Parachironomus* are using the deposits of fine particulate organic matter (FPOM).

The moss clumps, very frequent in sampling point 3 determine a very specific community based mainly on the relation detritus-Oligochaeta-Turbelaria. We presume that Oligochaeta use the high quantity of detritus sedimented within the moss clumps. This type of sediment is available for Oligochaeta but the filtering collectors are absent in this area. However, this situation is different at sampling point 4 where the FPOM is not only sedimented but also suspended thus allowing the establishment of the filtering collectors (Trichoptera Hydropsychidae and Diptera Simuliidae) which are very active and abundant.

Moving downstream (sampling point 5) the peryphyton is the main trophic resource used by scrappers (*Cochliopsyche*, Trichoptera Helicopsychidae, Coleoptera Psephenidae, Diptera Blephariceridae and Trichoptera Leptoceridae *Grumichella*) and gathering collectors (*Cloeodes*), rendering to this area the highest diversity of chironomids probably related with the high availability of fine detritus deposits (*Polypedilum*, *Goeldichironomus xiborena*, *Cryptochironomus*), filamentous algae (*Cricotopus* and *Beardius*), dead vegetal tissue (*Stenochironomus*). Furthermore, there are some genera characteristic of high altitude and cold waters (*Cricotopus*, *Corynoneura*) and of oligotrophic conditions (Tanytarsini genera varia, *Rheotanytarsus*).

The quantity of suspended FPOM is provided by the physical trituration of the coarse detritus within the waterfall. The presence of Hydropsychidae larvae is a normal reaction of the ecosystem to the available suspended FPOM. However, this tendency is evident at sampling point 6 although the determinant factors are different from those at sampling points 1, 2, 3 and 4 which are probably related to the presence of small inlets draining organic sewage from local farm lands.

In conclusion the recorded data on the diversity of benthic macroinvertebrates suggest the predominance of waters of good quality

despite the observed tendency of eutrophication in the sampling points 1, 2, 3, and 4. Although any previous data regarding the quality of the waters in Serra da Canastra based on faunistic analyses do not exist, one can presume that the eutrophication tendency is as old as the occurrence of fire (as a natural factor).

Considering the aquatic ecosystems (lotic ones) as subsystems of this complex of ecosystems (Serra da Canastra) any possibility of assessing the quality of the waters can be superposed on the general evaluation of the quality of the environment in this area.

For the future, one can predict that the upper part of river São Francisco has really good chances to be preserved keeping the present conditions considering the protection provided by the National Park and the implementation of its management plan.

ACKNOWLEDGEMENTS

The authors are grateful to Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre (UFMG) and IBAMA (Brazilian Institute for Environment) for the logistic support in National Park of Serra da Canastra.

MACRONEVERTEBRATE BENTONICE DIN IZVOARELE RÂULUI SÃO FRANCISCO (PARCUL NAȚIONAL SERRA DA CANASTRA, BRAZILIA)

REZUMAT

Parcul Național Serra da Canastra (Minas Gerais, Brazilia) reprezintă o zonă de interes deosebit pentru capacitatea sa de a păstra condiții de viață foarte apropiate de cele inițiale. Aici se găsesc izvoarele râului São Francisco, unul din cele mai importante din sud-estul Braziliei.

În scopul conservării și managementului comunităților naturale a fost făcută o primă estimare a calității apelor din zona de izvoare. S-au măsurat câțiva parametri fizico-chimici și s-a evaluat componența comunităților de macronevertebrate bentonice pe un sector de 20 km, situat în cea mai mare parte în incinta parcului.

Este discutată semnificația grupelor bentonice în privința felului de utilizare a resurselor trofice. Se pare că focul, ca factor natural, determină

indirect eutrofizarea apelor, prin eliberarea nutrienților, acest fenomen fiind mai evident în prima parte a sectorului investigat.

În ansamblu, calitatea apelor din zona de izvoare a râului São Francisco este foarte bună și există șanse reale pentru menținerea calității în viitor.

REFERENCES

- EPLER, J. H., 1995 - Identification manual for the larval Chironomidae (Diptera) of Florida. *Revised edition. Depart. of Envir. Protection of Florida*, 450 p.
- M.A./IBDF., 1981 - Plano de manejo do Parque Nacional da Serra da Canastra. *IBDF/FBPCN, Brasília*, 96 p.
- MERRITT, R. W., CUMMINS, K. W., 1988 - An introduction to the aquatic insects of North America. *2nd. edition. Kendall/Hunt*. 758 p.
- PESCADOR, M. L., 1997 - General ecology of mayflies: adaptations, reproductive strategies and trophic categories. *In: Bioindicadores ambientales de calidad de agua. Colombia, Universidad del Valle*.
- WIEDERHOLM, T. (ed.), 1983 - Chironomidae of the Holarctic region. Keys and diagnoses. Part 1. Larvae. *Entomologica Scandinavica*, 19: 1-457.

Received: May 16, 1999

Accepted: June 17, 1999

Nicolae Găldean

Muzeul Național de Istorie naturală "Grigore Antipa"

Șoseaua Kiseleff nr. 1 RO - 79744 București

România

e-mail: nick@antipa.ro

Marcos Callisto, Francisco A.R. Barbosa

Lab. Limnologia, Dep. Biologia Geral, ICB

Universidade Federal de Minas Gerais

CP 486, 30161-970 Belo Horizonte, MG, Brazil

e-mail: callisto@mono.icb.ufmg.br

e-mail: barbosa@mono.icb.ufmg.br