

**A PROPOSED TYPOLOGY FOR THE RIVERS OF SERRA  
DO CIPÓ (MINAS GERAIS, BRAZIL) BASED  
ON THE DIVERSITY OF BENTHIC MACROINVERTEBRATES  
AND THE EXISTING HABITATS**

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**Abstract**

The rivers from Serra do Cipó, Minas Gerais State, Brazil, represents a major freshwater source. The establishing of a typology of these ecosystems creates the base of a conservation strategy of the aquatic resources.

**Résumé**

La rivières de Serra do Cipó, l'Etat Minas Gerais, Brésil, represent une source majeure d'eau potable. La détermination d'une typologie de ces écosystèmes assure la base d'une stratégie de conservation des ressources aquatiques.

**Keywords:** diversity, communities, benthic macroinvertebrates, typology.

**INTRODUCTION**

The Serra do Cipó (south-east Brazil) contains a lot of small altitudinal rivers of excellent water quality, thus representing an important water sources for the State of Minas Gerais, so far under minimum human impacts. This area is the water divider of two important hydrographic basins: Doce and São Francisco rivers.

Several research activities have been conducted in the area among which the diversity of terrestrial plant and animal assessments are particularly important (e.g. Lara & Fernandes, 1996). Furthermore, the existance of high number of endemisms was pointed out by Giuliatti (1996).

Despite its importance as a potential area for water supply and aquatic resources, little it is known on the general limnology, particularly

concerning their biodiversity and the studies by Maia-Barbosa et al., (in press) and Cambraia (1992) are only existing data on some of the aquatic ecosystems in this area.

Considering that many years will be necessary to have a sounded evaluation of the existing aquatic biodiversity at specific level, preliminary surveys on distribution and structure of aquatic communities, assessments of the existing habitats/micro-habitats, availability of trophic resources, and of the distribution patterns of aquatic communities are of paramount importance in order to provide the basic information to define conservation priorities and sustainable uses for the area. Furthermore, considering the existing taxonomical constraints for the great majority of aquatic groups, it seems reasonable to adopt the utilization of higher taxonomic levels and/or functional groups of organisms, together with basic ecological features of the environments as suggested by Barbosa & Gáldean (1997), in order to obtain in a shorter time span some basic information on the existing biodiversity and to identify the major policies for its conservation and sustainable uses.

The present study had as its major objective the characterization of the benthic macroinvertebrate's communities in representative aquatic ecosystems of Serra do Cipó and its relationships with the availability of trophic resources and main features of the existing habitats and micro-habitats in the area. A monitoring for this area will then be defined, considering its potential uses as water supply for the near future and the fact that they constitute rivers possessing waters of excellent quality, more and more rare within the country.

### **The study areas**

The Serra do Cipó National Park lies at the central part of the State of Minas Gerais, specifically at the southern part of Cordilheira do Espinhaço (19°20' S; 43°44' W). The typical vegetation in the area is formed basically of "campos rupestres" within the range of 1200-1400 m and "cerrados", below 1000 meters. The soils in the area are predominantly latosols, deep and of low fertility (Giulietti, 1996). The rains are mainly concentrated during the period November-March, with an average of 1500 mm/year.

The following lotic systems were sampled during the year 1997, as representative of the area: rio Cipó and córrego Congonhas (São Francisco river watershed), and rio do Peixe, rio Preto do Itambé, and córrego Indaiá (Doce river watershed). These are environments possessing waters of high quality, proposed as "water quality standards" and constituting important water sources for future uses. Figure 1 shows a simplified hydrographic network for this area, showing the positions of these environments.

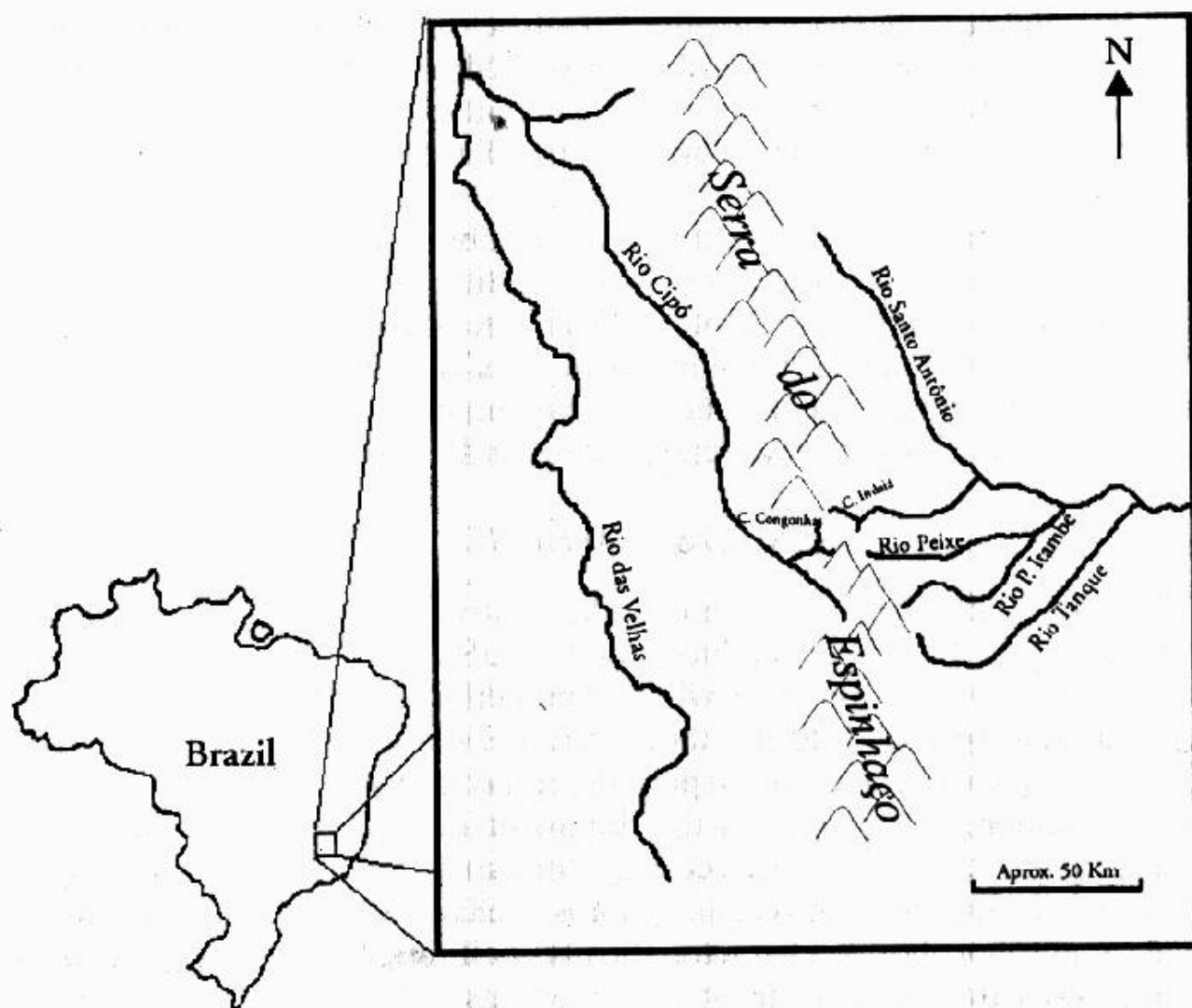


Fig. 1 – The Serra do Cipó National Park

### MATERIAL AND METHODS

20 sampling stations were chosen as representative of the area, in which *in situ* measurements of water temperature, pH, dissolved oxygen, and electrical conductivity were performed in February, March, (wet season) and May, September (dry season) of 1997. Water samples were also taken for measurements of total alkalinity and the concentrations of soluble reactive silica, ammonium-, nitrite-, and nitrate-nitrogen, soluble reactive phosphate and total nitrogen and phosphorus, according to the techniques described in Golterman et al. (1978) and Mackreth et al. (1978).

43 sediment samples were collected from these stations using a hand net and fixed with 10% formalin solution. In the laboratory these samples were rinsed with tap water through a 0.250 mm sieve and examined under stereomicroscope. The identified organisms were preserved with 70%

alcohol and are deposited in the scientific collection of the Institute of Biological Sciences, Federal University of Minas Gerais. At each sampling station the major trophic resources were identified considering both the field observations and the examinations of the biological material at the laboratory.

The communities' structure was established considering the existing knowledge on the recorded organisms, particularly those belonging to the groups Plecoptera, Ephemeroptera, Trichoptera and Diptera-Chironomidae. Furthermore, the major functional groups of the recorded organisms were also identified taken into account the existing trophic resources, as follows: scrapers, filters, herbivorous, carnivorous and detritivorous.

### RESULTS AND DISCUSSION

The waters are in general dark, relatively well oxygenated (>80% saturation) and of low conductivity (<20  $\mu$ S/cm), with the exception of some stretches at Cipó river where conductivities ranging between 70-80  $\mu$ S/cm were recorded during the rainy period and pHs ranging between 5.30 during the dry and rainy periods, respectively.

Ammonium-nitrogen is the dominant ion during the rainy period, reaching values c.972.1  $\mu$ g/l (córrego Indaiá) dropping to c.236.7  $\mu$ g/l (rio do Itambé). Soluble reactive phosphorus is characteristically low (< 20  $\mu$ g/l) and total phosphorus characteristically below 50  $\mu$ g/l, thus suggesting phosphorus limitation in most environments. On the other hand, soluble reactive silica is usually high, particularly during the rainy periods, reaching values of 53.4 mg/l (Cipó river).

Although there are differences among the studied ecosystems, these differences within the same period are small thus resulting in a similar pattern of water quality allowing for general classification of the whole system as possessing clear to dark waters, with no kind of particular contaminant, of low productivity and greatly dependent on allochthonous material as major sources of nutrients. Among the studied environments only the Cipó river would contain higher levels of nutrients, as demonstrated by the increased values of conductivity, although its soluble reactive phosphorus levels remain below 10  $\mu$ g/l. As reported previously by Maia-Barbosa et al. (in press), the high quality of these waters are a consequence of the low level of human occupation in the area, and the presence of the National Park of Serra do Cipó, which covers an area of c.33,800 ha. However it must be pointed out a potential threat to these waters which could be the increasing water demand for supplying,



particularly considering the proximity of the city of Belo Horizonte, with a population of c. 2.7 M inhabitants and relatively scarce of water sources, apart from subterranean waters.

The benthic macroinvertebrate communities are dominated by larvae of aquatic insects, namely Plecoptera, Ephemeroptera, Trichoptera, and Diptera-Chironomidae, also existing in some areas Crustacea, Bivalvia and Oligochaeta, in low densities.

Among the sampling sites the following were the major identified habitat types: river bed rocks, clay bed, aquatic macrophytes and riparian vegetation. Filamentous algae, mosses and lichens, and coarse and fine organic detritus onto or in between these habitats form the major micro-habitats in the area.

Considering these habitats and micro-habitats altogether, four major types and 6 secondary types of benthic macroinvertebrate communities were identified, as follows:

**1. Rocky substrata colonized by filamentous algae (bioderma)**

- 1.1. Communities types *Helicopsyche-Cricotopus*. Surfaces covered by filamentous algae and small patches of Bryophyta, particularly evident at córrego Congonhas. The major trophic category was formed by gathering collectors, namely *Baetis*, *Baetodes* (Ephemeroptera, Baetidae), *Phylloicus* (Trichoptera, Calamoceratidae), Odontoceridae (Trichoptera), *Cricotopus* (Diptera, Chironomidae). At this micro-habitat, scrapers (*Helicopsyche*) and herbivorous (*Cricotopus*) were the most characteristic taxa within the community.
- 1.2. Community type *Baetis* and Hydropsychidae: surfaces covered by filamentous algae and mosses, covered by more eutrophic waters, characteristic of the Cipó river near the locality Santana do Pirapama. The major trophic resource is the suspended fine particulated organic matter, used by the filter-feedings such as Hydropsychidae (Trichoptera), Simuliidae (Diptera) and Bivalvia. This community is also formed by *Baetis*, *Coryphorus* (Ephemeroptera, Baetidae and Trichorythidae), and Chironomidae (Tanytarsini genera varia, *Rheotanytarsus*, *Cricotopus*, *Thienemanniella*).
- 1.3. Community type *Hermanella* and *Grumichella*: surfaces covered by mosses characteristics of oligotrophic waters as found in Indaiá stream. The benthic community is formed mainly by gathering collectors and filter-feedings such as Gripopterygidae (Plecoptera), *Baetis*, *Baetodes*, *Camelobaetidius* (Ephemeroptera, Baetidae), *Hermanella*, *Hyllister* (Ephemeroptera, Leptophlebiidae), Hydropsychidae, *Helicopsyche*

(Trichoptera, Helicopsychidae), *Ochrotrichia* (Trichoptera, Hydroptilidae), *Grumichella* (Trichoptera, Leptoceridae), Simuliidae, and *Beardius*, Tanytarsini genera varia, *Thienemanniella*, *Corynoneura*, *Cricotopus* (Chironomidae). This is a particular type of micro-habitat since the associated mosses trap fine suspended particles of organic matter which are completely used by benthic macroinvertebrates, differently from other microhabitats also possessing mosses (e.g. Cipó river) where not all the present organic matter is consumed, typical of eutrophic environments.

- 1.4. Community type *Farrodes* and Hydropsychidae: surfaces covered by a bioderma composed mainly of bacteria and microscopic algae, characteristic of Peixe river, at Sobrado farm. The community is mainly composed of gathering collectors and filter-feeding such as *Hagenulopsis*, *Farrodes* and *Homothraulus* (Ephemeroptera, Leptophlebiidae), *Coryphorus* (Ephemeroptera, Trichorythidae), Trichoptera Hydropsychidae, Simuliidae, and also *Rheotanytarsus*, Tanytarsini genera varia, *Cricotopus*, *Corynoneura*, *Ablasbesmyia* (Diptera, Chironomidae).

Among the Ephemeroptera there seems to exist a competition between Baetidae and Leptophlebiidae. This last group possesses the same trophic needs as those of the Caenidae family, particularly abundant in the northern hemisphere within rivers rich in organic matter, accumulated by mosses living on the stony surfaces (Gáldean, 1994). Trichorythidae were generally present in low densities, probably due to higher capacity of Baetidae and Leptophlebiidae in utilizing the available trophic resources.

Comparing the taxonomic composition of Ephemeroptera and Trichoptera it is evident their distribution among the studied environments: in non impacted areas *Hermanella* is the predominant group while in environments showing some degree of eutrophication, *Farrodes* is the dominant one; the sites showing higher degree of eutrophication are mainly dominated by *Baetis*.

- 1.5. Community type *Baetis* and *Farrodes*: surfaces without mosses or filamentous algae although showing a thin bioderma, high water velocity, as occurring in Tanque river, at Ipoema. The community is mainly formed by gathering collectors and scrapers, namely: Leptophlebiidae and Trichorythidae (Ephemeroptera), Philopotamidae, Helicopsychidae and Leptoceridae (Trichoptera), *Cricotopus*, *Nanocladius*, *Rheotanytarsus*, *Polypedilum*, *Larsia* (Chironomidae).
- 1.6. Community type *Spaniophlebia*: surfaces mainly formed by coarse gravel and detritus, as occurring in the Cipó river, at the Sumidouro village. Gathering collectors, filter-feeders and herbivorous were the

predominant organisms, represented by *Farrodes*, *Hermanella*, *Spaniophlebia* (Ephemeroptera, Leptophlebiidae and Oligoneuriidae), Trichoptera Hydropsychidae, *Cricotopus*, *Nilotanypus*, *Corynoneura*, *Thienemaniella*, Tanytarsini genera varia, *Rheotanytarsus*, *Stenochironomus*, *Polypedilum*, *Endochironomus* (Diptera, Chironomidae).

This area is particularly rich in Ephemeroptera Trichorythidae (*Leptohyphodes*), maybe favoured by the low competition with Baetidae and Leptophlebiidae.

## 2. Clayey substrata

It is a peculiar substratum of the area, only found in Tanque river which possesses a benthic community basically composed of filter-feeders and detritivorous, namely Bivalvia Sphaeriidae, Oligochaeta and Ephemeroptera (*Baetis*), Tanytarsini genera varia, *Rheotanytarsus*, *Polypedilum* and *Stenochironomus* (Chironomidae). Among all the sampling sites this was the only one showing the co-existence of high numbers of Bivalvia (c. 300 organisms/m<sup>2</sup>) and Oligochaeta (c. 200 organisms/m<sup>2</sup>). According to our understanding, Oligochaeta would feed on the Bivalvia fecal pellets which in return would provide the oxygenation of the sediment surface through bioturbation, thus rendering a self-sustaining condition of available trophic resources and the maintenance of the existing microhabitat.

## 3. Aquatic macrophytes

Although not widespread within the studied area, the aquatic macrophytes constitute a particular microhabitat providing substrata for a highly diversified macrofauna, there existing gathering collectors, miners, scrapers and detritivorous, as founded particularly at the rivers Peixe and Preto do Itambé. The existing communities are composed by Ephemeroptera Baetidae, Leptophlebiidae (*Farrodes*) and Trichorythidae (*Coryphorus*), Odonata, Trichoptera Odontoceridae (*Marilia*), and Hydroptilidae. Particularly among the Chironomidae a high richness it was observed, mainly Tanytarsini genera varia (larvae of *Rheotanytarsus*), *Cricotopus*, *Corynoneura*, *Thienemanniella* and *Ablasbesmyia*.

This structure can be interpreted as a response of the ecosystem to the eutrophication process due to prevailing organic loads mainly from surrounding farm lands.

## 4. Riparian vegetation

This habitat generally shows a more stable community structure, well adapted to the seasonal water level fluctuation. Furthermore it constitutes a



refuge for several benthic macroinvertebrates. Among this community there are mainly gathering collectors, scrapers, and detritivorous although some filter-feeders are also found. The common existing groups are: Ephemeroptera (*Baetis*, *Farrodes*), Trichoptera Leptoceridae and Hydropsychidae, *Stenochironomus*, *Fissimentum*, *Polypedilum*, *Cryptochironomus*, *Microtendipes*, *Chironomus*, Tanytarsini genera varia (Chironomidae).

The above described typology, based on the composition and structure of the existing benthic communities and their characteristic habitats, is proposed as an important tool for the conservation of the aquatic ecosystems of Serra do Cipó. Its utilization is based on the knowledge of the structure and functioning of one of the most important communities within lotic ecosystems and their existing habitats. Our conclusion is that this knowledge would provide the necessary elements for the definition of feasible conservation strategies for the area. Furthermore, as pointed out previously (Barbosa & Găldean, 1997), this typology emphasizes the need for a better interaction of the existing taxonomical and ecological knowledges about the organisms.

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#### PROPUNERE DE TIPOLOGIE A RÂURILOR DIN SERRA DO CIPÓ (MINAS GERAIS, BRAZILIA) BAZATĂ PE DIVERSITATEA MACRONEVERTEBRATELOR BENTONICE ȘI A HABITATELOR EXISTENTE

#### REZUMAT

Cercetarea râurilor din Serra do Cipó, o zonă montană a statului Minas Gerais, Brazilia, a dus la identificarea mai multor tipuri de comunități de macronevertebrate bentonice, acțiune necesară pentru inventarierea habitatelor și microhabitatelor cât și a resurselor trofice disponibile. Studiul a fost concentrat asupra larvelor de insecte reofile din grupele Plecoptera, Ephemeroptera, Trichoptera și Diptera Chironomidae, totodată efectuându-se măsurători ale parametrilor fizico-chimici ai apei (temperatură, pH, conductivitate, alcalinitate totală, oxigen dizolvat, concentrația unor



nutrienți, viteza curentului, adâncimea). Râurile au fost investigate avându-se în vedere diversitatea taxonomică și a grupelor funcționale precum și distribuția acestora. Au fost identificate 4 tipuri principale de habitate, fiecare caracterizat de o anumită comunitate. Rezultatele vor servi pentru fundamentarea unei strategii de conservare a resurselor acvatice din această zonă a statului Minas Gerais.

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