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The importance of a Biosphere Reserve of Atlantic Forest for the conservation of stream fauna

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Abstract

Preservation of terrestrial fauna and flora has been the main reason for the settlement of most protected areas in the past 30 years, but although those areas may include water bodies, this does not necessarily mean that the biodiversity of freshwater environments are also protected. In the present study, the fauna inventory of eight streams (1st, 2nd, 4th and 5th orders) of three microbasins of Japi Mountain, a Biosphere Reserve of Atlantic Forest recognised by UNESCO since 1994, located in São Paulo state, southeast of Brazil, was conducted. The hypothesis of this study is that the conservation of this area is important for the maintenance of the aquatic biodiversity of this biome, and so, this world *hotspot* deserves priority conservation actions. From 2005 to 2007, benthic macroinvertebrates, fishes and, eventually, anuran amphibians were sampled in these streams. The results showed that Japi Mountain contributes to the conservation of 138 taxonomic units of the aquatic biota and covers a rich and representative biodiversity of freshwater fauna of the world (0.2%), Neotropical region (0.9%), Brazil (2.4%) and São Paulo state (17.9%). The studied streams in the Environmental Protection Area help protect endangered taxa like the fishes *Neoplecostomus paranensis* and *Pareiorhina* cf *rudolphi*, and shelter freshwater invertebrates and fishes whose distribution is restricted to the Brazilian territory. Japi Mountain is also an important haven of species that was missing there like the frog species *Vitreorana eurygnatha*. Thus, this species inventory emphasises the importance of conservation actions of the freshwater environments of this Biosphere Reserve of Atlantic Forest.

Keywords: amphibians, freshwater, fish, invertebrates, protected areas.

A importância de uma Reserva da Biosfera da Mata Atlântica para a Conservação da Fauna de Riachos

Resumo

A conservação da fauna e flora terrestres tem sido a principal razão para o estabelecimento da maioria das áreas protegidas nos últimos 30 anos, porém, apesar de muitas destas áreas apresentarem corpos d'água, isto não significa necessariamente que a biodiversidade dos ambientes dulcícolas também estará protegida. No presente trabalho foi realizado o levantamento da fauna de oito riachos (1ª, 2ª, 4ª e 5ª ordens) de três microbacias da Serra do Japi, localizada no estado de São Paulo e reconhecida como Reserva da Biosfera da Mata Atlântica pela UNESCO desde 1994. A hipótese do estudo é de que a conservação desta área seja de grande importância para a manutenção de sua biodiversidade aquática, comprovando assim a necessidade de ações prioritárias de conservação deste bioma. No período de 2005 a 2007 foram amostrados nestes riachos os macroinvertebrados bentônicos, peixes e, eventualmente, anfíbios anuros. Os resultados revelaram que a Serra do Japi contribui na conservação de 138 unidades taxonômicas da biota aquática e abriga rica e representativa biodiversidade da fauna de água doce do mundo (0,2%), da região neotropical (0,9%), do Brasil (2,4%) e do estado de São Paulo (17,9%). Os riachos das áreas de proteção ambiental estudados ajudam na proteção de táxons listados como vulneráveis a extinção no estado, como *Neoplecostomus paranensis* e *Pareiorhina* cf *rudolphi*, e abrigam animais dulcícolas de distribuição restrita ao território brasileiro. A Serra do Japi também constitui um importante reduto de espécies até então desaparecidas, como o anuro *Vitreorana eurygnatha*. Assim, este levantamento enfatizou a importância de ações de conservação dos ambientes aquáticos desta Reserva da Biosfera da Mata Atlântica.

Palavras-chave: anfíbios, água doce, peixes, invertebrados, áreas protegidas.

Introduction

Preservation of terrestrial fauna and flora has been the main reason for the settlement of most protected areas in the past 30 years, and because most include water bodies, some of these protected areas also protect the biodiversity of freshwater environments. However, as emphasised by Agostinho et al. (2005), these areas need the inventory studies of species to determine their effective importance to the preservation of the aquatic biota.

The lack of basic knowledge on the biodiversity of freshwater environments in Brazil is an obstacle to preservation studies (Agostinho et al., 2005). According to Rocha (2002), only 30% of the freshwater invertebrate diversity is presently known and some taxon as Porifera, Cnidaria, Platyhelminthes, Nemertea, Nematoda, Nematomorpha, Bryozoa, Annelida and several insect groups need specialists, collections and/or minimum updated information on identification, distribution and autoecology.

Unlike invertebrates, vertebrates are better known. Regarding the freshwater diversity, fish deserves attention because Brazil is the holder of the largest ictiofauna of the world (Lewinsohn and Prado, 2002; Agostinho et al., 2005). Considering the occurrence and distribution of 2,587 freshwater fish species registered in the country (Buckup et al., 2007), headwater streams have an essential role to preserve this group as 70-80% of this richness is exclusively and/or preferably found in small water bodies (Buckup, 1999; Castro, 1999; Pompeu et al., 2009; Oyakawa and Menezes, 2010).

The knowledge availability also reflects the number of species considered endangered, and the most studied groups present a greater number of species in the Red Book List of the Endangered Brazilian Fauna (Machado et al., 2008). From 627 species, 194 (31%) are from freshwater, 134 are fish, 16 are amphibians and 45 are invertebrates.

Besides the need of knowing if the Environmental Protection Areas help the conservation of non-threatened or threatened aquatic taxa, the functionality effectiveness of these areas need to be analysed regarding their contribution as a reserve of local, regional and global biodiversity (Balian et al., 2008). Thus, in the present study, we made the fauna inventory of streams of three micro basins in Japi Mountain, located in a reserve of the Atlantic Forest. We also aimed to contribute to the knowledge of threatened species and areas that may serve as shelter for groups with restrict geographical distribution. The hypothesis of this study is that the conservation of this area is important for the maintenance of the aquatic biodiversity of this biome, and so, this world *hotspot* deserves priority conservation actions.

Methods

Study area

Japi Mountain is located in the countryside of São Paulo state, is part of the Environmental Protection Areas (EPAs) of Jundiaí (47.67% of the total area), Cabreúva (41.16%) and Cajamar (0.68%), and integrates the Piracicaba-Capivari-Jundiaí Water Conservation and Management Unit that gathers important effluents of the Medium Tiete River basin (Figure 1). Japi Mountain has a total extension of 19,170 ha or 350 Km^2 and it is considered one of the last and biggest remaining continuous area of deciduous seasonal forest area of the state of São Paulo (Morellato, 1992).

In 1994, Japi Mountain was classified by UNESCO as a Reserve of the Atlantic Forest Biosphere and a world *hotspot* deserving priority actions to preserve its biodiversity. The protection and preservation of Japi Mountain are supported by several legal mechanisms like: the Protection Law for Animals (Decree No 24645/34); Water Code (Decree No 24634/34); Mining Code (Decree No 227/67); Fauna Protection Law (Law No 5197/67); Law for the Creation of Ecological Stations and Environmental Protection Areas (Law No 6938/6902/ 81); Article No 225 of the Federal Constitution 1988 that imposes the public power the preservation and restoration of ecosystems, preservation of diversity and integrity of genetic heritage of the Country; Forestry Code (Federal Law No 4771/65); State Law No 9146/95 about financial compensation mechanisms for municipalities that have protected areas; Resolution No 11 of March 8th 1983 of the Defense Council of the Historical, Archeological, Architectural and Tourism Heritage (Condephaat) on the protection of Japi Mountain area. However, as emphasised by Jesus and Cavalheiro (2004), such legal mechanisms are not enough to guarantee the protection of the area because 90% of their lands are private properties, the fiscalisation is precarious, and the lack of knowledge about its biodiversity makes its monitoring and management difficult.

The occupation and degradation of Japi Mountain is marked by the construction of Santos-Jundiaí Railroad in 1867 which led to logging of the area so that wood could be used as fuel by locomotives. Later, due to the need of human settlement expansion in the region, there was the substitution of natural areas for cultivation areas (coffee, sugarcane, rice, wheat, beans, potato, *Pinus*) and cattle farming. Recently, the construction of two important highways (Rodovia Anhangüera and Rodovia Marechal Rondon) has brought part of the development of the city of São Paulo to the cities of Jundiaí, Campinas and Itu, increasing the urbanisation process in natural areas close to these great urban centers (Jesus and Cavalheiro, 2004). Presently, the environmental problems of Japi Mountain are associated with real estate speculation, fires caused by agricultural activity, cattle raising, balloons, vegetation suppression and land movement by private individuals, hunting, mining and vandalism (Yoshida and Gonçalves, 2004).

The conservation state of Japi Mountain streams is related to the environmental zoning that defines the areas of the Biological Reserve and areas of the Preservation Zone (State Decree No 43.284/98 of São Paulo and Municipal Law No 417/04 of Jundiaí). Only three out of eight studied stretches of Ribeirão Ermida microbasin are located inside the Biological Reserve and are more preserved than the

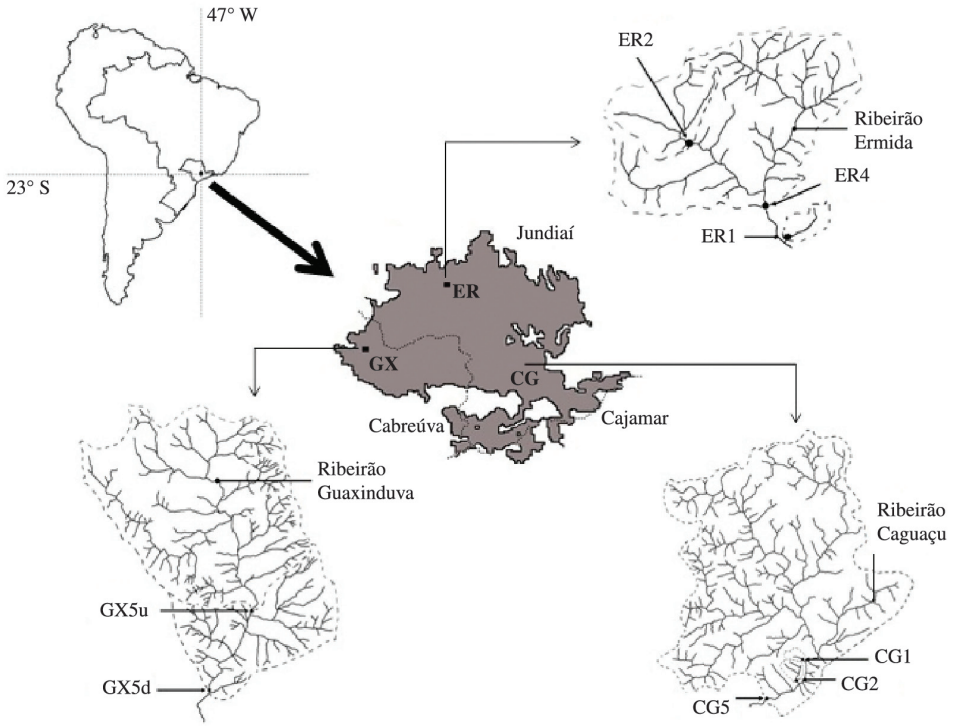

Figure 1. Location of the study area (South America, southeastern Brazil, São Paulo state) with the indication of de limits of Japi Mountain (draw in the center), including the municipalities of Jundiaí, Cabreúva and Cajamar. The hydrographic maps show details of the sampled sites in each of the three studied microbasins (Er- Ermida, GX- Guaxinduva, CG- Caguaçu). The numbers (1, 2, 3, 4, 5) refer to the order of the sampled stretches; for Guaxinduva an upstream (GX5u) and a downstream stretch (GX5d) were sampled.

stretches of Guaxinduva and Caguaçu microbasins that are located inside the Preservation Zone, where there is the presence of anthropic activity as agro-forestry-pastoral activities and small residential farms (Table 1, Figure 1).

Because the studied streams present water flow throughout the year, they fit the classification of perennial water courses and are part of a dendritic drainage net (Figure 1), typical of regions with prevalence of rocks that offer resistance to the erosive process (Christofoletti, 1980). Santoro and Machado (1992) reported that in the case of Japi Mountain this resistance is offered by predominant quartzite rocks in the region.

The relief of the terrain where the streams are located presents very weak to medium declivity (from < 6% to 15%) (Florenzano, 2008). Except for three 5th order stretches, the other sampled stretches are small, narrow and shallow, with fast current, high content of dissolved oxygen, low values of temperature and electric conductivity (Table 1). These characteristics for headwater streams have also been emphasised by other authors (Buckup 1999; Valente and Gomes, 2005).

Collection of environmental data

The morphological characteristics of the microbasins were based on the topographical map of Japi Mountain in a 1:25000 scale, obtained from the Department of Planning of Jundiaí City. Rainfall and air temperature data of the region of Jundiaí were obtained from the site of the Integrated Centre of Meteorological Information – CIIAGRO (www.ciiagro.sp.gov.br, accessed in July, 2008). The measurements of the stream canal and the limnological characteristics were carried out at all collection times of biotic data and at three distinct points of the longitudinal axis of each studied stretch. The streams were characterised according to their length, depth and luminosity (Minipa digital lightmeter, MLM1010 model) and the following physical and chemical water parameters: current (floating method), temperature (°C, measured by an Incoterm thermometer for maximum and minimum temperatures), dissolved oxygen (mg/L, determined by an Instrutherm oxymeter, model MO880), pH (measured by a digital pocket pHmeter, model pH1700), electrical conductivity (mS.cm^{-1}, measured with a pocket digital conductometer, model CD840).

Collection of fauna data

The macrofauna was collected at eight stream stretches of Japi Mountain at two periods: (1) monthly from February 2005 to January 2006, and (2) seasonally, twice in the dry season of 2006 (July and August) and twice in the rainy season of 2007 (January and February). Three microbasins were sampled: Ermida (ER), Guaxinduva

Table 1. Location, stream morphometry and physical and chemical characteristics of the water (mean values) determined in the eight studied sites, monthly or seasonally (July and August – dry season, January and February – wet season). Microbasin/Stream = ER- Ribeirão Ermida, CG- Ribeirão Caguaçu, GX- Ribeirão Guaxinduva. Order/Stretch = 1st, 2nd, 4th, 5th orders; u- upstream, d- downstream. Zone = CZ- conservation zone, BR- biological reserve.

Analyzed parameters	Fazenda da Corda	Churras	DAE	Paraiso	Trial	Santa Marta	Dog	Antônio Lopes Pardo
Microbasin/Stream	GX	GX	ER	ER	ER	CG	CG	CG
Order/Stretch	GX5u	GX5d	ER1	ER2	ER4	CG1	CG2	CG5
EPAs	Cabreúva	Cabreúva	Jundiaí	Jundiaí	Jundiaí	Jundiaí	Jundiaí	Jundiaí
Zone	CZ	CZ	BR	BR	BR	CZ	CZ	CZ
Human activity	yes	yes	no	no	no	yes	yes	yes
Altitude (m)	900	850	853	1050	904	800	750	750
Latitude	23°17'5"	23°17'4"	23°13'39"	23°14'36"	23°13'46"	23°17'3"	23°18'28"	23°18'27"
Longitude	47°0'29"	47°1'33"	46°58'7"	46°57'7"	46°58'1"	46°56'23"	46°56'29"	46°56'29"
Extension (Km)	6.25	8.60	0.75	1.73	3.83	0.23	0.63	8.53
Drainage area (Km^2)	15.71	22.32	0.38	2.04	10.30	0.12	0.22	27.03
Declivity (%)	4	5	15	10	10	14	4	11
Number of segments	197	272	1	8	63	1	4	234
Width (m)	4.44	4.72	1.3	1.6	3.6	3.4	4.2	4.6
Depth (cm)	16.72	24.27	6.7	16.7	25.1	19.0	28.5	29.8
Current (m/s)	0.52	0.68	0.36	0.65	0.63	0.49	0.63	0.66
Dissolved oxygen (mg/L)	10.55	10.87	9.76	10.64	11.11	11.30	9.92	10.03
pH	6.11	6.17	6.60	5.92	5.77	6.70	6.60	6.69
Conductivity (mS/cm)	0.01	0.01	0.01	<0.01	0.01	0.02	0.02	0.02
Luminosity (lux)	7425	16717	1240	2662	1857	4525	1019	2268
Period of data sample	2005-2006	2005-2006	2006-2007	2005-2007	2005-2007	2006	2006-2007	2006-2007
Frequency of sample	monthly	monthly	seasonally	monthly and seasonally	monthly and seasonally	dry season	seasonally	seasonally

(GX) and Caguaçu (CG), including stretches of 1st, 2nd, 4th 5th orders (sensu Strahler classification (Stanford, 1996)), with the orders indicated by numbers near the acronyms' microbasin (Table 1).

Monthly collections were conducted at four stream stretches (GX5u, GX5d, ER2, ER4) (Figure 1). In each stretch, six samples of the macroinvertebrate community were collected in a 30 m extension with a Surber sampler (30 × 30 cm and 500 mm mesh). The collected material was stored, transported in ice and later transferred to a refrigerator at 7 °C until screening (no later than three days after the collection). Macroinvertebrate screening was done visually by spreading the material in a white tray with incident light. The ictiofauna and, eventually, young forms of amphibians were collected along the bank vegetation with a 5 mm mesh sieve, fixed in formaldehyde 10% and preserved in alcohol 70% for posterior identification.

Seasonal collections were carried out in six stream stretches (ER1, ER2, ER4, CG1, CG2, CG5) (Figure 1). In each stretch, five areas of riffles of 5 m long each were selected in a 100 m extension for the aquatic fauna collections. In each area, four samples of macroinvertebrates (two from the banks and two from the middle of the stream) were collected with a Surber sampler (15 × 15 cm and 500 mm mesh), and the visually predominant substrate type in the sampler (sand, litter, gravel, rocks) was recorded. Next, the whole 5 m area was scanned with a trawl and a dip net (4 mm mesh) to capture fish and, eventually, young and adult anuran amphibians. The macroinvertebrates were fixed and preserved in alcohol 70% and the fishes were fixed in formaldehyde 10% and preserved in alcohol 70% for posterior identification. Macroinvertebrate screening was done with the use of a stereomicroscope.

The collected macroinvertebrates were deposited in the collection of the NGO Associação Mata Ciliar and the Laboratory of Stream Ecology of the Department of Zoology (UNESP – Botucatu). The fish species were deposited in the collection of the Museum of Zoology of USP and the Ichthyology Laboratory of UNESP - São José do Rio Preto.

The identification level of collected organisms was conducted mainly according to the adopted taxonomic levels in programs of macroinvertebrate and fish monitoring, and to the availability of identification keys and of specialists that could verify the identification of collected organisms. The study by Melo (2003) was used to identify Crustacea Decapoda; the studies of Lopretto and Tell (1995), Merritt and Cummins (1996), Nieser and Melo (1997), McCafferty (1998), Fernández and Dominguez (2001), Da-Silva et al. (2002), Costa et al. (2004), Olifiers et al. (2004), Paprocki et al. (2004), Rio Grande do Sul (2006), Passos et al. (2007), Calor (2007) and Manzo and Archangelsky (2008) were used for Insecta identification. The researchers Dr. Gustavo Melo, from the Museum of Zoology of USP, Dr. Sérgio L. S. Bueno, from the Institute of Biosciences of USP, and Dr. Célio Magalhães, from the National Institute of Amazon Research, were consulted for the crustacean identification. The specialists, Dr Melissa O. Segura, Dr. Mateus Pepineli and Dr. Irineu de S. Onofre, from the Department of Limnology of UFSCar, verify the identification of Coleoptera-Elmidae, Diptera-Simuliidae and Odonata, respectively. Dr. Francisco de A. G. de Melo confirmed the identification of Insecta-Orthoptera.

The fish identification was based on the studies by Britski (1972), Menezes et al. (2007), Buckup (1992), Garutti and Britski (2000), Chamon et al. (2005) and confirmed by the specialists Dr. Osvaldo T. Oyakawa, from the Museum of Zoology of USP, and Dr. Francisco Langeani Neto, from the Department of Zoology and Botany (UNESP - São José do Rio Preto).

The amphibians were identified by Daniel Contieri Rolim, from the Herpetology Laboratory of the Department of Zoology UNESP - Botucatu, who utilised the taxonomic key published by Ribeiro et al. (2005) and the descriptions done by Bokermann (1963) and Rada et al. (2007); Dr. Célio Fernando Baptista Haddad, from the Department of Zoology of UNESP-Rio Claro, confirmed their identification.

Results

The 26,219 specimens, representing 138 taxonomic units and mainly consisting of organisms from the aquatic macrofauna (Tables 2 and 3), were collected in the eight studied streams of Japi Mountain from 2005 to 2007. If each identified taxonomic unit is considered as an equivalent to a species, then Japi Mountain collaborates with almost 20% of the freshwater biodiversity of São Paulo state (Table 4).

For the macroinvertebrate groups whose identification was more refined (Crustacea and Insecta), the importance of Japi Mountain for the conservation of Brazilian aquatic biodiversity is more evident because the area helps maintain 50% of the families and 25% of the freshwater Decapoda and Insecta genera of Brazil (Tables 2 and 5).

Analysing the geographical distribution of nine collected fish families, except for Poeciliidae and Cichlidae, Japi Mountain streams contribute to conserve the ichthyofauna restricted to the American continent, mainly Callichthyidae and Erythrinidae exclusive to South America (Table 3).

Although anurans are not a target in the collection methodology, they were occasionally caught with the fish. Tadpoles of this Centrolenidae species were collected in stream stretches located on Santa Marta Farm (CG1) and at Dog (CG2), outside the area destined to the Biological Reserve of Japi Mountain. From the data published, it is verified that Japi Mountain contributes to the preservation of approximately 14% (31 out of 225 species) of anuran amphibians recorded in São Paulo state (Table 4).

Discussion

The average values of physical and chemical measured parameters indicate that the water in the studied streams has little deleterious anthropic influence (based on values of CONAMA Resolution 357/2005) and the studied average variations may be a reflection of the spatial differences related to the conservation state of the stretches as well as natural characteristics of streams like order, morphology and geology of the microbasin. Slightly acid pH, typical

Table 2. List of the invertebrates sampled in eight streams located in Japi Mountain in the period of 2005-2007. Taxonomic levels and sequence based on Ruppert et al. (2005).

PROTOZOA – "Amoebozoa" – "Lobosea" – testate amebas
ANIMAL
Cnidaria - Hydrozoa - *Hydra*
Platyhelminthes – "Turbellaria"
Tricladida
Temnocephalida - *Temnocephala*
Nemertea
Mollusca
Gastropoda
Bivalvia
Annelida
Polychaeta – Histriobdellidae - *Stratiodrilus*
Oligochaeta
Nematoda
Nematomorpha – Gordioida
Arthropoda
Chelicerata - Arachnida - Acari
Crustacea
Phyllopoda – Cladocera
Malacostraca
Decapoda
Aeglidae - *Aegla paulensis* Schmitt, 1942
Trichodactylidae - *Trichodactylus fluviatilis* Latreille, 1828
Palaemonidae - *Macrobrachium iheringi* Ortmann, 1897
Amphipoda – Gammaridea
Isopoda
Maxillopoda
Copepoda
Ostracoda
Tracheata – Hexapoda
Collembola
Isotomidae
Sminthuridae
Onychyuridae

Table 2. Continued with Hexapoda. Taxonomic levels based on Merritt and Cummins (1996).

Ephemeroptera
Baetidae
Americabaetis Kluge, 1992
Apobaetis Day, 1955
Baetodes Needham & Murphy, 1924
Camelobaetidius Demoulin, 1966
Cloeodes Traver, 1938
Paracloeodes Day, 1955
Tupiara Salles, Lugo-Ortiz, Da-Silva & Francischetti, 2003
Waltzoyphius McCafferty & Lugo-Ortiz, 1995
Zelusia Lugo-Ortiz & McCafferty, 1998
Caenidae - *Caenis* Stephens, 1835
Euthyplociidae - *Campylocia* Needham & Murphy, 1924
Leptohyphidae
Leptohyphes Eaton, 1882
Traveryphes Molineri, 2001
Tricorythodes Ulmer, 1920
Tricorythopsis Traver, 1958
Leptophlebiidae
Askola Peters, 1969
Farrodes Peters, 1971
Hylister Domínguez & Flowers, 1989
Massartella Lestage, 1930
Miroculis Edmunds, 1963
Thraulodes Ulmer, 1920
Traverella Edmunds, 1948
Odonata
Aeshnidae
Aeshna Fabricius, 1775
Coryphaeschna Williamson, 1903
Limnetron Förster, 1907
Calopterygidae
Coenagrionidae - *Argia* Rambur, 1842
Corduliidae - *Navicordulia* Machado & Costa, 1995
Gomphidae - *Progomphu*s Selys, 1854
Libellulidae - *Brechmorhoga* Kirby, 1894
Megapodagrionidae
Heteragrion Selys, 1862
Oxystigma Selys, 1862
Orthoptera - Gryllidae - Nemobiinae/Pteronemobiini

of quartzite soils (Rodriguez and Shepherd, 1992), was probably the factor that influenced the average values of water pH between 5.8 to 6.7.

Considering the inventory done by Biota Project FAPESP (Steiner and Amaral, 1999), it is possible to infer that Japi Mountain is an important area to conserve unique species described for the state of São Paulo, like Nemertea *Prostoma eilhardi* (Montgomeri, 1894) (Forneris, 1999b) and Nematomorpha *Paragordius flavescens* Linstow, 1906 (Forneris, 1999c), even with the low identification resolution of some less abundant taxa. Besides the validity of the record of Temnocephalida order for the state, not cited by the Biota project (Forneris, 1999a), when contributing to the preservation of this group, Japi streams help to maintain the ecological ectosymbiosis relation between temnocephalida and crustraceans of the *Aegla* (Amato et al., 2003) and *Trichodactylus* genera (Amato et al., 2006). Still using the Biota Project FAPESP inventory results (Steiner and Amaral, 1999), Japi Mountain also collaborates for the conservation of freshwater polychaete of the *Stratiodrilus*

Table 2. Continued with Hexapoda. Taxonomic levels based on Merritt and Cummins (1996).

Plecoptera
Gripopterygidae
Gripopteryx Pictet, 1841
Guaranyperla Froelich, 2001
Paragripopteryx Enderlein, 1909
Tupiperla Froehlich, 1969
Perlidae
Anacroneuria Klapálek, 1909
Kempnyia Klapálek, 1916
Hemiptera
Belostomatidae - *Belostoma* Latreille, 1807
Hebridae - *Hebrus* Curtis, 1833
Naucoridae - *Ctenipocoris* Montandon, 1897
Veliidae - *Rhagovelia* Mayr, 1863
Megaloptera - Corydalidae - *Corydalus* Latreille, 1802
Trichoptera
Calamoceratidae - *Phylloicus* Müller, 1880
Ecnomidae - *Austrotinodes* Schmid, 1955
Glossosomatidae
Itauara Müller, 1888
Mexitrichia Mosely, 1937
Protoptilinae sp1
Helicopsychidae - *Helicopsyche* Siebold, 1856
Hydrobiosidae - *Atopsyche* Banks, 1905
Hydropsychidae
Leptonema Guérin, 1843
Smicridea McLachlan,1871
Hydroptilidae
Byrsopteryx Flint, 1981
Flintiella Angrisano, 1995
Neotrichia Morton, 1905
Leptoceridae
Grumichella Müller, 1879
Nectopsyche Müller, 1879
Notalina Mosely, 1936
Oecetis McLachlan, 1877
Triplectides Kolenati, 1859
Odontoceridae
Barypenthus Burmeister, 1839
Marilia Müller, 1880
Polycentropodidae - *Cyrnellus* Banks, 1913
Sericostomatidae – *Grumicha grumicha* Müller, 1879
Xiphocentronidae - *Xiphocentron* Brauer, 1870
Lepidoptera – Pyralidae

Table 2. Continued with Hexapoda. Taxonomic levels based on Merritt and Cummins (1996).

Coleoptera
Curculionidae
Dryopidae
Dytiscidae
Elmidae
Austrolimnius Carter & Zeck, 1829
Heterelmis Sharp, 1882
Hexacylloepus Hinton, 1940
Huleechius Brown, 1981
Phanocerus Spangler & Santiago, 1992
Macrelmis Mostchulsky, 1859
Neoelmis Musgrave, 1935
Promoresia Sanderson, 1954
Stegoelmis Hinton,1939
Xenelmis Hinton, 1936
Larvae C (based on Passos et al. (2007))
Larvae D (based on Passos et al. (2007))
Elminae sp1
Psephenidae
Psephenus Haldeman, 1853
Eubriinae sp1
Scirtidae
Diptera
Blephariceridae
Ceratopogonidae
Atrichopogon Kieffer, 1906
Bezzia Kieffer, 1899
Chaoboridae
Chironomidae
Dixidae
Empididae
Muscidae
Psychodidae
Simuliidae
Simulium anamariae Vulcano, 1962
Simulium incrustatum Lutz, 1910
Stratiomyidae
Tabanidae
Tipulidae
Hymenoptera
Diapriidae
Scelionidae

genus, and it is possible to suggest that *S. arreliai* Amaral & Morgado, 1997 is present in Japi, considering only the distribution information (proximity to Jaraguá peak) and hosts (*Aegla* sp.).

Regarding genera and species of crustacean and insects recorded only in Brazil, Japi Mountain streams stand out in the maintenance of the crustaceans *Aegla paulensis* (Bond-Buckup et al., 2008) and *Macrobrachium iheringi* (Coelho and Ramos-Porto, 1984), the Ephemeroptera *Tupiara* (Salles et al., 2003), the Plecoptera *Kempnyia* and *Guaranyperla* (Lecci & Froelich 2007) and the Trichoptera *Mexitrichia* (Flint et al., 1999).

Out of 121 fish species of streams recorded in the Atlantic Forest area in São Paulo state (Menezes et al., 2007), 31

Table 3. Taxonomic list of vertebrates sampled in eight streams located at the Japi Mountain, in the period of 2005-2007. The worldwide area of occurrence of the families is indicated as: SAm- South America, CAm- Central America, NAm- Norte America, NT- Neotropic, AF- Africa, OR- Orient. Taxonomic levels of fish groups based on Reis et al. (2003); occurrence data for fish based on Lucinda (2008) and Menezes et al. (2007) and for amphibians based on Duellman (1999).

List of vertebrates	Occurrence area
Pisces	
Order Characiformes	
Crenuchidae	NT
Characidium gomesi Travassos, 1956	
Characidium oiticicai Travassos, 1967	
Characidae	SAm, CAm, NAm
Astyanax paranae Eigenmann, 1914	
Astyanax sp.	
Oligosarcus paranensis (Menezes & Géry, 1983)	
Erythrinidae	SAm
Hoplias malabaricus (Bloch, 1794)	
Order Siluriformes	
Trichomycteridae	NT
Trichomycterus sp.	
Callichthyidae	SAm
Callichthys callichthys (Linnaes, 1758)	
Loricariidae	NT
Hypostomus ancistroides (Ihering, 1911)	
Neoplecostomus paranensis Langeani, 1990	
Pareiorhina sp.	
Heptapteridae	NT
Rhamdia quelen (Quoy & Gaimard in Freycinet, 1824)	
Order Cyprinodontiformes	
Poeciliidae	SAm, CAm, NAm, AF
Phalloceros harpagos Lucinda, 2008	
Phalloceros reisi Lucinda, 2008	
Order Perciformes	
Cichlidae	NT, AF, OR
Geophagus brasiliensis (Quoy & Gaimard, 1824)	
Class Amphibia	
Order Anura	
Centrolenidae	SAm
Vitreorana eurygnatha (A. Lutz, 1925)	
Leptodactylidae	NT
Crossodactylus sp.	
Ischnocnema guentheri (Steindachner, 1864)	
Physalemus cuvieri Fitzinger, 1826	

species (25%) were recorded in Japi Mountain (Rolla et al., 2012). In our study, ichthyofauna sampled in 8 streams represented a high percentage of orders (67%), families (82%), genera (50%) and species (47%) also surveyed by Rolla (2008) at fifteen collection stations of Japi Mountain.

Brazilian freshwater fishes are classified in nine orders, six of which occur in the streams of the Atlantic Forest (Oyakawa et al., 2006; Menezes et al., 2007). Characiformes, Siluriformes, Cyprinodontiformes, Synbranchiformes and Perciformes are broadly distributed worldwide and Gymnotiformes order presents distribution limited to Nearctic and Neotropical regions (Lévêque et al., 2008).

With identification refinement, it is noticed that Japi Mountain streams preserve broadly distributed genera and species nationwide (*Callichthys callichthys*, *Trichomycterus*, *Rhamdia quelen*, *Astyanax*, *Hoplias malabaricus*), species only distributed in the eastern and southeastern basins of the country (*Phalloceros harpagos* and *Geophagus brasiliensis*), and species limited to the basins of Alto Paraná, Tietê, Paraíba do Sul and Paranapanema rivers

Table 4. Total number (or the lowest estimated value) of freshwater macrofauna species described in the world, in the Neotropical region (NT), in Brazil, in the State of São Paulo (SP) and in Japi Mountain. References: [I]Manconi and Pronzato (2008); [II]Volkner-Ribeiro (1999); [III]Jankowski et al. (2008); [IV]Silveira and Schlenz (1999); [V]Schockaert et al. (2008); [VI]Forneris (1999a); [VII]Sundberg and Gibson (2008); [VIII]Forneris (1999b); [IX]Abebe et al. (2008); [X]Poinar Junior (2008); [XI]Forneris (1999c); [XII]Massard and Geimer (2008); [XIII]Forneris (1999e); [XIV]Bogan (2008); [XV]Avelar (1999); [XVI]Strong et al. (2008); [XVII]Simone (1999); [XVIII]Glasby and Timm (2008); [XIX]Steiner and Amaral (1999); [XX]Martin et al. (2008); [XXI]Righi (1999); [XXII]Balian et al. (2008); [XXIII]Forneris (1999d); [XXIV]Mugnai et al. (2010); [XXV]Magalhães (1999); [XXVI]Froehlich (1999a); [XXVII]Hubbard and Pescador (1999); Strixino and Strixino (1999); Carvalho (1999); Froehlich (1999a,b) (*without Coleoptera); [XXVIII]Lévêque et al. (2008); [XXIX]Buckup (1999) e Buckup et al. (2007) (stream ictiofauna); [XXX]Menezes et al. (2007) (ictiofauna of Atlantic forest streams); [XXXI]Rolla et al. (2012); [XXXII]Vences and Köhler (2008); [XXXIII]SBH (2010); [XXXIV]Araújo et al. (2009); [XXXV]Ribeiro et al. (2005).

Macrofauna	World	NT	Brazil	SP	Japi
Porifera	219[I]	65[I]	44[II]	6[II]	-
Cnidaria	13[III]	?	8[IV]	7[IV]	1
Platyhelminthes	1303[V]	150[V]	84[VI]	81[VI]	2
Nemertea	22[VII]	4[VII]	2[VIII]	1[VIII]	1
Nematoda	1801[IX]	281[IX]	?	?	1
Nematomorpha	326[X]	32[X]	10[XI]	1[XI]	1
Bryozoa	88[XII]	30[XII]	10[XIII]	6[XIII]	-
Bivalvia	1026[XIV]	226[XIV]	115[XV]	44[XV]	1
Gastropoda	4000[XVI]	533[XVI]	193[XVII]	70 [XVII]	1
Polychaeta	168[XVIII]	53[XVIII]	4[XIX]	3[XIX]	1
Olighochaeta	806[XX]	178[XX]	70[XXI]	46[XXI]	1
Acari	6149[XXII]	1330[XXII]	332[XXIII]	20[XXIII]	1
Isopoda	942[XXII]	109[XXII]	20[XXIV]	?	1
Amphipoda	1866[XXII]	127[XXII]	?	?	1
Decapoda	2832[XXII]	513[XXII]	116[XXV]	33[XXV]	3
Collembola	103[XXII]	28[XXII]	5[XXVI]	?	3
Insecta	75874[XXII]	8594[XXII]	3464[XXVII]	330[XXVII*]	97
Pisces	12740[XXVIII]	5546 [XXVIII]	2060[XXIX]	121[XXX]	31[XXXI]
Amphibia - Anura	3978[XXXII]	1661[XXXII]	849[XXXIII]	225[XXXIV]	31[XXXV]
TOTAL	114256	19460	7342	984	178
% of Japi biodiversity	0.2%	0.9%	0.4%	17.9%	

Table 5. Number of families and genera of the most abundant aquatic macroinvertebrates sampled in Japi Mountain, showing worldwide, national and local data. References: [I]Balian et al. (2008); [II]Melo (2003); [III]De Grave et al. (2008); [IV]Yeo et al. (2008); [V]Barber-James et al. (2008); [VI]Mariano and Froehlich (2007); [VII]Fochetti and Tierno de Figueroa (2008); [VIII]Lecci and Froehlich (2007); [IX]De Moor and Ivanov (2008); [X]Paprocki et al. (2004); [XI]Wagner et al. (2008); [XII]Pinho (2008); [XIII]Jäch and Balke (2008); [XIV]Benetti et al. (2006); ? scanty or inexistent data.

	Families			Genera		
Order	World	Brazil	Japi	World	Brazil	Japi
Decapoda	46[I]	7[II]	3	629[III, IV]	26[II]	3
Ephemeroptera	42[V]	10[VI]	5	400[V]	63[VI]	22
Plecoptera	16[VII]	2[VIII]	2	286[VII]	8[VIII]	6
Trichoptera	46[IX]	16[X]	12	610[IX]	51[X]	23
Diptera	29[XI]	23[XII]	13	~1389[XI]	?	?
Coleoptera	27[XIII]	11[XIV]	9	~730	?	?

(*Hypostomus ancistroides*, *Oligosarcus paranensis*, *Astyanax paranae*, *Characidium*, *Phalloceros reise*) (Buckup et al., 2007; Lucinda, 2008). It is noteworthy to point out that Japi Mountain streams also collaborated to conserve endangered species of armored catfish in São Paulo state - *Neoplecostomus paranensis* and *Pareiorhina* cf *rudolphi*.

Although anurans are not a target in the collection methodology, they were occasionally caught with the fish. From four identified species (Table 3), *Vitreorana eurygnatha* deserves attention because it was believed to be extinct in the region (Ribeiro et al., 2005). Tadpoles of this Centrolenidae species were collected in stream stretches

located on Santa Marta Farm (CG1) and at Dog (CG2), outside the area destined to the Biological Reserve of Japi Mountain. From the data published by Ribeiro et al. (2005) and Araújo et al. (2009), it is verified that Japi Mountain contributes to the preservation of approximately 14% (31 out of 225 species) of anuran amphibians recorded in São Paulo state (Table 4).

Concluding remarks - The Japi Mountain (Environmental Protection Areas of Jundiaí and Cabreúva municipalities) is effective in the conservation of aquatic fauna, comprising 138 taxonomic units and showing a rich and representative biodiversity of the freshwater fauna of the world (0.2%), Neotropical region (0.9%), Brazil (2.4%) and São Paulo state (17.9%). The streams of these Environmental Protection Areas help the conservation of taxa listed as vulnerable in the state of São Paulo, such as the fish species *Neoplecostomus paranensis* and *Pareiorhina* cf *rudolphi*. These areas also comprise important habitats for freshwater crustaceans, aquatic insects and fish of restrict distribution in South America and in restrict basins of Brazil. The importance of Japi Mountain for the conservation of stream fauna is also emphasised when the occurrence of unknown or believed to be extinct species in the studied streams, like the coleopteran *Huleechius* and the anuran *Vitreorana eurygnatha*, are considered. Thus, this species inventory emphasises the importance of conservation actions of the freshwater environments of this Biosphere Reserve of Atlantic Forest.

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