

Freshwater sponges from the Pampa Biome, Brazil, with description of a new species of *Oncosclera*¹

Esponjas continentais do Bioma Pampa, Brasil, com descrição de nova espécie de *Oncosclera*

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Abstract

The Environmental Protection Area of Ibirapuitã embodies the upper portion of the Ibirapuitã River, which drains a representative part of the Pampa Biome in Brazil. A survey for the sponge fauna in this region was needed in view of the few registers available and none for this protected area. Following that purpose, three expeditions were carried on in 2011, four in 2012 and one in 2013, along four stations in the Ibirapuitã River and one in Sarandizinho its contributing brook. Sampling was done crossing the river/brook rocky bottoms by foot and sampling the sponges manually. The study indicated the occurrence of a new species of the genus *Oncosclera* Volkmer-Ribeiro, *O. rosariae* n. sp., besides *O. navicella* and *O. schubarti* (Potamolepidae), and *Heteromeyenia insignis*, *Corvoheteromeyenia australis* and *Corvospongilla seckti* (Spongillidae). The surveyed assemblage is representative of stony shallow lotic environments subjected to remarkable high levels and low temperatures of the waters in the winter. The results disclosed the existence of five unique sponge assemblages of lotic environments for the whole Pampa Biome. A key to the sponge species occurring at the Environmental Protection Area of Ibirapuitã is presented.

Keywords: freshwater sponges, lotic environment, conservation.

Resumo

A Área de Proteção Ambiental do rio Ibirapuitã abrange todo o curso superior desse corpo d'água, resguardando, ao mesmo tempo, uma porção representativa do Bioma Pampa no Brasil. A região detinha escassos estudos voltados para as esponjas continentais, indicando a necessidade de levantamento extensivo. Esse foi realizado durante três expedições em 2011, quatro em 2012 e uma em 2013, em quatro estações de amostragem no leito do rio Ibirapuitã e uma no arroio Sarandizinho. As amostras foram coletadas manualmente, vadeando-se o leito rochoso de trechos dos mananciais. Em dois períodos sazonais distintos de 2012, foram colhidas amostras de água para avaliação dos parâmetros físicos e químicos. O estudo revelou a ocorrência de nova espécie do gênero *Oncosclera* Volkmer-Ribeiro, *O. rosariae* n. sp., além de *O. navicella*, *O. schubarti*, da família Potamolepidae, e *Heteromeyenia insignis*, *Corvoheteromeyenia australis* e *Corvospongilla seckti*, da família Spongillidae. As assembleias amostradas caracterizam ambientes lóticos rasos, de fundos pedregosos, com significativos aumentos de volume e redução de temperatura das águas no inverno. Os resultados evidenciam a existência de cinco assembleias de esponjas de ambientes lóticos únicas para todo o Bioma Pampa. Uma chave para as espécies de esponjas ocorrentes na Área de Proteção Ambiental do rio Ibirapuitã é apresentada.

Palavras-chave: esponjas de água doce, ambiente lótico, conservação.

¹ <http://zoobank.org/urn:lsid:zoobank.org:pub:5B2DB2C1-A705-4EAE-BC6C-8B48EC6A0CA1>

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Introduction

The South American Pampas are lowlands, covering more than 750.000 km² that include the Argentine provinces of Buenos Aires, La Pampa, Santa Fe, Entre Ríos and Córdoba; most of Uruguay; and the southern half of the Brazilian State of Rio Grande do Sul (Roesch *et al.*, 2009). Only 0.04% (about of 7.000 hectares) of this Biome is in conservations areas of integral protection. Among these, the Environmental Protection Area (EPA) of Ibirapuitã, in Rio Grande do Sul State is a federal conservation area in the Sustainable Use category, established with the Federal Decree n° 529 of May, 20th, of 1992, with an area of 316,882.75 ha. This EPA stands for the only Brazilian conservation unit of the Pampa Biome and its respective water reserves (Silva, 2008).

The knowledge of the freshwater sponge fauna of the Pampa Biome is geographically discontinuous. A retrospective indicates for the Pampa in Argentine the works of Bonetto and Ezcurra de Drago (particularly those of 1967, 1970) and Ezcurra de Drago and Bonetto, 1969, with focus in tributaries of the Paraná and Uruguay Rivers at the northeastern part of the country. A sole report was produced by Cordero (1924) for Uruguay. The largest number of sponges detected at southern Brazil is in fact of the southern half of Rio Grande do Sul State's provenance, i.e. the Brazilian part of the Pampa Biome (De Rosa-Barbosa, 1984; Fontoura *et al.*, 2004; Silva and Volkmer-Ribeiro, 1998; Tavares *et al.*, 2003, Volkmer-Ribeiro *et al.*, 2007a, 2007b, 2009).

It should be noted that these studies, particularly those obtained from the western edge of the Brazilian Pampa, are isolated, and in no way represent a comprehensive survey of the sponge fauna of the region, or even of the sampled water bodies. In this sense, the present study provides new data regarding a sponge survey along the Ibirapuitã River, in an Environmental Preservation Area entirely located

within the Brazilian Pampa region. In addition, a new species of freshwater sponge for the Brazilian Pampa is described herein and a key to the sponge species occurring at the Environmental Protection Area (EPA) of Ibirapuitã is provided.

Material and methods

Study area

The Environmental Preservation Area (EPA) of Ibirapuitã encompasses the upper, middle and initial low stretches of the Ibirapuitã river basin, a tributary of the Ibicuí River (29°21'48.25"S and 55°57'27.58"W), which, in turn, flows into the Uruguay River. The EPA is located on the international border between Brazil and Uruguay, along the western border of Rio Grande do Sul State. The territory of the EPA is distributed among the municipalities of Alegrete (15%), Quaraí (12%), Rosário do Sul (16%) and Santana do Livramento (57%), in an area formed almost exclusively by private farms, in which activities are regulated by the Federal Government through the ICMBio (Chico Mendes Institute for Biodiversity Conservation).

The EPA of Ibirapuitã lies within the morphostructural domain of the Sediment covering basins in the Campanha Plateau ecomorphological region, a unit of the Uruguiana Geomorphological Plateau. The Serra Geral Formation, related to continental drift processes that led to the separation of South America and Africa (MMA, 1999), constitutes most of the area.

The Ibirapuitã River, which divides the EPA of Ibirapuitã longitudinally (Figure 1), passes from south to north through the preserved area for 100 kilometres before emptying into the Ibicuí River in Alegrete. The riverbed is in part rocky and in part sandy (Figure 1). In flood seasons (level 81.8 m compared to the average level of 64.7 m), large areas are flooded and receive organic loads originating from arable

and livestock farming, which predominate in the region. The river is fed by several streams (the Restinga, Caverá and Inhanduí) downstream from the EPA and others (Sarandizinho, Caiboatê, Jararaca, Capivari and Salso) that lie within or upstream from the EPA.

The Botucatu formation, which lies on the eastern edge of the EPA and in the eastern portion of the area, is characterized by desert-like deposits in the form of dunes and sandy shields. Recent alluvial deposits consisting of sands, gravels and silts occur along the valley of the rivers, including the Ibirapuitã, as from approximately the centre of the EPA. Within the region covered by the EPA, the soil types include Podzolic, Dark Red Alic, eutrophic Planosols, Vertisols and Lithosols (Ker *et al.*, 1986 in MMA, 1999). The climate is subtropical, warm and temperate, with well-distributed rainfall and seasons (type Cfa in the Koppen classification). The mean annual rainfall is 1200mm (Simioni *et al.*, 2014). The lowest precipitation rates usually occur in August and the highest in October. The average annual temperature is 18.6°C, ranging from 13.1°C in July to 24°C in January. Since 1931, the minimum temperature recorded was -4.1°C and the maximum 40.4°C. The annual relative air humidity is about 75% (MMA, 1999).

Sampling methodology

The sponge surveying and sampling were carried out in three portions of the river, and one in a contributing brook. At the northern area of the EPA, sampling was done in the municipality of Alegrete, at two sites: Estância 28 or Marona (30°06'10"S – 55°42'37"O) and Estância Sá Brito (29°59'10"S – 55°45'27"W) (Figure 1). At the southern portion, sampling occurred in the municipality of Santana do Livramento, at two sites: Passo do Ferrão (30°27'24"S – 55°42'37"W), and Passo do Cerrito (30°37'36"S – 55°40'56"W), besides one site at the brook Arroio Sarandi-

Ibirapuitã Environmental Protection Area Pampa Biome

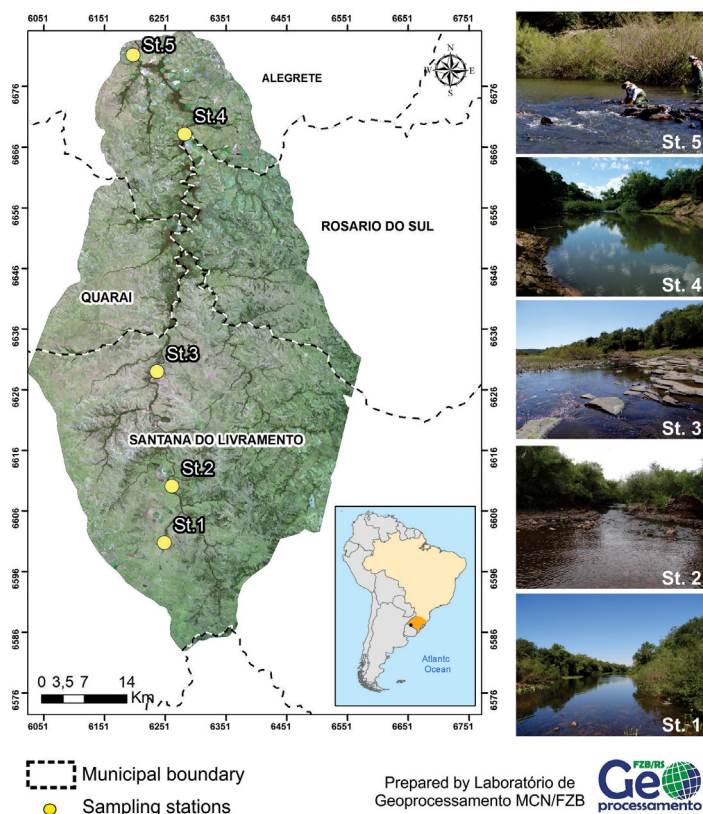


Figure 1. Map of the Environmental Protection Area (EPA) of Ibirapuitã, Rio Grande do Sul, Brazil, with photographs (at right) of the sites in the sampling stations in Sarandizinho Stream (St.1) and along the Ibirapuitã River (St.2-St.5). St.2: Passo do Cerrito; St.3: Passo do Ferrão; St.4: Estância Marona; St.5: Estância Sá Brito.

zinho (30°42'41,5"S – 55°41'25,8"W) (Figure 1). The sampling was performed in all sites during three expeditions in 2011 (March, 21-26; June 06-11 and November 28- December 03), four expeditions in 2012 (January 30-February 04; March 26-31; June 04-09 and November 19-24), and one expedition in 2013 (January 21-26). Thus, sampling encompassed summer, autumn and spring seasons. Sampling was done crossing the river/brook rocky bottoms by foot and sampling the sponges manually. Small pieces were taken and the substrates with the main sponge crust were photographed and set back in the water. Small specimens had to be sampled with the substrate. The samples were set to dry at the laboratory and next

deposited and catalogued in the Porifera Collection of Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul (MCN-POR). Identification was processed after sponges fragments were prepared for Light and SEM microscopy following Volkmer-Ribeiro and Turcq (1996). The SEM photographs were taken at the Central Laboratory for Microscopy and Microanalysis of Pontificia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul State. The presented synonymy was restricted to the works which the authors consider to contribute to a more precise characterization and thus identification of the involved species. In order to characterize the habitats where the sponge assemblages oc-

curred, physical and chemical parameters of the water were taken for summer (January) and winter (June) seasons of 2012, with a multiparameter water quality meter (HORIBA mod. U-50 series). The parameters analyzed were Oxidation-Reduction Potential (ORP), conductivity, turbidity, pH, total dissolved solids (TDS) and temperature.

Taxonomy

SPONGILLIDAE GRAY (1867)

Gênero *Heteromeyenia* POTTS (1881)
Heteromeyenia insignis WELTNER
(1895)
(Figures 2A; 3A)

Heteromeyenia insignis Weltner (1895, p. 142); Volkmer (1963, p. 277); Volkmer-Ribeiro *et al.* (2009, p. 100).

Examined material: BRAZIL, Rio Grande do Sul: Santana do Livramento, EPA of Ibirapuitã, Ibirapuitã River, Passo do Cerrito, 08.VI.2012, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8927; 23.XI.2012, MCN-POR 8941; Arroio Sarandizinho, 02.XII.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8903; 30.III.2012, MCN-POR 8911; 08.VI.2012, MCN-POR 8933.

The sponge only occurred in two stations (Table 1), on clean rocky substrates or with accumulated fine sediments, in areas exposed to sunlight and with reduced water coverage. In Passo do Cerrito, St. 2, in June 2012, at the time of sampling, the surface of the river was frozen. The sponge formed seasonal crusts, gemmuliferous, shallow and delicate or with finger-like projections, light green in colour (Figure 2A). The spicule set (Figure 3A) corresponded to that shown in the re-description of this species (Volkmer, 1963).

Remarks: To date, records of *H. insignis* are circumscribed to the states of Rio Grande do Sul and Santa Cata-

Table 1. Occurrence of five sponge species in the sampling stations Sarandizinho brook (St. 1) and Ibirapuitã River (St.2 - St.5), southern Brazil, in expeditions carried out from March 2011 to January 2013. Dec: December; Feb: February; Jan: January; Jun: June; Mar: March; Nov: November; St.2: Passo do Cerrito; St.3: Passo do Ferrão; St.4: Estância Marona; St.5: Estância Sá Brito.

Period	Early Autumn	Autumn	Spring	Summer	Early Autumn	Autumn	Spring	Summer
	Mar 2011	Jun 2011	Nov/Dec 2011	Jan/Feb 2012	Mar 2012	Jun 2012	Nov 2012	Jan 2013
<i>O. navicella</i>	St. 3, 5	St. 4, 5	St. 3, 5	St. 3	St. 3, 4, 5	St. 3, 5	St. 3, 5	St. 5
<i>O. schubarti</i>	St. 3, 5	St. 4, 5	St. 3, 4, 5		St. 4, 5	St. 5	St. 5	St. 4, 5
<i>C. australis</i>	St. 3		St. 3	St. 2, 3	St. 3	St. 3	St. 3	
<i>C. sekti</i>	St. 5				St. 5	St. 5	St. 5	St. 5
<i>O. rosariae</i>		St. 4, 5	St. 3, 5		St. 4	St. 3, 4	St. 3, 4	
<i>H. insignis</i>			St. 1		St. 1	St. 1, 2	St. 2	

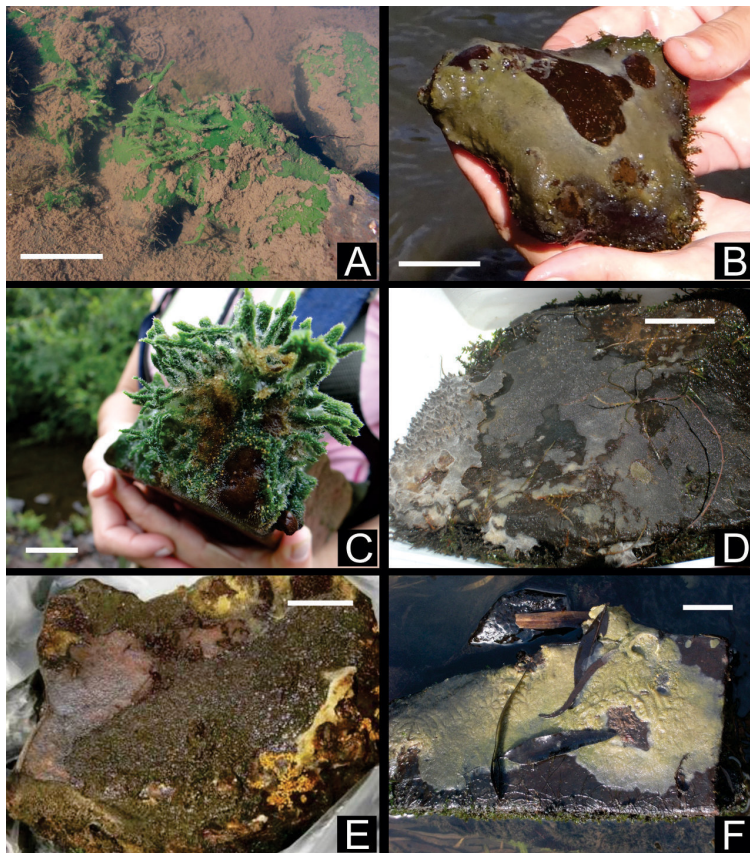


Figure 2. Photographs of the living sponge species detected in the Environmental Protection Area (EPA) of Ibirapuitã, southern Brazil. A, *Heteromeyenia insignis* WELTNER (1895); B, *Corvospongilla sekti* BONETTO and EZCURRA DE DRAGO (1966); C, *Corvoheteromeyenia australis* (BONETTO and EZCURRA DE DRAGO, 1966); D, *Oncosclera navicella* (CARTER, 1881); E, *Oncosclera schubarti* (BONETTO and EZCURRA DE DRAGO, 1967); F, *Oncosclera rosariae* n.sp. Bar = 3 cm.

rina (Weltner, 1895; De Rosa-Barbosa, 1984; Volkmer-Ribeiro *et al.*, 2009), occurring in locations exposed to the sun, commonly in rivers with cold, shallow and rapid waters, flowing over basaltic bedrock of the southeastern flank, while rarely encrusting

submerged vegetation, and if so, with very thin specimens. Due to their soft consistency, these sponges disintegrate during winter/torrential waters distributing their abundant gemmules downstream, where they become trapped in the rocky interstices, devel-

oping again in the spring, as shown in Table 1. The species is included in the Rio Grande do Sul State's official list of threatened fauna (Rio Grande do Sul, 2014).

Gênero *Corvospongilla* ANNANDALE (1911)

Corvospongilla sekti BONETTO AND EZCURRA DE DRAGO (1966) (Figures 2B; 3B)

Corvospongilla sekti Bonetto and Ezcurra De Drago (1966):133; (1967); De Rosa-Barbosa 1988:116-122; Ezcurra de Drago and Bonetto (1969):366; Tavares *et al.* 2003:177. Examined material: BRAZIL, Rio Grande do Sul: Alegrete, EPA of Ibirapuitã, Ibirapuitã River, Estância Sá Brito, 23.III.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8847; 27.III.2012, MCN-POR 8912; 05.VI.2012, MCN-POR 8931; 20.XI.2012, MCN-POR 8940; 22.I.2013, M.C. Tavares-Frigo, A.E.Z. Oliveira and M. Pairet Jr. *leg.*, MCN-POR 8944.

The sponge only occurred in one station (Table 1), situated at the point furthest downstream in the EPA and in deeper locations with no access by foot. It formed crusts on loose stones lying on the flat rocky bottom of the Ibirapuitã River, as well as in rocky pans almost 1m deep, which were sheltered from the current. Due to the greater depth both of the bed and the craters, the sponge occurred

in shaded environments. The crusts have a smooth and delicate but compact consistency, with irregular shapes and variable thickness, not exceeding a few centimetres, with brownish to slightly yellowish colouring (Figure 2B). Gemmules were present but not conspicuous. The findings indicate occurrence regardless of seasonality. The spicule set corresponds to the original description of the species (Bonetto and Ezcurra de Drago, 1966) (Figure 3B).

Remarks: The records of *C. seckti* represent a continuous distribution from the North (Volkmer-Ribeiro and Tavares, 1993) to the South of Brazil and Argentine waters. The record of *C. seckti* in the Ibirapuitã River is the second for the Uruguay basin in the State of Rio Grande do Sul, the first being made by De Rosa-Barbosa (1984, 1988) in the Ibicuí Mirim River. In Rio Grande do Sul State, the species is abundant in the Jacuí River Basin (De Rosa-Barbosa, 1984).

Gênero *Corvoheteromeyenia* Ez-
CURRA DE DRAGO (1979)

Corvoheteromeyenia australis
(BONETTO AND EZCURRA DE DRAGO,
1966)
(Figures 2C; 3C)

Corvomeyenia australis Bonetto and Ezcurra De Drago (1966):137; Ezcurra de Drago (1979):110; Tavares *et al.* (2003):177.

Examined material: BRAZIL, Rio Grande do Sul: Santa do Livramento, EPA of Ibirapuitã, Ibirapuitã River, Passo do Ferrão, 25.III.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8844; 02.XII.2011, MCN-POR 8899; 03.II.2012, MCN-POR 8906; 30.III.2012, MCN-POR 8907; 08.VI.2012, MCN-POR 8925; 23.XI.2012, MCN-POR 8934; Ibirapuitã River, Passo do Cerrito, 03.II.2012, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8904.

The sponge only occurred in two stations (Table 1), which correspond to

sites with shallow water. In Passo do Cerrito the surface water was frozen in June 2012. The sponge formed crusts on substrates exposed to sunlight, encrusting both the continuous rocky bottom and adjacent loose stones, or in the region along the exposed edge, next to the sandy bank of the Ibirapuitã River, in the latter case, sometimes adhering to submerged vegetation. The specimens varied in form from thin crusts to arborescent showing up to 5.0cm in height, with intense green colouring (Figure 2C) and whitish gemmules, both dispersed on the skeleton and attached to the substrate. The sponge did not present specimens throughout the sampling periods, indicating seasonal development (Table 1). The spicule set conformed to the original description of the species (Bonetto and Ezcurra de Drago, 1966) (Figure 3C).

Remarks: To date, the records of *C. australis* are restricted to occurrences in the Pampa Biome, both in Argentina and in Rio Grande do Sul State, as well as in Lake Guaíba (Tavares *et al.*, 2003) and downstream of it, in coastal lagoons surroundings the Laguna dos Patos (Volkmer-Ribeiro *et al.*, 2007a, 2007b). However, sponge spicules from this species have recently been identified in lake sediments from the Pleistocene age in the State of Goiás, acting as an environmental indicator that the climate was previously colder in that region of the country (Machado *et al.*, 2014). The species is included in the official list of Rio Grande do Sul State's threatened fauna (Rio Grande do Sul, 2014).

POTAMOLEPIDAE BRIEN (1967)

Gênero *Oncosclera* VOLKMER-RIBEIRO
(1970)

Oncosclera navicella (CARTER, 1881)
(Figures 2D; 3D)

Spongilla navicella Carter (1881):87; Bonetto and Ezcurra de Drago, 1967:335.

Oncosclera navicella Volkmer-Ribeiro (1970):437; Tavares and Volkmer-

Ribeiro (1997): 97; Volkmer-Ribeiro and Pauls (2000):19; Tavares *et al.* (2003):177.

Examined material: BRAZIL, Rio Grande do Sul: Alegrete, EPA of Ibirapuitã, Ibirapuitã River, Estância Sá Brito, 23.III.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8846; 07.VI.2011, MCN-POR 8895; 29.XI.2011, MCN-POR 8901; 27.III.2012, MCN-POR 8914; 05.VI.2012, MCN-POR 8930; 20.XI.2012, MCN-POR 8939; 22.I.2013, M.C. Tavares-Frigo, A.E.Z. Oliveira and M. Pairet Jr. *leg.*, MCN-POR 8946; Ibirapuitã River, Estância Maronna, 07.VI.2011, MCN-POR 8920; 27.III.2012, MCN-POR 8910. Santa do Livramento, Ibirapuitã River, Passo do Ferrão, 25.III.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8842; 02.XII.2011, MCN-POR 8898; 03.II.2012, MCN-POR 8905; 30.III.2012, MCN-POR 8908; 08.VI.2012, MCN-POR 8926; 23.XI.2012, MCN-POR 8936.

The sponge encrusts the solid rocky bottom or loose stones in the river, forming permanent crusts varying in thickness from thin to thick, with occasional needle-like projections of up to 15mm in height (Figure 2D) with whitish, yellowish or greyish colouring (Figure 2D). Large, visible gemmules, orange-yellow colour, noticeable particularly in the peripheral region of the crusts, fixed to the substrate, or even forming isolated clusters, were evident and observable to the naked eye. The sponge occurred in three stations (Table 1). The spicule set conformed to the redescription of the species (Tavares and Volkmer-Ribeiro, 1997) (Figure 3D).

Remarks: In Rio Grande do Sul State *O. navicella* was recorded in tributaries of the Lake Guaíba basin, particularly the Jacuí River, with isolated records of the species also in the Ibicuí-Mirim, a tributary of the Ibicuí (De Rosa-Barbosa, 1984). However, *O. navicella* commonly occurs on the

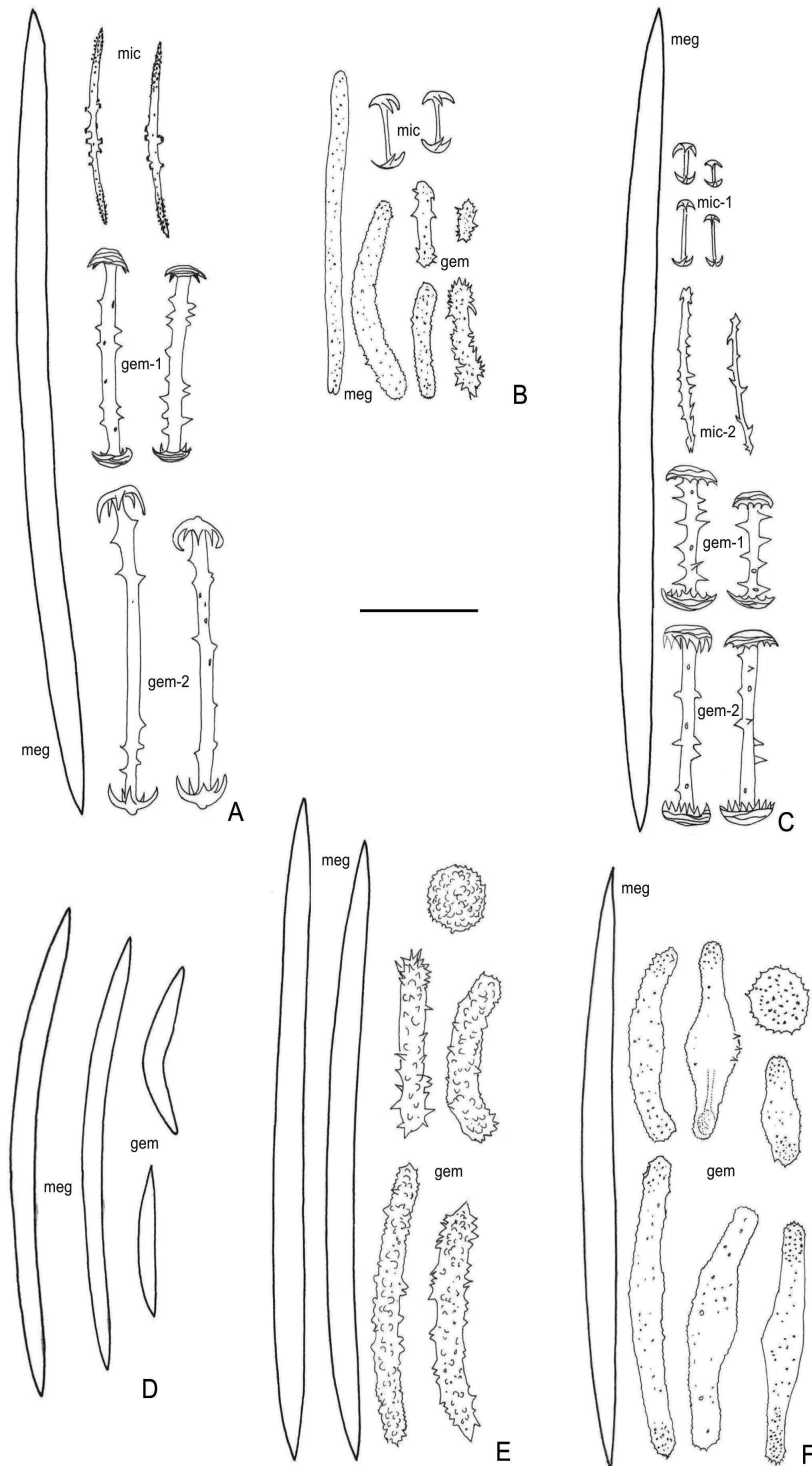


Figure 3. Camera lucida drawings of the spicular sets of sponge species sampled in the Environmental Protection Area (EPA) of Ibirapuitã, southern Brazil. A, *Heteromeyenia insignis* WELTNER (1895); B, *Corvospongilla sekti* BONETTO AND EZCURRA DE DRAGO (1966); C, *Corvoheteromeyenia australis* (BONETTO AND EZCURRA DE DRAGO, 1966); D, *Oncosclera navicella* (CARTER, 1881); E, *Oncosclera schubarti* (BONETTO AND EZCURRA DE DRAGO, 1967); F, *Oncosclera rosariae* n.sp. meg: megascleres; gem: gemmoscleres; gem-1: short gemmoscleres; gem-2: long gemmoscleres; mic: microscleres; mic-1: chaela microsclere; mic-2: birotulated microsclere). Bar = 50 micrometers.

rocky beds of large South American rivers, and is distributed continuously from Venezuela (Volkmer-Ribeiro and Pauls, 2000), in the north to the south of Brazil (Tavares and Volkmer-Ribeiro, 1997; Batista *et al.*, 2003), and in the Paraná-Uruguay Basin, in Argentina (Bonetto and Ezcurra de Drago, 1967, 1970; Ezcurra de Drago and Bonetto, 1969).

Oncosclera schubarti

(BONETTO AND EZCURRA DE DRAGO, 1967)
(Figures 2E; 3E)

Spongilla (Euspongilla) schubarti Bonetto and Ezcurra de Drago (1967):339; (1968):429; (1970):52, 53, 56; Ezcurra de Drago and Bonetto (1969):364-367; De Rosa-Barbosa, 1984:143; Batista and Volkmer-Ribeiro (2002):125.

Examined material: BRAZIL, Rio Grande do Sul: Alegrete, EPA of Ibirapuitã, Ibirapuitã River, Estância Sá Brito, 23.III.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8845; 07.VI.2011, MCN-POR 8915; 29.XI.2011, MCN-POR 8900; 27.III.2012, MCN-POR 8913; 05.VI.2012, MCN-POR 8932; 20.XI.2012, MCN-POR 8938; 22.I.2013, MCN-POR 8945; Ibirapuitã River, Estância Marona, 07.VI.2011, MCN-POR 8896; 29.XI.2011, MCN-POR 8902; 27.III.2012, MCN-POR 8909; 05.VI.2012, MCN-POR 8929; 22.I.2013, M.C. Tavares-Frigo, A.E.Z. Oliveira and M. Pairet Jr. *leg.*, MCN-POR 8943. Santana do Livramento, Ibirapuitã river, Passo do Ferão, 25.III.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8843; 02.XII.2011, MCN-POR 8897; 08.VI.2012, MCN-POR 8923.

Sponge encrusting the continuous rocky bed or loose stones of the Ibirapuitã River, occurring particularly in shady banks. It occurred in three stations (Table 1). The specimens form permanent gemmuliferous crusts that are thin, hard, reticulated, hispid,

dark brown in colour, not exceeding a few centimetres, with dark greyish to brownish colouring (Figure 2E). Dark gemmules adhered to the substrate, forming small clusters in the peripheral region of the crusts. The spicule set conforms to the original description and redescription of the species (Bonetto and Ezcurra de Drago, 1967; De Rosa-Barbosa, 1984; Batista and Volkmer-Ribeiro, 2002) (Figure 3E).

Remarks: *O. schubarti* has confirmed records in South America, from north to south of Brazil (Volkmer-Ribeiro *et al.*, 2008; De Rosa-Barbosa, 1984) and Argentina (Bonetto and Ezcurra Drago, 1970; Ezcurra Drago and Bonetto, 1969).

***Oncosclera rosariae* n.sp.**
(Figures 2F; 3F, 4-6)

Type material. Holotype, Brazil, Rio Grande do Sul: Alegrete, EPA of Ibirapuitã, Ibirapuitã River, Estância Marona, 30°06'10"S–55°42'37"W, 27.III.2012, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8928.

Paratypes: BRAZIL, Rio Grande do Sul: Alegrete, EPA of Ibirapuitã, Ibirapuitã River, Estância Sá Brito, 07.VI.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8916; 29.XI.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8918; Ibirapuitã River, Estância Marona, 27.III.2012, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8919; 05.VI.2012, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8928; 20.XI.2012, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8937. Santana do Livramento, Ibirapuitã River, Passo do Ferrão, 02.XII.2011, M.C. Tavares-Frigo and M. Pairet Jr. *leg.*, MCN-POR 8917; 08.VI.2012, MCN-POR 8924; 23.XI.2012, MCN-POR 8935.

Diagnosis. Sponges thin, soft, greenish brown, spongin scarce, surface undulated, reflecting the structure of the canal system, pinacoderm thick. Skel-

etal reticulum with axial and lateral fibers. Microscleres absent. Megascleres in one category of straight, abruptly pointed, smooth oxea. Gemmoscleres spiny short amphistrongyla resembling peanut shells and forming a basal thick continuous layer where the nude gemmules are merged. Gemmules abundant, foraminal tube short, straight, turned upside, an incipient pneumatic layer may form around some of the gemmoscleres. Isolated packages of gemmules merged in the gemmoscleres crust may be seen cov-

ered by the pinacoderm.

Description. Living sponge forming jelly, thin, irregular, greenish brown crusts with whitish thinner rim on the upper face of stones (Figure 2F). Surface smooth, however irregular, undulated and sort of conforming the conspicuous canal system (Figures 4A, 4B). Dry sponge evidencing a thick pinacoderm with conspicuous oscules and protrusion of the main fibers (Figure 4C). Skeleton anisotropic with main and secondary multispicular fibers. Microscleres absent. Megascleres

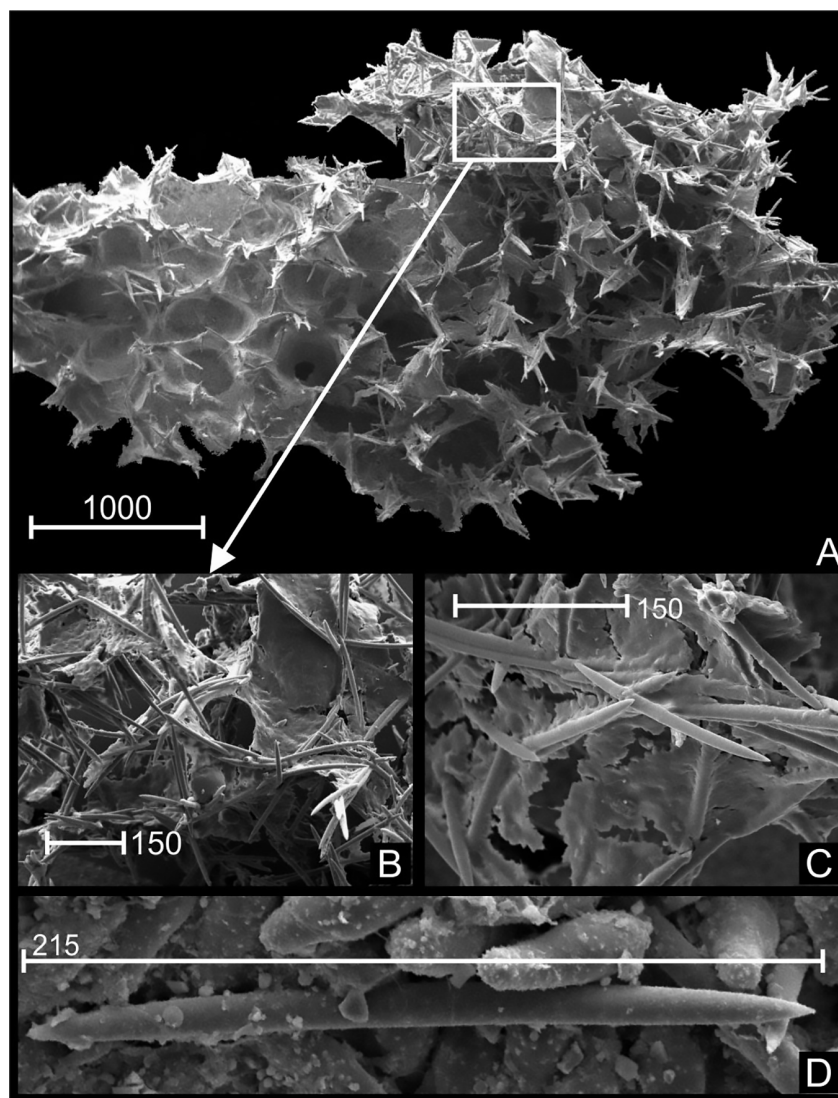


Figure 4. SEM photographs of *Oncosclera rosariae* n.sp: A, dry sponge evidencing a thick pinacoderm with conspicuous oscules and protrusion of the main fibers; B, oscule detail; C, pinacoderm and protrusion of one main fiber; D, megasclere and gemmoscleres. Bar in micrometers.

short, smooth, straight slightly curved, abruptly pointed anfiroxa (Figures 3F, 4D). Gemmoscleres, spiny, short to longer amphistrongyla resembling peanut shells (Figures 3F, 5A). Spines more abundant at the sclere extremities (Figures 3F, 5B). A bumped middle region is present in the gemmoscleres so that quite cylindrical ones are rare (Figures 3F, 5A). Spherical forms rare (Figure 3F). The gemmoscleres compose a basal thick continuous layer where the nude gemmules are side by side merged (Figures 6A-C). Dimensions of spicules in Table 2. Gemmules large (Figure 6D), extremely abundant, ovoid, contained inside the thick, basal, common strata of gemmoscleres, inner gemmular coat thick (Figure 6D), pneumatic coat incipient or absent (Figures 6A, 6D), gemmoscleres disorderly packed in the basal layer and over the gemmules (Figures 6B, 6D). Foraminal tube is single, turned upside, provided with short collar projecting at the surface of the gemmosclere covering (Figures 6D, 6E).

Type locality: Ibirapuitã River, EPA of Ibirapuitã River, Rio Grande do Sul State, Brazil (29°21'48.25"S -

55°57'27.58"W).

Distribution: Presently known only from the type locality.

Habitat: The sponge occurred in three stations (Table 1) under heavy river current and in areas not exposed to the sun along the margins. The specimens incrustated stones in the middle, margins and craters of the river, as well as the very river bedrock. The species was found throughout the sampling period and so seems to be a permanent component of the sponge fauna at such places (Table 1).

Etymology: The species name is dedicated to the memory of M. Sc. Rosaria De Rosa Barbosa, for the many years of friendly collaboration on the research of the Brazilian freshwater sponge fauna, not to forget the always stimulating companionship along many field campaigns in the state of Rio Grande do Sul.

Remarks: *Oncosclera rosariae* n. sp. is closer to *Oncosclera jewelli* (Volkmer-Ribeiro, 1970) but stands apart for its longer cylindrical gemmoscleres with reduced middle inflation and their conspicuous arrangement into a continuous common basal layer, where

large nude gemmules with incipient to absent pneumatic coats are merged. On the other hand, the brittle rough green crusts of *O. jewelli*, however never stony hard as stated by Manconi *et al.* (2012), and its single gemmules invested with short amphistrongilous gemmoscleres and not restricted to the basal portion of the sponge grant the species its own indisputable position.

Oncosclera rosariae n. sp. stands also close to *O. asiatica* Manconi *et al.* (2012), which has, however, spiny megascleres and longer, stout, straight to slightly curved cylindrical amphistrongyla gemmoscleres, with a rare occurrence of the middle enlarging and a more extensive distribution of small spines. Also to take into consideration is the disjunct distribution of genus *Oncosclera* which shows its larger specific richness in the Neotropical Region with now *O. rosariae* n.sp. representing the tenth species in this Region and the 17th in terms of present and past global distribution (Manconi *et al.*, 2012). Bonetto and Ezcurra de Drago (1967) advanced a gonduanic distribution for genus *Stratospongilla* ANNADALE (1909) and not *Oncosclera* VOLKMER-RIBEIRO (1970) as referred by Manconi *et al.* (2012), once at the time *Oncosclera* had not yet been described. As a matter of fact, genus *Stratospongilla* ANNADALE (1909), restricted to species with microscleres (Volkmer-Ribeiro, 1970), has not yet been detected in the Neotropical Region. However, a gonduanic distribution was formally proposed for genus *Oncosclera*, together with all other genera for the first time grouped in the Family Potamolepidae by Volkmer-Ribeiro and De Rosa-Barbosa (1979).

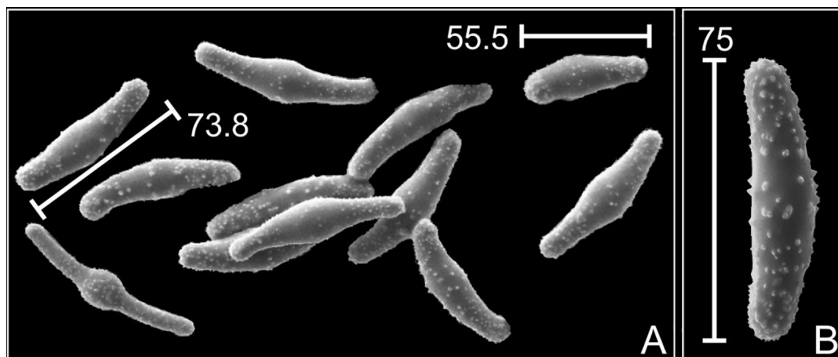


Figure 5. SEM photographs of *Oncosclera rosariae* n.sp. A; gemmoscleres; B, detail of spine size and distribution on one gemmosclere. Bar in micrometers.

Table 2. Dimensions in micrometers of the megascleres and gemmoscleres of *Oncosclera rosariae* n. sp.

Spicule categories	Megascleres		Gemmoscleres	
	length	width	length	width
Minimum	152.5	5	25	12.5
Average	204.3	10.3	67.2	20.1
Maximum	252.5	15	137.5	30

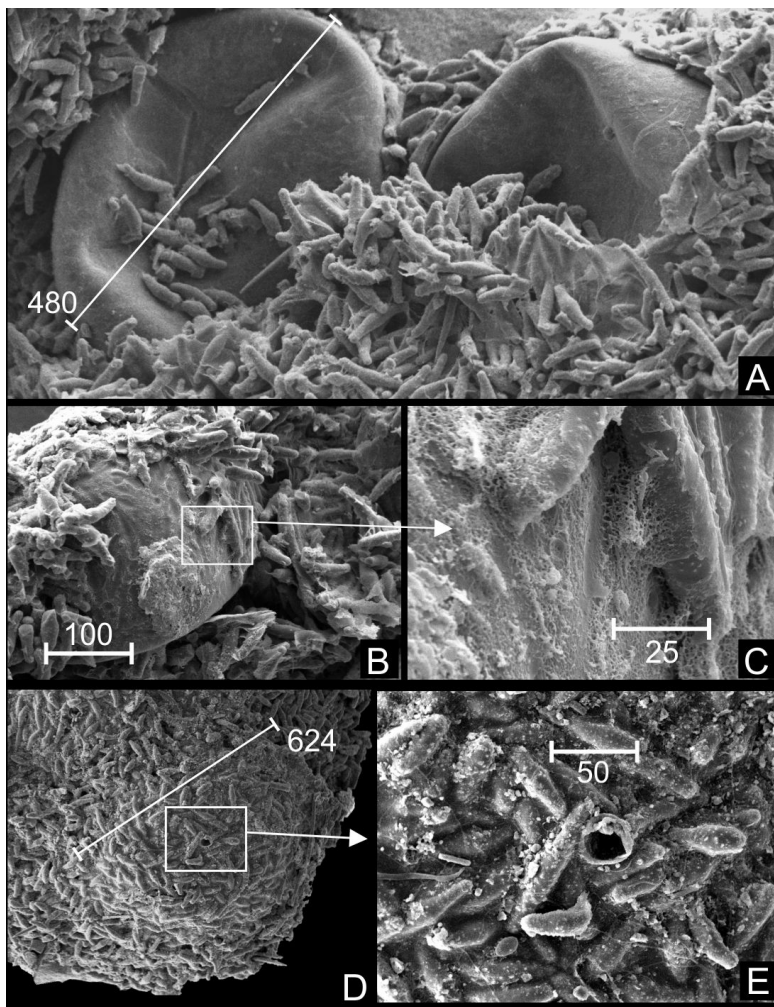


Figure 6. SEM photographs of the gemmules of *Oncosclera rosariae* n.sp. A, two young gemmules merged in the common layer of gemmoscleres; B, incipient pneumatic areas forming around the gemmoscleres; C, detail of the gemmoscleres incrusting on the inner gemmular coat and incipient pieces of pneumatic coat; D, whole gemmule with foraminal tube; E, detail of the foraminal tube and outer thin gemmular coat. Scale in micrometers.

Key to the sponge species at the Environmental Protection Area (EPA) of Ibirapuitã

- 1. Microscleres are present 2
- 1a. Microscleres are missing..... 3
- 2. Microscleres in one single category 4
- 2a. Microscleres in two categories, one of minute chaeta and the other of small spiny birotulated scleres with minute rotules... *Corvoheteromeyenia australis* (Figure 2C)
- 3. Gemmoscleres are smooth, curved

- anfxioe with abruptly pointed extremities *Oncosclera navicela* (Figure 2D)
- 3a. Gemmoscleres are spiny anfxiongyla..... 5
- 4. Microscleres are spiny anfxioea with abruptly pointed extremities *Heteromeyenia insignis* (Figure 2A)
- 4a. Microscleres are minute chaeta.... *Corvospongilla sekti* (Figure 2B)
- 5. Gemmoscleres are restricted to the surface of the gemmules *Oncosclera schubarti* (Figure 2E)
- 5a. Gemmoscleres compose a thick common basal layer containing the gemmule..... *Oncosclera rosariae* n.sp. (Figure 2F)

Distribution of the sponges species along the Environmental Protection Area (EPA) of Ibirapuitã

The survey revealed a consistent difference in the distribution of the five sponge species along the river waters in the EPA of Ibirapuitã (Table 1; Figure 7). *Corvospongilla sekti* was the only species with occurrence restricted to one single site (St. 5). *Heteromeyenia insignis* was the only species detected in St.1. On the other hand, *C. australis* occurred only in Sts. 2 and 3. *Oncosclera navicella*, *O. schubarti* and *O. rosariae* n.sp. formed a group of species with occurrence in Sts. from 3 to 5. The higher specific richness was attained in stations 3 to 5, decreasing from station 3 to station 1 (Table 1).

A distinction can also be perceived of the sharing of the river bottom at the EPA of Ibirapuitã between two families of freshwater sponges: Spongillidae, in the upper part, represented by genera *Heteromeyenia* and *Corvoheteromeyenia*. Potamolepidae is represented by one single genus *Oncosclera* in the lower stretch (Figure 7).

Physical and chemical parameters

The physical and chemical parameters of the brook and the river waters measured in January and June 2012 are presented in Table 3. The values obtained for the water temperature allow the assumption that the January sampling may stand for summer conditions and that of June for early winter conditions.

Values of ORP, conductivity and turbidity were the sole to show differences among the sampled stations (Table 3). The lowest conductivity values were observed in Passo do Ferrão, Estância Marona and Estância Sá Brito and the highest in Sarandizinho brook and Passo do Cerrito. Higher values for ORP, conductivity and temperature

Table 3. Physical and chemical parameters of water of Ibirapuitã River, Environmental Protection Area (EPA) of Ibirapuitã, southern Brazil, sampled during two seasonal periods at four sampling stations (St.2 – St.5). Conduct, conductivity (mS/mm); ORP: Oxidation-Reduction Potential (mV); pH: Hydrogen potential; St.2: Passo do Cerrito; St.3: Passo do Ferrão; St.4: Estância Marona; St.5: Estância Sá Brito; TDS, Total dissolved solids (g/L); Temp: temperature (°C); Turbid: turbidity (U.N.T.).

Parameters	January/2012				June/2012			
	St. 2	St. 3	St. 4	St. 5	St. 2	St. 3	St. 4	St. 5
ORP	344	232	260	253	224	176	218	243
Conduct	150	236	200	182	100	187	211	171
Turbid	4.5	3.6	46.4	5.4	8.7	5.2	7.6	8
pH	6.1	7.69	7.97	8.26	7.88	7.59	7.78	6.85
TDS	0.038	0.153	0.13	0.18	0.065	0.122	0.137	0.111
Temp	24.86	26.25	30.62	31.16	8.5	10.17	16.03	16.64

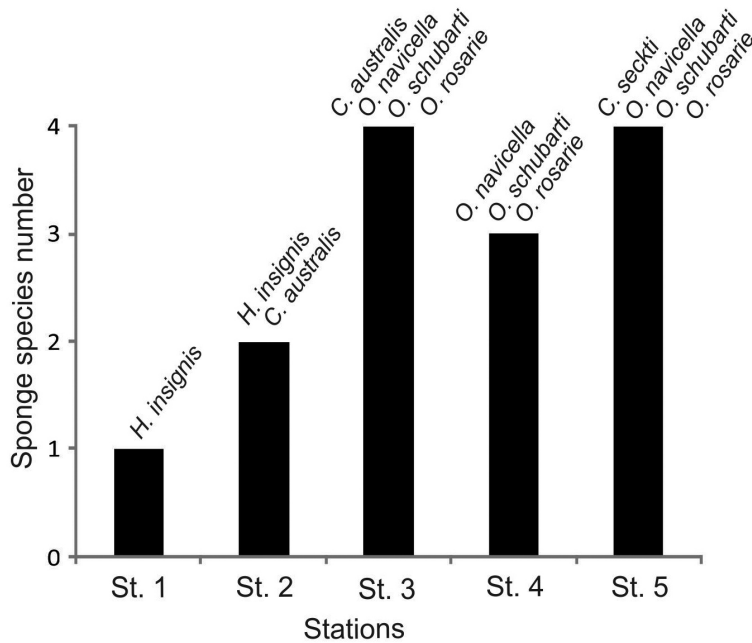


Figure 7. Distribution of the sponges species in the sampling station at Sarandizinho brook (St. 1) and the ones at Ibirapuitã River (St.2: Passo do Cerrito; St.3: Passo do Ferrão; St.4: Estância Marona; St.5: Estância Sá Brito), southern Brazil.

and reduced turbidity characterize the summer period. The values of pH and TDS did not show differences among the seasonal periods. These waters may be characterized by low turbidity, TDS and conductivity.

Discussion

The diversity of the sponge species found in the water bodies in the EPA of Ibirapuitã is remarkable. Considering the water bodies within the Ibirapuitã EPA to be integral representatives of

the Pampa biome, this record indicates an unprecedented lotic sponge community for this biome. The physical and chemical characteristics detected in the Ibirapuitã waters inside this protection area stand for ecological parameters linked its diverse sponge fauna and close to certainly more ideal conditions. These characteristics reflect the nature of the terrain in which the EPA of Ibirapuitã is located. Gomes *et al.* (1990) indicated that the Ibirapuitã River runs generally at the level of the low-lying hilly

terrain. The basalt and fine sandstone bedrock/s reduce the permeability of the soil, resulting in water retention, slow drainage and an expanded flood plain. These authors also point out that the regime of the river reflects the irregular rainfall, which produces exceptional droughts to flooding. Thus, the highest occurrence of sponges was in the period immediately before the winter of 2012 (Table 1), characterized by higher ORP and conductivity values and reduced turbidity and temperature. The physical and chemical characteristics of the river waters are the second ones offered in the sponge literature for a lotic environment in the Pampa Biome in Brazil. The first ones refer to Candiota brook, at the eastern part of the Brazilian Pampa, where a poor sponge fauna occurred on its head waters, once natural conditions are not present downstream, due to the coal mining in the basin (Fontoura *et al.*, 2004).

Of the species of sponges identified in the EPA of Ibirapuitã, to date, only *C. australis* is restricted to the Pampa biome. Its occurrence extends from the north-east of the Pampa Biome, in Rio Grande do Sul State, to the Jacuí Delta (Tavares *et al.*, 2003), the coastal lagoons surrounding the Patos Lagoon (Volkmer-Ribeiro *et al.*, 2007a, 2007b), to the central area of the Argentine Pampa, in Setúbal Lake, Don Felipe Lake, and in waterbodies of Carabajal Island, Province of Santa Fe, all of which constitute environments within the Middle Paraná River flood-

plain (Ezcurra de Drago, 1979). The restricted occurrence of *C. australis* in past aquatic environments of the Cerrado Biome corroborates the proposal put forward by Machado *et al.* (2014). On that occasion, the authors pointed to the occurrence of a colder climate in central Brazil, Goiás State, about 50,000 years BP, after identifying spicules from *C. australis* in sediments from the Cemitério Paleolake.

Although the record of *C. australis* is practically restricted to lentic environments, Ezcurra de Drago (1979) previously indicated that this species preferred considerable flowing water, as observed in the Jacuí Delta (Tavares *et al.*, 2003) and now in lotic water bodies of Ibirapuitã EPA (St 1 and St 2; Figure 1). However, the substrate used by this species in Ibirapuitã River differs from those described in the literature (Ezcurra de Drago, 1979; Tavares *et al.*, 2003; Volkmer-Ribeiro *et al.*, 2007a, 2007b). In these latter studies, *C. australis* was found encrusting the roots of macrophytic vegetation, whereas rocks were the preferred substrate of this species in the Ibirapuitã River. It should be noted that Ezcurra de Drago (1979), Tavares *et al.* (2003) and Volkmer-Ribeiro *et al.* (2007a, 2007b) reported the occurrence of minute specimens in the roots of aquatic vegetation, which differs considerably from those recently detected on the rocks at the EPA of Ibirapuitã, when *C. australis* produces arborescent forms reaching heights of up to 5.0cm. Therefore, the Ibirapuitã River (St. 2) represent an environment with ideal characteristics for this species, such as rocky substrates, reduced flow and water column, besides full light exposure.

The sampling now conducted in the Ibirapuitã River was the first to propose the investigation of the sponge assemblages from the upper to the edge of the low course of a river entirely contained within the Pampa Biome. As can be seen from the results presented herein, the sponges of Ibirapuitã River indicate the presence of

different assemblages from the upper to the lower stretch.

In the upper stretch, the presence of sponges with green colour due to their association with zoochlorellae algae is remarkable. This association enables *H. insignis* and *C. australis* to occupy substrates under full sun exposure in the shallow, clear and cooler river head waters. This kind of election had already been remarked in all the previous registers of *H. insignis* in Rio Grande do Sul State, all restricted to the Araucaria Plateau at the northeastern part of the State (Volkmer-Ribeiro *et al.*, 2009) and as such in the Mata Atlântica Biome. The present register is also the first to detect an assemblage composed of *H. insignis* and *C. australis*, the latter constituting a species with a marked preference for encrusting macrophytes in lotic environments with reduced water current (Tavares *et al.*, 2003) or event coastal lentic environments (Volkmer-Ribeiro *et al.*, 2007a, 2007b).

Corvospongilla seckti, in spite of being counted as a spongillid, was found now associated with potamolepid sponges, making up assemblages with beige to brown or gray tint, encrusting the basalt continuous bed, which according to Iriondo and Kröling (2008), occurs in the middle and particularly in the low stretches of the river, with deeper, darker and stronger waters.

Despite cattle and sheep breeding and rice farming being traditional economic practices in the area surrounding the Ibirapuitã River, there is a remarkable diversity of sponge species, especially in the lower reaches of the Ibirapuitã River. In station 5, the nearest to Alegrete, four of the six species of sponges found in the EPA of Ibirapuitã were recorded. Gomes *et al.* (1990) highlighted the occurrence of extensive areas prone to flooding along the Ibirapuitã River, which prevents the establishment of such economic activities in those areas. The authors point out that the river generally flows at the level of the low-lying hilly terrain.

Coming now to freshwater sponges in the Ibicuí River itself, the largest river entirely contained in the Pampa Biome, besides being the largest tributary to the left margin of the Uruguay River in Brazil, one finds that highly discontinuous registers of sponge species had been produced. The most remarkable one has to do with its eastern most portion, also enclosing the tributaries Toropi Mirim and Jaguari (Volkmer-Ribeiro *et al.*, 1983; De Rosa-Barbosa, 1984). A freshwater sponge assemblage was detected composed of large specimens of *Drulia browni* (BOWERBANK, 1863) of the family Metaeniidae, which contained inside minute specimens of *Trochospongilla paulula* (BOWERBANK, 1863), *Trochospongilla lanzamirandai* (BONETTO AND EZCURRA DE DRAGO, 1964), *Trochospongilla minuta* (POTTS, 1887) of the family Spongillidae, besides *O. navicella*, a potamolepid sponge. This singular assemblage is found from the north to the south of South America living in oxbow lakes seasonally flooded by the rivers. Its unique southern most register is the one now reported for Ibicuí River in the Brazilian Pampa and that for the flooded areas of Middle Paraná River (Drago *et al.*, 2003). On the other hand, sponges common to rocky bottoms of the Uruguay River, such as *Houssayella iguazuensis* (BONETTO AND EZCURRA DE DRAGO, 1966), *Trochospongilla repens* (HINDE, 1988) and *Oncosclera petricola* (BONETTO AND EZCURRA DE DRAGO, 1967), were found in Itú River and *Corvospongilla seckti* in Ibicuí River Mirim, contributors to the right margin of the Ibicuí River (Volkmer-Ribeiro, 1969, 1971; De Rosa-Barbosa, 1984).

Regarding the area of the Pampa Biome in Rio Grande do Sul State, two other lotic environments were surveyed for their sponge assemblages. One was carried out south of Ibirapuitã River, at Arroio Candiota (Fontoura *et al.*, 2004), a left-bank tributary of Jaguarão River, which marks the southernmost border between Brazil and Uruguay. The only detected spe-

cies were *Anheteromeyenia ornata* (BONETTO AND EZCURRA DE DRAGO, 1970), *Eunapius fragilis* (LEIDY, 1851) and *Trochospongilla paulula* (BOWERBANK, 1863), exclusively in the stretch upstream from the influence of coal processing. *Trochospongilla paulula* is listed by Bonetto and Ezcurra de Drago (1967) for the Upper Paraná and Middle Uruguay, *A. ornata* only appears in one tributary of the Upper Paraná (Bonetto and Ezcurra de Drago, 1970) and *E. fragilis* is not reported in either of the two listings referred herein.

The other lotic environment focused the sponge assemblages of the delta region at the mouth of Jacuí River, in the Lake Guaíba (Tavares *et al.*, 2003). The ten detected species form small gemmuliferous crusts in the roots of the voluminous *Eichhornia* stands which surround the islands and where *Trochospongilla paulula* was the most frequent species. In addition, *Corvoheteromeyenia australis* had its first register for a lotic environment outside its type locality, the Guadalupe and San Felipe Lakes, at the middle Paraná River, in the Province of Santa Fe, Argentine (Ezcurra de Drago, 1979).

The most comprehensive studies conducted for the freshwater sponge fauna by Bonetto and Ezcurra de Drago (1967, 1970) in Argentine focused on the western side of the Pampa Biome and were devoted to stretches of the Paraná and Uruguay rivers, or sites along some of their small tributaries, while it should be noted that the head waters of these two large rivers are farther north outside of this biome. Nevertheless, these studies are the only sources of information for this fauna in the current lotic environments of the western part of the Pampa. All species now mentioned for the eastern region of the Pampa Biome in Brazil, including the ones for Ibirapuitã River, may also be found in the Middle Paraná and Middle Uruguay rivers (Bonetto and Ezcurra de Drago, 1967).

Results presented herein indicated that the lotic environments of the Pampa Biome hold a common freshwater sponge fauna that embodies that of the Middle Paraná and Middle Uruguay rivers and extends eastwards towards the Atlantic border of Brazil, at the State of Rio Grande do Sul. In this respect, it is important to cite the geologic studies of Iriondo and Kröling (2008) that evidenced a past connection of the Middle Course of river Uruguay with that of Paraná River registered in the San Salvador Formation. This Formation embodies the deposits of a huge paleo meandering lotic stretch, northwest of Corrientes, Argentine, dated of the Pliocene/Pleistocene boundary and formed under a climate similar to the present one. The isolated record of the sponge *Drulia browni* at the eastern meandering extreme of Ibicuí River, a considerably geographic distance apart from its only register in the Middle Paraná River and none so far in the Uruguay River, comes to offer another evidence of a past connection between these two basins.

The sponge species registered for the first time at the EPA of Ibirapuitã stand for a significant group of the Brazilian and South American sponge faunas that now finds protection inside another Brazilian conservation area.

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