Anthropically dislodged assemblages of sponges (Porifera: Demospongiae) in the River Araguaia at Araguatins, Tocantins State, Brazil

Assembléias de esponjas desalojadas no Rio Araguaia em Araguatins, Estado do Tocantins, Brasil

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Abstract: A recent outbreak of an human ocular disease at Araguaia River by the town of Araguatins, TO, Central Amazonia, along the low water period of 2005 required pathological analyses of surgically extracted ocular tissues. Spicules which invest the gemmules of the freshwater sponges *Drulia uruguayensis* and *D. ctenosclera* were found inside these ocular materials. Such relation between an ocular disease and freshwater sponge spicules, for the first time scientifically stablished and reported, raised two questions. Would the two sponge species occur in the river by the town and why the gemmoscleres and not the megascleres, the most abundant spicules of the sponge skeleton pervaded the eye tissues? A sponge survey altogether with a square sampling of the other components of the zoobenthos was undertaken during the low-water period of 2006, in the river in front of the town, at places where people had bathed and dived with open eyes, as well as up and downstream of the town. The results evinced that at least eleven sponge species, including *D. uruguayensis* and *D. ctenosclera* were present in the river bottom upstream but absent in front and downstream the town, where a rearrangement of the river benthos took place with dislodgment of several macroinvertebrates by the snail *Melanoides tuberculatus.* The results signal to the failure of the gemmular ecclosion at such places with liberation of the gemmoscleres into the water as well as to a relationship with the total absence of sewage treatment at the town.

Keywords: freshwater sponges, *Melanoides tuberculatus*, ocular disease, Amazonia.

Resumo: Surto recente de doença ocular na cidade de Araguatins, TO, à margem do rio Araguaia, Amazônia Central, no período de águas baixas de 2005, requereu análises patológicas de tecidos oculares cirurgicamente extraídos dos pacientes. Espículas que investem as gêmulas das esponjas de água doce *Drulia uruguayensis* e *D. ctenosclera* foram encontradas nesses materiais oculares. Essa primeira relação cientificamente estabelecida e publicada, entre uma doença ocular e espículas de esponjas continentais, constituindo inédito agente de patologia ocular, levantou duas questões. Ocorriam essas duas espécies de esponja no leito do rio junto à margem da cidade e a outra, por que gemoscleras e não as megascleras, espículas que constituem abundantemente os esqueletos das esponjas, estavam nos tecidos extraídos. Foi realizado, no período de águas baixas de 2006, levantamento para esponjas e amostragem por quadrados para os demais componentes do macrobentos no rio, em frente à cidade, nos locais onde as pessoas haviam mergulhado com os olhos abertos, bem como a montante e jusante da cidade. Os resultados mostraram que, no mínimo, onze espécies de esponjas, incluindo *D. uruguayensis* e *D. ctenosclera* ocorriam no leito do rio a montante mas estavam ausentes em frente e a jusante da cidade, onde um rearranjo do bentos teve lugar com o desalojamento de diversos macroinvertebrados pelo gastrópode *Melanoides tuberculatus*. Os resultados apontam tanto para o insucesso da eclosão gemular nesses locais, com liberação das gemoscleras na água quanto para uma relação com a ausência de saneamento na cidade.

Palavras-chave: esponjas de água doce, *Melanoides tuberculatus*, doença ocular, Amazônia.

1. Introduction

The South American continental sponge fauna is one of the richest of the planet, particularly that one from rivers of the Amazonian Region (Volkmer-Ribeiro,1981). The sponges, sessile animals, form continuous crusts on the rocky or stony bottom of these rivers joining together larger stones, pebbles and even thick sand, contributing to the stabilization of the river bed at the same time that they carry out their filter function. Archeologists and zoologists of the 19th and the 20th centuries (Hilbert,1955) and up to the present (Gomes, 2002), report that native tribes from the Amazon produced sophisticated ceramics, using those sponges siliceous spicules as antiplastic. These natives avoided the contact with rich sponge waters due to the penetration of the spicules in the skin, what immediately caused itch, followed by several allergic reactions. These precautions included not to dive in "itchy waters" with open eyes (Brazil, 1938).

Volkmer-Ribeiro and Batista, knowing about the richness of sponges in the Araguaia River (Batista et al., 2003, 2007; Volkmer-Ribeiro and Batista, 2007), alerted the regional sanitary authorities that the outbreak of ocular disease might have been caused by sponge spicules, once all the patients, without exception, had dived in the river with open eyes and scratched them afterwards. Several speculations credited this outbreak of ocular disease to the massive presence of two exotic mollusks, *Melanoides tuberculatus* (Müller, 1774) and *Corbicula fluminea* (Müller, 1774), along the river bank by the town. Histopathological analyses of surgically removed materials from the eyes of some patients revealed the presence of sponge spicules in these affected ocular tissues (Volkmer-Ribeiro et al, 2006). They were identified as gemmoscleres belonging to the species *Drulia ctenosclera* Volkmer-Ribeiro and Mothes de Moraes, 1981 and *Drulia uruguayensis* Bonetto and Ezcurra de Drago (1968). These spicules invest gemmules, asexual reproduction bodies abundantly produced by freshwater sponges.

Here we report the unfolding of the research which focused on the detection of the two sponge species in the river and the investigation why the spicules pervading the eyes were gemmoscleres, which are imbedded in the gemmule wall, and not megascleres, which constitute the skeleton of the sponges and are easily released.

2. Material and Methods

A survey for sponges was performed in three georreferenced stations (Figure 1), along the river right bank bed in September 25, 2006, period of low and crystalline waters: one by the river upstream the town of Araguatins (St. 1, 22L 0815734 UTM 9371235); one in front of the town (St. 2, 22L 0817859 UTM 9375231), and the other downstream the town, where most of the patients of the ocular disease had dived with open eyes (St. 3, 22L 0819505/UTM 9377664). Aiming a comparative purpose sponges were also looked for in the central channel and in the opposite left margin of the river. Pebbles and stones were taken from the river bed in order to detected sponge crusts. Voucher sponge specimens were preserved dry and deposited in the Porifera Collection of the "Museu de Ciências Naturais" of "Fundação Zoobotânica do Rio Grande do Sul". At the lab the sponges were processed for taxonomic identification following Volkmer-Ribeiro (1985). The other benthic macroinvertebrates were surveyed using the quadrat sampling method (Paillex et al. 2007; Cabral et al. 2004) at the same stations referred for the sponge sampling. For that purpose the bottom sediment was removed down to 10 cm inside a 625 cm^2 iron frame, with four replicates and washed at the field using a 200 μm mesh size sieve. The collected materials were preserved in formaldehyde 10%, identified, quantified and the total density per m^2 was calculated.

3. Results

The survey reveled the absence of sponges (Table 1) along the river bank in front of and downstream the city of Araguatins and the occurrence of eleven sponge species covering the river bed and joining together pebbles, stones and sand (Figure 2), upstream the town, as well as in the central channel and along the left opposite margin of the river. The sponge assemblage was composed by distinct combinations of crusts of the following species: *Trochospongilla paulula* (Bowerbank, 1863), *Trochospongilla repens* (Hinde, 1888), *Corvospongilla seckti* Bonetto and Ezcurra de Drago, 1966, *Heteromeyenia cristalina* Batista *et al*. 2007, *Oncosclera navicella,* (Carter, 1881), *Oncosclera spinifera* (Bonetto and Ezcurra de Drago, 1973), *Oncosclera schubarti* (Bonetto and Ezcurra de Drago, 1967), *Oncosclera tonolli* (Bonetto and Ezcurra de Drago, 1968), *Drulia uruguayensis* Bonetto and Ezcurra de Drago, 1968, *Drulia ctenosclera* Volkmer-Ribeiro and Mothes de Moraes, 1981 and *Drulia cristata* (Weltner, 1895).With the exception of *O. schubarti* and *O. tonolli* all these sponges had already been registered (Batista et al., 2003, 2007) and illustrated (Batista et al., 2007)) for the Araguaia River, upstream the town of Araguatins or along the town during the high water period (Volkmer-Ribeiro and Batista, 2007).

The number of macroinvertebrates registered at the sampled stations, as well as their density per m^2 are shown in Table 1. Remarkable differences are seen in the composition of the benthos at stations two and three when compared to that of station one. The most obvious ones presented at those two sites are the absence of the following groups: sponges, the native molluscs *Eupera* and *Ancylidae,* larvae of the aquatic insects Leptoceridae, Hydropsichidae, Sericostomatidae, Naucoridade, the Chironomidae *Aedokritus, Tanytarsus, Ablabesmya* and *Cricotopus.* On the other side an increased abundance of the exotic gastropod

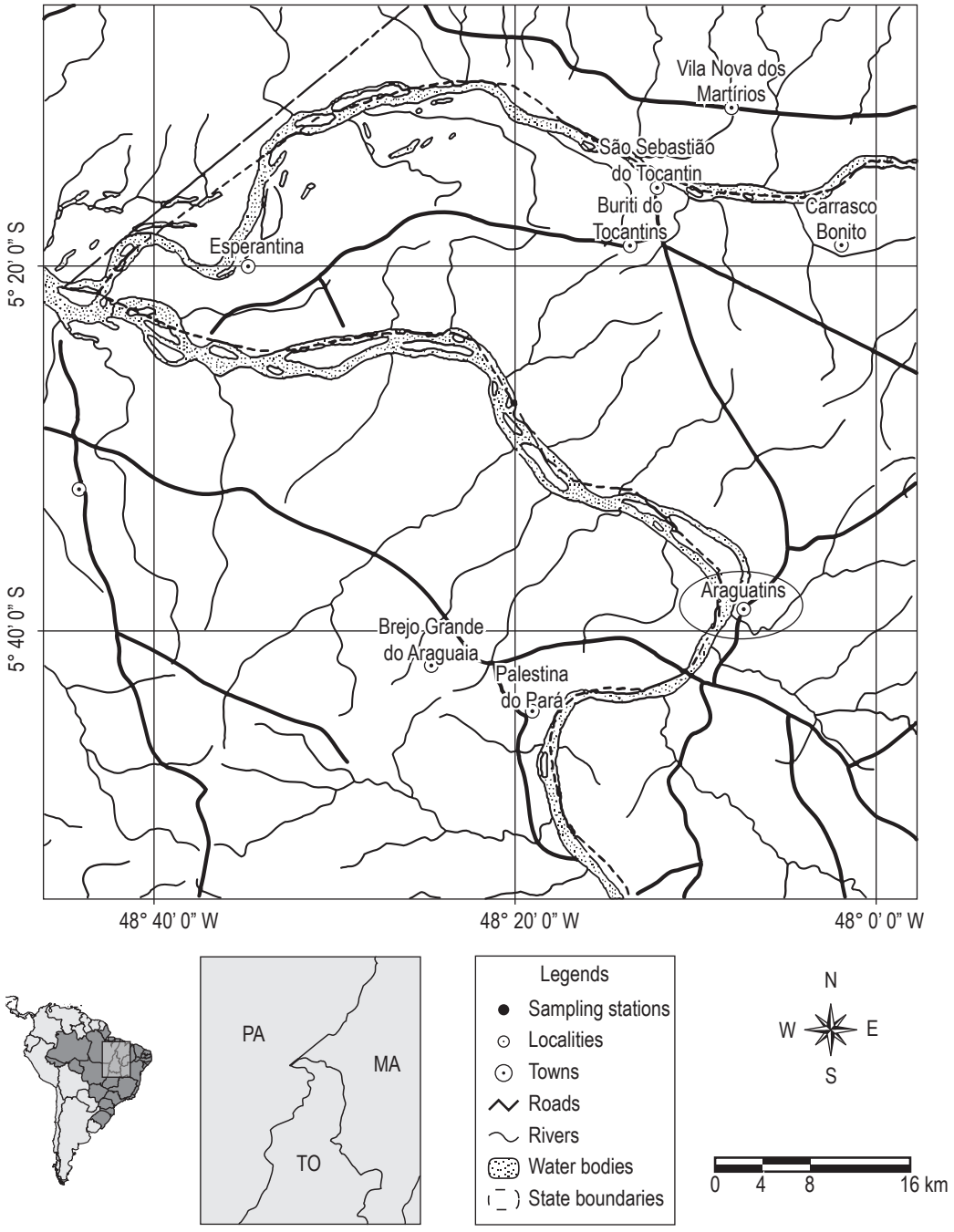


Figure 1. Map of the Araguaia River by the town of Araguatins, indicating the three collection stations determined for the quantitative survey of macroinvertebrates and qualitative survey of sponges.

Melanoides tuberculatus, the also exotic bivalve *Corbicula fluminea* and of the Tubificidae takes place altogether with the appearance of the gastropod *Doryssa* sp., of turbellarians and of hirudineans.

4. Discusssion

The present results confirmed previous surveys which indicated a rich and abundant sponge fauna in the rocky stretches of River Araguaia (Batista et al., 2003, 2007) and also that *Drulia uruguayensis* and *Drulia ctenosclera,* the two species of sponges which had gemmoscleres found in the pathological analyses of the patients' eyes were present, besides being frequent, in the river bed upstream the town of Araguatins. In that sense their gemmules are being produced in the river and being released downstream as are the ones of the other sponge species surveyed upstream.

However the quantitative sampling of the benthic community (Table 1) showed a drastic change at the river bed in

front of and downstream the town (stations 2 and 3) where sponges and larvae of some aquatic insects were replaced by large amounts of molluscs of particularly the exotic species *Melanoides tuberculatus* (Figure 3) and to a lesser amount *Corbicula fluminea*, as well as by turbelarians, hirudineans and tubificidians, all such organisms indicators of organically enriched waters (Rosenberg and Resh, 1993). The exotic molluscs were present upstream (Figure 2) but evidently are facing the competition with sponges and other components of a richer healthier benthos. Previous registers of the invading *Melanoides tuberculatus* in Brazil, (Vaz et al., 1986) remark its abundance in waters subjected to domestic sewage input at São Paulo State. Guimarães et al. (2001) report the ability of *M. tuberculatus* to displace native gastropods at two man-made lakes in Minas Gerais State. Spongivory by freshwater gastropods has never been registered despite of the fact that marine Pleurotomariid gastropods have been reported to feed on sponges (Harasewych et al. 1988) So the possibility that *M. tuberculatus* may be also scrapping out the young sponges ecloded from the gemmules trapped along the pebbled substrate in front and down stream the town may not be excluded. In that respect it is quite interesting to recall Jackson and Sala (2001) considerations on the distortion of trophic relations and food webs and loss of biodiversity brought about by anthropically disturbed coastal marine bottoms.

Figure 2. Sample of the Araguaia River healthy rocky substrate showing the heavy incrustation by sponges. Picture Batista, TCA.

Figure 3. Fraction of the abundant sampling of the the exotic mollusk *Melanoides tuberculatus* taken at the River Araguaia by the town of Araguatins.Specimens of the exotic bivalve *Corbicula fluminea* are also seen in the picture. Picture Batista TCA.

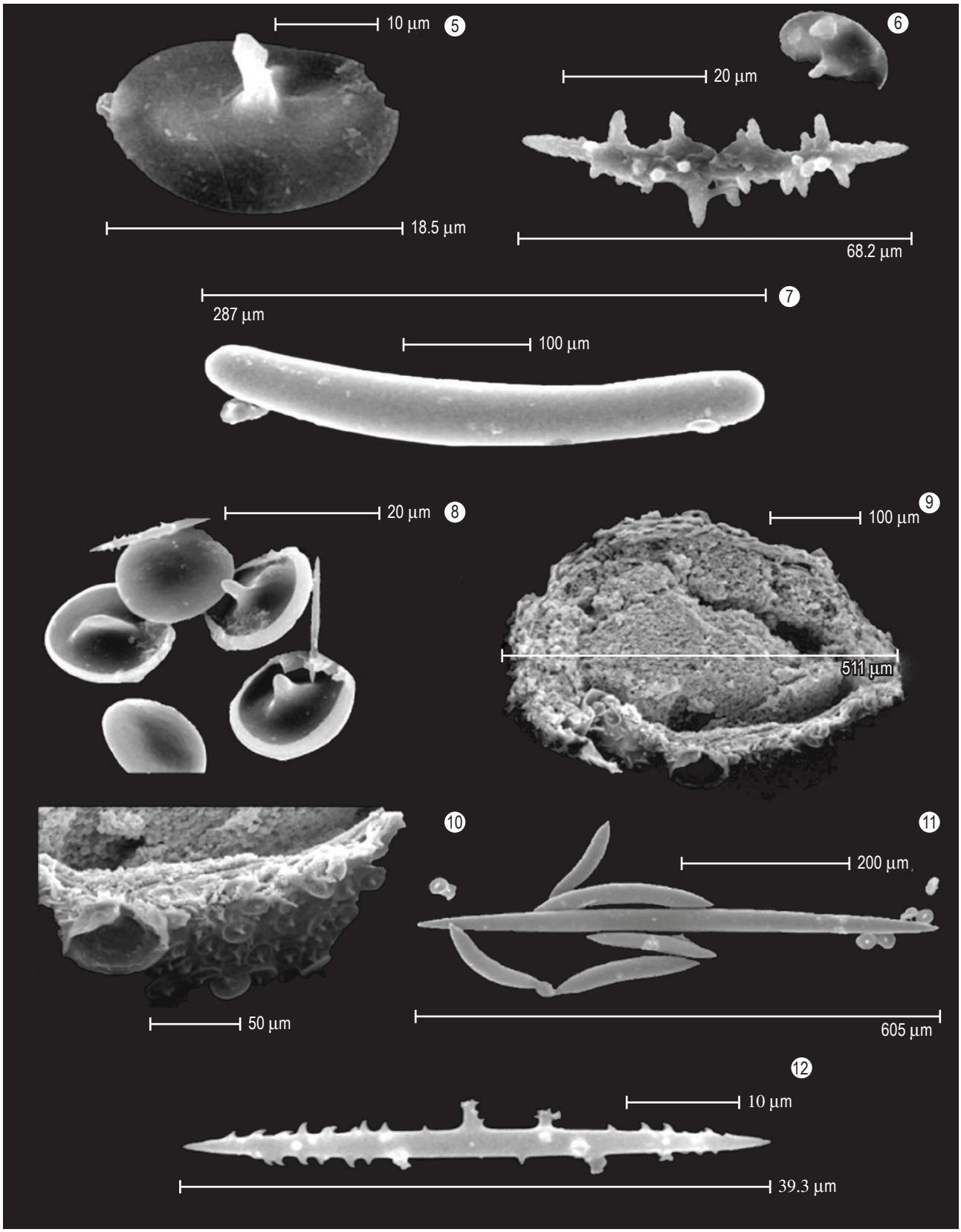
Upon interviewing leaders of the local community, the authors heard and next saw (Figure 4) that the works of the sewage treatment station at Araguatins had been abandoned, so that the population completely misses this sanitation process. Moreover the town is placed on a slope which drains straight into the river right margin and its population triplicates during summer time due to tourism focused on the river, thus contributing to an increased volume of domestic sewage production. Furthermore, sand and pebble industrial extraction has been intensively performed at the river bed in front of and downstream the town. Thus an organic enrichment of the river waters is expected to take place at the right bank of the river by the town, contributing to the algal production, a basic food item of *M. tuberculatus* (Gulf States Marine Fisheries Commission, 2007).

The detected occurrence of the sponges *D. uruguayensis* and *D. ctenosclera* at the river bed upstream the town indicates that their gemmules, as well as those of the other sponges present at that location, were transported downstream by the water current.This fact was documented by Volkmer-Ribeiro and Batista (2007) as a result of the survey for sponge spicules at the river waters and sediments on the high-water period which followed the outbreak of the ocular disease. In their attempt to eclode and encrust on rocky substrates in front and downstream the town, those gemmules will certainly brake out liberating their gemmoscleres.The spicular sets of the two sponges (Figures 5-12) clearly illustrate the large difference in size between the

Figure 4. Abandoned works of the sewage treatment station at Araguatins. Picture Batista, TCA.

Table 1. Number of macroinvertebrate individuals sampled in each of the four replicates at stations 1 (upstream), 2 (in front of) and 3 (downstream) the town of Araguatins, river Araguaia, TO. T = total number of individuals taken at each station. D = density of individuals per m^2. The eleven sponge species listed at the Results where detected only at station 1 and enter the table as a whole (Porifera). The character X indicates the presence of Porifera in the sampling.

Taxonomic Group	Station 1						Station 2						Station 3					
	1	2	3	4	T	D	1	2	3	4	T	D	1	2	3	4	T	D
Porifera	X	X	X	X														
Mollusca																		
Cobiculidae																		
Corbicula fluminea							3	5	11	7	26	104			2	1	3	12
Sphaeriidae																		
Eupera				3	3	12												
Gastropoda																		
Thiaridae																		
Melanoides tuberculatus	65	39	64	49	217	868	507	793	629	517	2446	9784	221	255	200	231	907	3628
Pleuroceridae																		
Doryssa sp.							25	17	51	16	109	436		1			1	4
Ancylidae			2		2	8									5	3	8	32
Planorbidae																		
Biomphalaria	3		3	1	7	28				1	1	4						
Plathyhelmintes																		
Turbellaria							11				11	44						
Annelida																		
Hirudinea							2	7	5	13	27	108	4	1		1	6	24
Oligochaeta																		
Naididae													2				2	80
Tubificidae				1	1	4	5	43	29	1	78	312	3	16	8	12	39	156
Insecta																		
Ephemeroptera																		
Baetidae			2		2	8	2	9	4	2	17	68						
Leptophlebiidae							7	16	9	4	36	144						
Trichoptera																		
Leptoceridae			1	1	2	8												
Hydropsychidae																		
Leptonema			1		1	4												
Odontoceridae																		
Marilia	2				2	8		2	2	2	6	24						
Sericostomatidae			2		2	80												
Coleoptera																		
Elmidae								3	1		4	16						
Hemiptera																		
Naucoridae	2				2	8										1	1	4
Diptera																		
Ceratopogonidae																		
Chironomidae																		
Chironominae																		
Aedokritus			1	2	3	12												
Harnischia							1		1		2	8						
Polypedilum			1	3	4	16			1	2	3	12						
Tanytarsus				1	1	4												
Tanypodinae																		
Coelotanypus															1		1	40
Ablabesmyia		1			1	40												
Orthocladiinae																		
Cricotopus			1		1	40												
Total no. of individuals	72	40	78	61			563	895	743	565			230	273	216	249		



Figures 5-12. SEM pictures of the spicular set of the sponges *Drulia ctenosclera* (5-7): 5) detail of the gemmosclere thumbtack shape; 6) gemmosclere and microsclere; 7) megasclere and three gemmoscleres; and *Drulia uruguayensis* (8-12): 8) set of gemmoscleres and microscleres ; 9) cross section of one gemmule depicting the foraminal tube and the incrusting of several layers of gemmoscleres at the gemmular wall; 10) magnification of the foraminal area seen in Figure 9 to evince the loose attaching of the gemmoscleres at the gemmular wall.; and 11) set of one alpha megasclere, five beta megascleres and several gemmoscleres.

spicules (megascleres and microscleres) which make up the sponge skeleton and gemmoscleres, the ones which invest the gemmular wall. The shape of thumbtacks of these minute siliceous gemmoscleres (Volkmer-Ribeiro et al., 2006), is extraordinarily appropriated to adherence and cause itching in the human eye, besides their light weight enables them to stay in the water column for a long time. Scratching finally makes them penetrate into the eye tissues. The fixation of the new sponges resulting from the constant sowing of the gemmules carried from upstream fails in front of and downstream of the city. This failure may be attributed to the movement and frequent scraping of the rocky substrates, particularly by the exotic mollusk *Melanoides tuberculatus*. This mollusk, as well as the other altered components of the impacted benthos, are resistant to the anthropically originated organic enrichment of the river. The results come to point out the reappearance of sponges and the reduced abundance of the exotic mollusks as biological indicators in monitoring processes and recovering of the original water and bottom quality of the river at the impacted area. Furthermore, these organisms alert to the risks to the human health of the urban and tourism development not preceded by environmental planning and basic sanitation projects along Amazonian rivers.

Acknowledgements

The authors acknowledge the Health Departments of the State of Tocantins and of the Municipality of Araguatins, the Fundação Natureza do Tocantins/Naturatins, the Centro Policia e Meio Ambiente/Cipama and the Fisheries Association of Araguatins, for valuable support with the field activities and the PIBIC-CNPq. fellow Karina F. de Oliveira for help with the image processing of figs. 2-12. They are indebted to the three anonymous referees and to Dr. Demetrio Gadagnin, UNISINOS, São Leopoldo-RS, for the valuable suggestions offered. The senior author acknowledges CNPq. for the research fellowship and corresponding Grant.

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Received: 30 January 2008
Accepted: 01 August 2008