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Freshwater sponges as indicators of floodplain lake environments and of river rocky bottoms in Central Amazonia

by

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Abstract

Two complementary surveys were carried out in the same area of the Araguaia River Basin, Central Amazonia, Brazil: one of sponges in the low water, the other of the water quality in the dry and the high water. Two environments were selected for the sponge survey: an exposed rocky bottom stretch of the river and several nearby várzea lakes. This revealed seasonal sponge assemblages characteristic of each of the two habitats. The high water parameters detected in the river and várzea lakes come out now as the ones which set the first ecological frame for this seasonal fauna and are required for gemular eclosion and growth.
Keywords: **Sponges, ecology, várzea lakes, river rocky bottoms, flood pulse, Central Amazonia.**

Resumo

Dois levantamentos complementares foram realizados numa mesma área da bacia do rio Araguaia, Amazônia Central, Brasil: um de esponjas na estação da seca e o outro da qualidade da água nas estações de seca e cheia. Dois ambientes foram selecionados para o levantamento das esponjas: um trecho exposto do fundo rochoso do rio e diversos lagos de várzea vizinhos. Esse revelou assembléias de esponjas, características de cada um dos dois habitats. Os parâmetros das águas altas detectados no rio e nos lagos de várzea revelam-se agora como os que revelam o primeiro conhecimento ecológico para esta fauna sazonal e são requeridos para eclosão gemular e o crescimento.

Introduction

The most widely studied sponges of the Amazonian region are those thriving in the floodplain lakes of the rivers. Specimens can easily be seen and collected during the low water season, dried out, encrusting the trunks, branches, twigs and leaves of the flooded forest (VOLKMER-RIBEIRO 1976, 1981, 1986, 1990; VOLKMER-RIBEIRO

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& DE ROSA BARBOSA 1972, 1974; VOLKMER-RIBEIRO & COSTA 1992; VOLKMER-RIBEIRO & TAVARES 1993, 1997).

The first sponge survey from the rocky bed of a Central Amazon (FITTKAU 1983) river was reported by VOLKMER-RIBEIRO & HATANAKA (1991), where *Drulia uruguayensis* BONETTO & EZCURRA DE DRAGO, 1968, *Oncosclera navicella* (CARTER, 1881), *Trochospongilla repens* (HINDE, 1888) and *Corvospongilla seckti* BONETTO & EZCURRA DE DRAGO, 1966 were registered for the Tocantins River, downstream the lake of the Tucuruí Hydroelectric Plant, in the State of Pará. TAVARES (1994) and VOLKMER-RIBEIRO & TAVARES (1997) carried out an extensive taxonomic study of the sponges from the rocky beds of numerous rivers in Central Amazonia upon samples collected during the construction of hydroelectric dams in the region. VOLKMER-RIBEIRO & PAULS (2000) did a similar study of material collected from the rocky bed of the Orinoco River Basin in Venezuela during the low water. Using this material, VOLKMER-RIBEIRO & TAVARES (1995) reviewed the genus *Drulia* GRAY, 1867 and redescribed *Drulia uruguayensis*, noting its frequency in those environments, where *D. cristata* (WELTNER, 1895), *D. conifera* BONETTO & EZCURRA DE DRAGO, 1973 and *D. ctenosclera* VOLKMER-RIBEIRO & MOTHES DE MORAES, 1981 were also found. TAVARES & VOLKMER-RIBEIRO (1997) redescribed *Oncosclera navicella* and *Spongilla spoliata* VOLKMER-RIBEIRO & MACIEL, 1983 and noted that, in the rocky beds of Amazonian rivers, these sponges developed more varied and robust forms, skeletal structures and spines because such environments constitute their ideal habitats.

There is a need to study these communities due to concern with the quality of the water in the permanent lakes formed as a result of the hydroelectric projects in the area and their colonisation by sponges. Sponges are filter feeders that, as well as indicating the oxygen levels of the water, contribute to its purification, retaining high levels of particles, especially bacteria, which constitute their main food source (SIMPSON 1984).

No study had been done with both the river bed and the várzea lakes of a single river, in order to compare sponge colonies in the two environments as well as the nature of specific adaptations and occupation of the habitat.

The only register of sponges until now in the basin of the Araguaia River was of *Tubella meloleitaoi* (MACHADO 1947). It was based upon samples of the species taken by the author from the Tapirapés River, a left bank tributary of the Araguaia River in the State of Mato Grosso. VOLKMER-RIBEIRO (1984), after studying the type deposited in the "Museu Nacional do Rio de Janeiro" (National Museum of Rio de Janeiro), Brazil, synonymized *Tubella meloleitaoi,* partly in *Metania reticulata* (BOWERBANK, 1863) and partly in *Trochospongilla pennsylvanica* (POTTS, 1882).

Given that MACHADO (1947) reported an abundance of sponges in the area, it may be assumed that such abundance might include other species and not just those two previously reported. It may also be supposed that distinct areas from the lakes visited by MACHADO (1947) could contain other representative species of this fauna. The Araguaia River, which is known for its clear waters, has recently been the subject of consideration due to the environmental impact that would result from the construction of the Tocantins-Araguaia waterway. It seems, therefore, to be an ideally suitable candidate for a survey of the sponges that would include both the rocky substrates and the várzea lakes, before more drastic alterations affect the biota. Two sample collection areas were selected based upon their accessibility: one on the border between the States of Pará (PA) and Tocantins (TO), overlooking the municipality of Santana do Araguaia/PA on the left bank (LB) and the municipality of Caseara/TO on the right bank (RB); the second area was located on the Urubu River, a tributary to the right bank of Araguaia River, in the municipality of Lagoa da Confusão/TO. Given that the riverside populations draw their water supplies from these waters, the results obtained will be made available as indicators of the environmental conditions, contributing to the knowledge and maintenance of the quality of the water in the Basin.

The most recent taxonomic knowledge concerning Brazilian freshwater sponge fauna, in terms of both habitat and species, has rendered applications in distinct areas of environmental knowledge, be it in indicative species of water in natural conditions (VOLKMER-RIBEIRO et al. 1998), indicative of special habitats or present-day ecosystems (VOLKMER-RIBEIRO 1992, 1999; VOLKMER-RIBEIRO et al. 1998), as well as paleoindicative of Holocene/Pleistocene environments due to the presence of siliceous spicules in sediments, especially lacustrine deposits (VOLKMER-RIBEIRO et al. 2001).

Hydrochemical studies were found referring to the upper Araguaia (upstream from the River das Mortes) (GREEN 1970) and lower Araguaia (GIBBS 1967). SANTOS (1983) classified the lower Araguaia (immediately above its confluence with the Tocantins River) as a clear water river and transitional in relation to the carbonated/non-carbonated classification, with a tendency towards the latter. The author also mentions that the river water showed a good equilibrium between alkali and alkali-earth metals and differs significantly from other clear water rivers of the Amazon Basin (e.g., Curuá-Una, Mués-Açú).

The present work aimed to survey and compair the sponge assemblages and the water quality in the river and the várzea lakes. The first sponge survey purpose was done at the low water period, when the largest number of substrates are exposed. Hydrochemical analysis were performed at both high and lowwater periods.

Study area

The Araguaia River constitutes the main drainage basin of the Central-West Region of Brazil and one of the largest courses of the region. Its sources are located in the Serra do Caiapó region, in the extreme southwest of the State of Goiás, bordering the States of Mato Grosso and Mato Grosso do Sul. The main channel is not well defined due to sand deposits and the fact that it breaches its banks during the rainy season (October-April), reaching depths of over 2 m above the flooded margins. During this period it extends over large areas, forming numerous várzea lakes and guaranteeing the existence of a rich biota. During the low water (May-September), the level of the river falls drastically, at some points the main channel is only 60 cm deep and vast banks of clear sand are uncovered, forming islands and extensive beaches (DEL'ARCO et al. 1999).

The spongological and hydrochemical studies were performed in the Araguaia River at several sites located along the stretch 15 km upstream from the mouth of the Javaés River and 30 km downstream from Caseara (Fig. 1).

Samples of sponges were taken from the Araguaia River in the municipalities of Caseara/TO and Santana do Araguaia/PA, Brazil, between the co-ordinates 9°-10°S and 49°-50°W, on the border between the states of Pará and Tocantins and from the Urubu River in the municipality of Lagoa da Confusão, State of Tocantins.

In the Araguaia River, two different environments were selected for sponge sampling: 1) the rocky substrate of the river bed, which is exposed during the low water (Fig. 2); 2) two várzea lakes, one on the left bank known locally as Lagoa da Mata, in Pará State and the other, which we named Lagoa da Queimada, on the right bank, Tocantins State. Both lakes are located in the vicinity of the rocky river bed sampled.

The rocky bottom of the Araguaia River selected for sampling was next to the right bank. It consisted of continuous rocky substrate, overlaid with stones of varying sizes and sand. The area was completely exposed during the sampling period. The margins consist of long steep of sandbanks topped by wooded vegetation. The river water was clear and transparent at the time.

The lakes selected for sampling along the rivers Araguaia and Urubu were all located within the floodplain of the rivers. The lake shore arboreals are capable of withstanding periodic flooding due to structural adaptations, such as aerial and tabular roots (Fig. 3). The first sampling site, the Lagoa da Mata, by the Araguaia River, was the largest of the four várzea lakes sampled. It is long meanderform and divided into a series of interconnected pools. The second, Lagoa da Queimada, was smaller and had little water. There were many leaves, branches and signs of recent burning around it. The lakes by the Urubu River were similar and intermediate in size compared with the lakes on the Araguaia River.

In the area of the Urubu River, two várzea lakes at the right-bank were chosen as sampling sites. Both were located on the Estância Terra Negra, about 23 km from the town of Lagoa da Confusão: the larger is known as Lagoa dos Jacarés (Fig. 4) because of its large population of caymans, and the smaller was named by the autors Lagoa 2. At the time the samples were collected, the water level was low in the lakes and the exposed sandy shores were colonized by grasses (Fig. 4).

During the floods, each lake forms an integral part of the river although the water flow is reduced in the areas of the lakes as the water is contained by the vegetation. During the low water the rivers and lakes become frequently isolated, benefiting fully from their respective lotic and lentic characteristics (Fig. 5).

In order to establish the limnological characteristics of the surveyed area, sampling was performed during the extremes of the high and low waters of the extremes of the hydrological cycle of 2000 (i.e., high water and low water), in the middle reach of the Araguaia River and lower reach of the Javaés River as well as in four marginal lakes located in the basins of these rivers, three located in the Araguaia River basin (Lago do Piquizeiro, Lago do Panela and Lago Naru), and one in the basin of the Javaés River (Lago Volta Grande).

The hydrochemical studies were performed in the Araguaia River at three sites, located equidistantly along the stretch 15 km upstream from the mouth of the Javaés River and 30 km downstream from Caseara. In the Javaés, at 2 sites: the first almost 15 km upstream from its confluence with the Araguaia and the other at a linkage channel between the Araguaia and Javaés that empties downstream from the confluence of the two rivers, known locally as the Javaezinho.

Although the survey of the limnological characteristics of the river and its várzea lakes did not take place in the same sites as that of the survey of sponges, the sites were close enough to permit that the aquatic universe considered in the two surveys may be seen to be the same, especially given the large size of the Araguaia River.

Material and methods

Samples of sponges were taken in 1999 at the end of the low water (from the Araguaia River on the 25th and 26th and from the Urubu River on the 28th of September). In order to establish the limnological character of the area surveyed, sampling was performed during the extremes of the high and low waters of the hydrological cycle of 2000.

The sponges, collected by hand, were dried and preserved according to VOLKMER-RIBEIRO (1985), catalogued and deposited in the Porifera Collection of the Museu de Ciências Naturais (MCN), Fundação Zoobotânica do Rio Grande do Sul (FZB). Analysis of the material was carried out using an optical microscope following preparation of the skeletal spicules as well as the gemmules, according to VOLKMER-RIBEIRO (1985). Sediment samples were also taken from the shores of the lakes in order to detect the presence of spicules and compare them to those of specimens taken from the flooded forest. The sediments were catalogued and processed in the same way as the specimens, in order to obtain permanent preparations destined for examination with an optical microscope VOLKMER-RIBEIRO (1985).

The following limonological variables were measured: transparency (SECCHI disc), temperature, dissolved oxygen, pH, electrical conductivity, alkalinity, total and organic carbon. The carbon concentration was calculated from the total CO_2 levels (inorganic carbon) and from chemical oxygen demand (organic carbon). The methodology applied in the collection, preservation and analysis of the water was based upon the recommendations described in STRICKLAND & PARSONS (1972), APHA (1975), GOLTERMAN et al. (1978), MACKERETH et al. (1978) and WETZEL & LIKENS (1991).

In the rivers, water samples were taken from below the surface at collection sites located along the main channel.

In the central area of each lake, two collections sites were established, one at the surface and the other at the maximum depth. RUTTNER's bottle was used at all sites and collections were carried out in February (high water) and August (low water) of 2000. Transparency was measured in the field using a white 30 cm diameter SECCHI disc. Temperature, conductivity, pH and dissolved oxygen were measured *in situ* using digital field potentiometers. The alkalinity and total CO_2 were determined by means of potentiometric titration using the pH meter. The chemical oxygen demand (COD) was determined using the $KMnO_4$ oxidation method.

Results

The sponge fauna was abundant, in both the exposed rocky river bed and the várzea lakes of the Araguaia River. Identification of the 179 specimens collected revealed the presence of the following taxonomic entities:

Family Spongillidae GRAY, 1867

Trochospongilla gregaria (BOWERBANK, 1863)

This sponge was present with minute specimens, with gemmules, attached to the aerial roots of the floodplain forest. The skeletons were always delicate or had loose gemmules within the reticulum of another species, *Metania reticulata*.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4088, 4383, 4384); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4934); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa dos Jacarés, várzea, 28.09.1999, (MCN 4167, 4905, 4908, 4910, 4914); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa 2, várzea, 28.09.1999, (4176, 4918, 4919, 4921, 4923, 4924, 4927), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Trochospongilla paulula (BOWERBANK, 1863)

Sponge delicate, full of gemmules, attached to the aerial roots of the floodplain forest or fallen tree trunks at the lakeshore.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4086, 4346, 4932); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4935); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa dos Jacarés, várzea, 28.09.1999, (MCN 4164, 4904, 4906, 4909, 4911, 4913); Brazil, Lagoa da Confusão, Urubu River (RB), Lagoa 2, várzea, 28.09.1999, (MCN 4178, 4922, 4925, 4926), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Trochospongilla repens (HINDE, 1888)

This sponge was found in the rocky river bed, forming fine continuous resistant crusts (Fig. 6), covering the upper and lower surfaces of the rocks. Coloration consisting of grey tones in the former case and white in the latter. Large numbers of gemmules were attached to the substrate by a hard, dark carapace, which was shared by several gemmules.

Material examined:

Brazil, Tocantins State, Caseara, Araguaia River (RB), rocky bottom, 25.09.1999, (MCN 4112-4115, 4121, 4408, 4410); same locality, 26.09.1999, (MCN 4140, 4144, 4147, 4151, 4153, 4157, 4163, 4436), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Trochospongilla lanzamirandai BONETTO & EZCURRA DE DRAGO, 1964

Only gemmules were found, attached to tree trunks or associated to specimens of *Metania reticulata*.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4933); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa 2, várzea, 28.09.1999, (MCN 4917), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Trochospongilla delicata BONETTO & EZCURRA DE DRAGO, 1967

Present with a few gemmules, associated to *Saturnospongilla carvalhoi* (MCN 4138).

Material examined:

Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4428), C.V. RIBEIRO & T.C.A. BATISTA leg.

Corvospongilla seckti BONETTO & EZCURRA DE DRAGO, 1966

Found in the rocky river bed, gemmules were extremely abundant, single or in groups, attached to the skeleton of other species, such as *T. repens*, and *D. uruguayensis*. The skeletal parts were rarely found. In the lake sites, it was found with reduced squeleton and gemmules inside the skeletal network of *M. reticulata*. The number of specimens of *C. seckti* (Table 1) was counted upon the incidence of gemmules over every other specimen examined. For instance, every sample of *D. uruguayensis* with gemmules of *C. seckti* was counted as one sample of *C. seckti* and another *of D. uruguayensis*.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4103, 4359); Brazil, Tocantins State, Caseara, Araguaia River (RB), rocky bottom, 25.09.1999, (MCN 4118, 4122, 4124, 4388, 4391, 4392, 4394, 4397, 4400, 4401, 4403, 4404, 4406, 4409, 4416); same locality, 26.09.1999, (MCN 4154, 4158, 4159, 4161, 4162, 4435, 4437, 4439, 4443, 4444, 4899, 4900-4903), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Radiospongilla amazonensis VOLKMER-RIBEIRO & MACIEL, 1983

This sponge had the gemmules attached to the tree trunks covered by a fragile skeleton.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4099); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa 2, várzea, 28.09.1999, (MCN 4920), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Saturnospongilla carvalhoi VOLKMER-RIBEIRO, 1976

This sponge had a delicate skeleton, built between the leaf spines of palm stems standing (ticum), up to 2 m in height, with large quantities of gemmules attached to the skeletons or isolated gemmules attached to trunks.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4944); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4138, 4427); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa dos Jacarés, várzea, 28.09.1999, (MCN 4938), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Family Potamolepidae BRIEN, 1967

Oncosclera navicella (CARTER, 1881)

Sponge found on the upper face (Fig. 6) and especially on the lower face of stones in the rocky river bed. It had a well-developed skeleton, was coloured pale yellow, with large numbers of gemmules either loose, or adhering to the skeleton or the substrate. In the várzea lakes it occurred on the aerial roots of the lake shore trees, with isolated gemmules surrounded by a reduced skeleton.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4087, 4361); Brazil, Tocantins State, Caseara, Araguaia River (RB), rocky bottom, 25.09.1999, (MCN 4108-4111, 4405, 4407, 4930); same locality, 26.09.1999, (MCN 4141, 4143, 4148, 4160, 4430, 4440, 4442, 4897); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4424); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa dos Jacarés, várzea, 28.09.1999, (MCN 4912, 4937), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Oncosclera spinifera (BONETTO & EZCURRA DE DRAGO, 1973)

Found on the riverbed, forming extremely fine crusts, whitened with a closed reticulum.

Material examined:

Brazil, Tocantins State, Caseara, Araguaia River (RB), rocky bottom, 25.09.1999, (MCN 4390, 4393, 4417); same locality, 26.09.1999, (MCN 4438, 4441, 4445, 4898, 4931), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Family Metaniidae VOLKMER-RIBEIRO, 1986

Acalle recurvata (BOWERBANK, 1863)

Sponge forming fine, delicate crusts, on flooded (trunks and branches), with basal strata of gemmules, or groups of 6-10 gemmules devoid of covering skeleton.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4095, 4379, 4385); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa dos Jacarés, várzea, 28.09.1999, (MCN 4170, 4907, 4936); Brazil, Tocantins State, Lagoa da Confusão, right bank Urubu River, Lagoa 2, várzea, 28.09.1999, (MCN 4916), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Drulia browni (BOWERBANK, 1863)

Only found as isolated gemmules or as small groups of gemmules, adhering to trunks or branches of the flooded forest.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4101, 4375, 4376, 4386); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4129, 4137), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Drulia cristata (WELTNER, 1895)

This sponge, found on the rocky river bed, formed hispid crusts with a rigid skeleton. It was attached to upper surface of rocky substrate, with gemmules found on the base of the skeleton.

Material examined:

Brazil, Tocantins State, Caseara, Araguaia River (RB), rocky bottom, 25.09.1999, (MCN 4116); same locality, 26.09.1999, (MCN 4142), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Drulia uruguayensis BONETTO & EZCURRA DE DRAGO, 1968

Well developed conspicuous hemispheric specimens, with an open weave, radial skeleton (Fig. 6), having long primary fibres and reduced secondary fibres. The consistency was tough, but brittle when dry. The sponges were found in the rocky river bed. The gemmules were in fixed packets, distributed from the base to the periphery of the skeleton.

Material examined:

Brazil, Tocantins State, Caseara, Araguaia River (RB), rocky bottom, 25.09.1999, (MCN 4107, 4117, 4119, 4120, 4123, 4125); same locality, 26.09.1999, (MCN 4145, 4146, 4149, 4150, 4152, 4155, 4156), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Metania reticulata (BOWERBANK, 1863)

Robust specimens, of an almost stone-like consistency, having tuberous forms on tabular roots, sub-spherical forms hanging from branches (Figs. 7, 8) or even crusts of varying sizes over tree trunks and branches.

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999, (MCN 4089-4094, 4096, 4098, 4100, 4102, 4104-4106); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999, (MCN 4126-4128, 4130-4136, 4423); Brazil, Tocantins State, Lagoa da Confusão, right bank Urubu River, Lagoa dos Jacarés, várzea, 28.09.1999, (MCN 4165, 4166, 4168, 4169, 4171, 4172); Brazil, Tocantins State, Lagoa da Confusão, right bank Urubu River, Lagoa 2, várzea, 28.09.1999, (4174, 4175, 4177, 4179-4182), all C.V. RIBEIRO & T.C.A. BATISTA leg.

Sponge assemblages in the river rocky bed

The river rocky bed site on the Araguaia River was completely exposed during the low water (Fig. 2). Its sponge assemblage was formed by the following species, in order of abundance (Table 1): *Corvospongilla seckti, Trochospongilla repens, Oncosclera navicella, Drulia uruguayensis, Oncosclera spinifera,* and *Drulia cristata*. This assemblage had sponges that formed crusts, either thin, extensive, hard or with closed skeletal reticulum, as well as arboreal specimens, also hard, though having an open skeleton. The ever abundant gemmules were retained within the skeletons (*D. cristata* and *D. uruguayensis*) or produced between the rock and the basal part of sponge (*T. repens*) or produced from the base up to the surface of the sponge (*C. seckti, O. navicella* and *O. spinifera*). In these assemblies, epizoic incidents are frequent, due to the competition for substrate, particularly on the sandy bed of the river where rocky outcrops are scarce, as in the area studied. In this case, it was revealed that the first species to occupy the substrate was *T. repens,* followed by *O. navicella*. *C. seckti,* with its delicate skeleton it is particularly apt to overlap other species and form an immense quantity of gemmules. With the impact of the rains and floods, its skeleton disintegrates, releasing gemmules over the crusts of the other species, even reaching the várzea lakes. At the site, stones of diverse sizes were colonized by *T. repens* both on the upper surface, where it tended to be grey in colour and on the lower surface, where it tended to be white. *D. uruguayensis* is generally found on surfaces opposing the current, within recesses of the rocks. It is capable of withstanding the presence of coarse sand due to its hard open weave skeleton. Due to this latter characteristic, this species was occasionally epizoic, capable of superimposing itself on *T. repens* (Fig. 6). We believe that such assemblages must occur in other stretches of the river where the bed is rocky and is either subject to exposure in the low water or permanent immersion. When the rocky bed is located in deeper water and subject to permanent immersion, the sponges of these assemblages form differentiated skeletal structures. They develop arboreal, flabelate or digital forms, oriented with the current and produce fewer gemmules (TAVARES & VOLKMER-RIBEIRO 1997), and for this reason, specific identification is more difficult.

Sponge assemblages in the várzea lakes

The sampling in the várzea lakes showed another assembly of sponges formed of 11 species, composed of order of abundance (Table 2): *M. reticulata, T. gregaria T. paulula, A. recurvata, D. browni, O. navicella, S. carvalhoi, R. amazonensis, T. lanzamirandai, C. seckti* and *T. delicata*. The sponges from these environments were found distributed from the base to the high water mark of the flooded forest, in substrates that vary from tabular roots and tree trunks to the aerial roots, branches and leaves (Fig. 3). While *M. reticulata* proved to be the sole occupant of the basal level, having voluminous tuberous crusts (Figs. 7, 8), in the sub-apical portion of the floodplain forest it was present together with the other species listed above. While in the floodplain lake assemblages all the sponges had abundant gemmules, two distinct types of skeletal structure are identifiable: 1) in *M. reticulata*, the specimens are large, hard, the skeleton has a closed reticulum with thick polyspicularal fibres and little spongin. The gemmules are contained in capsules within the skeleton. The specimens of *M. reticulata* do not disintegrate from one season to another. Since their gemmules are attached up to the superficial layer of the sponge, a new crust of sponge is produced on the dead crust with every rainy season. This gives rise to specimens that are robust, tuberous and, when suspended from branches, sub-spherical; 2) in the other species, the skeletons are frequently small and fragile, with fibres constituted of few spicules and more spongin, the gemmules remain loose on the skeleton or surface of the sponge. It is possible to distinguish these species by their gemmules that have exuberant pneumatic chambers, especially adapted to floating and retention in a flooded forest environment, like *S. carvalhoi* and *A. recurvata*, (VOLKMER-RIBEIRO 1976; VOLKMER-RIBEIRO & DE ROSA-BARBOSA 1972). Such differentiated skeletal structures result in the disintegration of those individuals that have fragile skeletons and the release of their gemmules during the following flood period permitting the colonisation of new substrates in the flooded forest.

Results of sample analysis of sediments from várzea lakes of the Araguaia and Urubu Rivers

Material examined:

Brazil, Pará State, Santana do Araguaia, Araguaia River (LB), Lagoa da Mata, várzea, 25.09.1999 (MCN 4097); Brazil, Tocantins State, Caseara, Araguaia River (RB), Lagoa da Queimada, várzea, 26.09.1999 (MCN 4139); Brazil, Tocantins State, Lagoa da Confusão, Urubu River (RB), Lagoa dos Jacarés, várzea, 28.09.1999 (MCN 4173), all C.V. RIBEIRO & T.C.A. BATISTA leg.

The three samples of sediments contained spiclules of the species found in table 2, confirming the relevance (VOLKMER-RIBEIRO 1985) of sampling the sediments in order to assess the sponge fauna present in the area. With the exception of *Metania reticulata* and *Acalle recurvata*, which were identified due to the peculiarities of their alpha and beta megascleras, the other species were present in the form of gemmoscleres in the sediments. Spicules were not abundant in the sediments. These spicules were clearly carried from the flooded forest and deposited in the sediment of the lakes as the waters receded. Given the large numbers of caymans observed in all the sampled lakes and the stirring of sediment that their movement causes in the shallow waters it is doubtfull that these remaining waters contain live sponges.

Limnology and hydrological cycle

The analysis performed in the lotic and lentic environments revealed: 1) the absence of a well defined spatial variability; 2) the seasonal character of the limnological conditions in the bodies of water (i.e., a high degree of variability), the origin of which may be attributed to the fluctuation of the hydrological regime (high and low water).

Transparency: There was a notable seasonal variation in the transparency of the water in the lotic and lentic environments, with the highest values registered in the high water. The exception was the Araguaia River, where the measurements taken at low water were higher and more uniform (0.77±0.03 m) than in the high water (0.60±0.15 m) (Fig. 9). The small variation between the measurements from high and low water phases in the Araguaia River and the evident reduction in transparency found in the other water bodies during the low water, suggests the existence of conditions that significantly alter the optical quality of the water mass. In general, independently of the phase of the hydrologial cycle, transparency was lower in rivers than in lakes. Among the lakes, highest transparency was found in Piquizeiro (1.55 m) and the lowest in lake Naru (0.90 m) and common to both phases of the hydrological cycle.

Temperature: There was considerable thermal uniformity in both environments during the same phase of the hydrological cycle. The water temperature of the rivers and lakes was high (ranging from 26 to 30 °C) and quite homogenous, with small variations in the spatial and temporal scale (Fig. 9). However, during low water, the water bodies were 1-3 °C warmer than in the high water. The reduction in the column of the water volume favours superficial warming in the low water. In the rivers, the maximum temperature variation oscillated around 2-3 °C. The marginal lakes presented discret thermal gradients between the superficial and deep layers of water (ca. 1 °C) and the absence of well defined thermocline. It is worth highlighting the occurrence of periods of complete thermal uniformity (circulation) in the lakes in both phases of the hydrologic cycle.

Dissolved oxygen: The concentrations of dissolved oxygen in both lotic and lentic systems were found to be relatively high, particularly in the low water (Fig. 9). It can be seen that, during low water, the concentration in both rivers approached 100 % of O_2 saturation (94-98 %) and were practically constant at all sampling points. However, in the high water phase, the Araguia River (60±8 % = 4.8±0.6 mg O_2/l) showed better conditions of oxygenation than the Javaés River. These percentages correspond to concentrations varying from 3.4 to 7.4 mg O_2/l with averages between 3.4±0.0 mg O_2/l in the high water to 7.3±0.1 mg O_2/l in the low water. In the marginal lakes, the concentration of oxygen oscillated between 44 % (3.4 mg O_2/l) and 73 % (5.5 mg O_2/l) of O_2 saturation, indicating a well oxygenated environment. In the latter, the highest indices of oxygenation were observed in the upper layers of the water column, with slightly lower values in the deeper layers.

Electrical conductivity: The electrical conductivity in the lotic and lentic systems showed almost constant levels at around 20-22 μS_{25}/cm during high water (21±0.6 μS_{25}/cm); the highest values were registered at low water, oscillating between 25.5 μS_{25}/cm and 35.9 μS_{25}/cm (31±0.6 μS_{25}/cm) (Fig. 9). It is noteworthy that the variation between the average high and low water values represented an increase in the entire system of 32 % (10 μS_{25}/cm); the variation in the Araguaia River was 23 % (6 μS_{25}/cm), while in the other water bodies it was 36 %, representing an average increase of around 12 μS_{25}/cm.

Hydrogen ion potential (pH): The pH values increased from the high water (minimum indices) to the low water (maximum indices) in both environments and were always higher in the Araguaia River within the same phase of the hydrological cycle (Fig. 9). The variation range of the pH values (from 6.04 to 7.97) of the rivers and lakes investigated suggests a large variation in the concentration of hydrogen ions (H^+) and considerable instability with regards the proportion of this cation in the environments studied. The maximum variation range between both phases was 1.90 units in Araguaia River, chiefly due to the high pH value (7.97) registered during low water. In the Javaés River, there was lower variability between the measurements (6.07 to 6.81). In the lakes, the degree of variation was much lower, raging from 0.60 units (high water) to 0.18 units (low water). The extremes of this variation occurred during high water in lakes Volta Grande (6.04) and Piquizeiro (6.64).

Total alkalinity: The alkalinity at the lowest level of water in the rivers and lakes showed values almost twice those found in high water (Fig. 9). Also, during the same phase of the cycle, in the same environment, the values exhibited considerable uniformity of the ions (carbonates/bicarbonates) associated with this variable. The greatest variation was registered during the low water, in the Araguaia River (0.277±0.03 meq/l) between the longitudinal points, and in the Lago Panela between the superficial and bottom layers (0.985±0.23 meq/l). The variation range of these measurements was lower in the rivers (from 0.251 meq/l or 15 mg HCO_3^-/l to 0.710 meq/l or 43 mg HCO_3^-/l) compared to the lakes (from 0.210 meq/l or 13 mg HCO_3^-/l to 1.150 meq/l or 70 mg HCO_3^-/l).

Carbon: The average concentration of carbon in both phases of the hydrological cycle was slightly higher in the Javaés River. The average C totals in high, (15±1 mg/l) and low water (13±0.9 mg/l) were about 13.3 % and 7.7 % greater than those of the Araguaia River in the same phase. In both rivers, the proportions found were greater during high water than in the low water and oscillated between 12 and 15 mg/l. It can be seen that, though the variation of the proportion of organic C was similar to that of total C in the two seasons of the hydrological cycle, the range of variation was much greater. In the Javaés River, the organic fraction was nearly 11 % to 25 % greater than that of the Araguaia River in the high and low water phases, respectively. It is also worth noting the different contribution of the organic C fraction to the total C pool in both phases of the cycle: during high water organic C represented ca. 60-62 % of the total C in both rivers, while in low water only 25-27 % of the total C was due to the organic fraction, with values around 8.5 mg/l (high water) and 3.5 mg/l (low water).

Discussion

The surveys carried out by VOLKMER-RIBEIRO & HATANAKA (1991), TAVARES (1994) and VOLKMER-RIBEIRO & TAVARES (1997) of sponges found in the rocky beds of several Amazonian Rivers, including the Orinoco River (VOLKMER-RIBEIRO & PAULS, 2000), showed that the assemblages consisted of, depending on the river sampled, various combinations, within a range of 3 families, 8 genus and 15 species. Of these, the sponge fauna of rocky river beds of Tocantins was the richest (TAVARES 1994.), and with which the assemblages in the present study were most similar, though differing due to the absence of *Drulia conifera, D. ctenosclera* e *Spongilla spoliata* in the Araguaia River.

Comparison between the results obtained from the survey in the Araguaia River and those from studies of the sponge fauna of the várzea lakes of the middle Juruá River performed by VOLKMER-RIBEIRO (1976) and VOLKMER-RIBEIRO & DE ROSA-BARBOSA (1972), shows that *A. recurvata, D. browni, M. reticulata, T. delicata, T. lanzamirandai, T. paulula, T. gregaria* and *S. carvalhoi* are common to both areas and while the Araguaia River also had *R. amazonensis* it lacked *T. minuta*. It is noteworthy that *D. browni* occurred in both the Juruá River and Araguaia River, though with small specimens or solely gemmules, indicating a marked ecological differentiation within the universe of várzea lakes within Amazonia and beyond. Large, open meshed examples of this species have been found in other South American várzea lakes (VOLKMER-RIBEIRO et al. 1983; VOLKMER-RIBEIRO & TAVARES 1995; VOLKMER-RIBEIRO & PEIXINHO 1989), which leads us to suppose that the preferred habitat of this species may be those floodplains subject to stronger, though temporar, currents of white or black river waters, not, therefore, the várzea lakes of the clear waters of the Araguaia River.

C. seckti and *O. navicela*, here considered rocky river bed species, were found in the sampled várzea lakes of the Araguaia River. However, the samples from the várzea lakes had only a few isolated gemmules, while in the rocky river bed they covered the substrate extensively, forming thick crusts with plentiful gemmules located from the base until the sponge surface in the case of *O. navicella,* or delicate crusts with an abundance of gemmules as with *C. seckti*. Of the species that occur on the rocky river bed *O. navicella* and *C. seckti* produce the least hard, skeletons, are rich in spongin, and have the fewest spicules, permitting the release of gemmules especially after the sponge is exposed to drought. This exuberance in the production of gemmules, linked to the ease of their release, leads us to consider that during the rainy season a great number of gemmules may be carried from the rocky river bed to the várzea lakes, permitting sporadic occupations of this environment, as witnessed.

On the other hand, *Acalle recurvata*, a species more typical of the várzea lakes is occasionally found in the rocky substrates of the river, but only in areas protected from strong currents, such as cracks or interstices of the rocks (VOLKMER-RIBEIRO & PAULS 2000).

The seasonal fluctuation of the water level in the rivers of the Amazon basin (or flood pulse) is an important ecological parameter that regulates and controls the existence, productivity and interactions of the biological characteristics of the river floodplain system (JUNK et al. 1989). In this context, the várzea lakes have a fundamental role, due to their high productivity allied to the variability of habitat and the multiplicity of food resources. The analysis of the aquatic environments studied revealed marked seasonal character of the hydrochemical conditions which is based upon the fluctuating nature of the rivers' flood pulse over the low lying areas within their drainage basins.

The division of the Amazonian waters into white, black and clear waters (SIOLI 1950) was based, fundamentally on their optical qualities. White waters have a lower light penetration rate and reflect more light, while the contrary is true for the black and clear water types (MUNTZ 1978). The lower level of light penetration of the white waters is essentially due to the large quantities of sediment that they carry. In Central Amazonia, the clear waters are represented by the forest streams, given that the large rivers (e.g. Xingu, Tapajós, Araguaia, Tocantins) are located in the southeast of the basin. The low visibility levels detected in the Araguaia River (0.45 to 0.75 m), considered a typical clear water river, suggests that its natural optical conditions are being masked by the large quantities of sediment that it is carrying, which is certainly related to the implantation of agro-forestry or other operations along the length of the drainage system. The low transparency levels noted in the marginal lakes, are within the range of those detected in várzea lakes, whose variation is from 0.3 to 2.0 m visibility, depending on the degree of decantation of the of lake water (MARLIER 1967; RIBEIRO 1978; SANTOS 1980; SCHMIDT 1976). However, they are below those of the Amazonian black and clear water basin lacustrine environments, where the visibility levels are typically in the order of 1.5-4.0 m (ALVES 1983; MARLIER 1967; RAI & HILL 1981; RIBEIRO 1978; SCHMIDT 1976, 1982).

The high temperatures registered in the rivers and lakes, independently of the sampling time, are characteristic of Amazonian environments. The absence of a well defined thermocline in the lakes as well as isothermal periods in both phases of the hydrological cycle appear to be conditioned: 1) by the continuous interaction between the river and the lake during high water; 2) by the gradual cooling of the water column at low water conditions, probably related to the vertical movement and homogenisation of the mass of water due to wind action. The lack of data covering a daily cycle of observations hampers the establishment of a standard thermal stratification for the lakes, that is, the occurrence of distinct periods of thermal heating and cooling. SANTOS (1983) recorded, in the lower Araguaia River, water temperatures in the same range as those recorded in this study of the mid-Araguaia River.

A general comparison between the rivers and lakes of the Araguaia/Javaés system shows that the proportion of oxygen in the waters of the Araguaia River was always greater than in the other environments: around 30 % greater than in the Javaés River in the high water and in the lakes in both phases. The results indicate the high degree of oxygenation of the waters in both the environments studied during the entire hydrological cycle. In this respect, there is certainly no environmental pressure on the aquatic community in the region of this study, contrary to the situation in many lakes where complete anoxia is common, or the reduced concentrations of O_2 registered in the large rivers of the Amazon basin, such as the Solimões/Amazon (DARWICH 1995).

Given the extreme values of the electrical conductivity detected (ca. 20-36 μS_{25}/cm), the waters included in the study can be classified as clear, draining areas of crystalline shield. As the degree of electrical conductivity of the water is an expression of the proportion of ions dissolved within it, the values vary directly with the concentration of these ions. Of these, the cations Na^+, K^+, Ca^{2+} and Mg^{2+}, as well as having a biological importance are the most relevant in the determination of this variable. Thus, it can be expected that these ions may have a variation similar to that of the electrical conductivity in the high and low water phases. It should be highlighted that between the sampled sites in the rivers (longitudinal sampling), the electrical conductivity showed discret elevation in direction of the river mouths. It is possible that this longitudinal variation may be related to the addition of salts dissolved into the rivers along their courses, and that the lower values recorded during high water may be related to the predominance of dilution by heavy rainfall.

The variation range of the pH values detected is indicative of the slightly acid to neutral character of the water from the rivers and lakes in this study, and is also reflected in the concentration of hydrogen ions (H^+). In the rivers, the pH variation range between the high and low water phases oscillates between a minimum of 0.74 units (Javaés River) and a maximum of 1.90 (Araguaia River); in the lakes, the variation range was from 0.60 and 0.18 units, respectively. Numerically, these oscillations represent an extremely high variation of the proportion of hydrogen ions. In the Araguaia River, this variation represented a reduction of the H^+ concentration of about 79.5 times from the high (pH 6.07 = 0.8511 µeq/l) to the low water phase (pH 7.97 = 0.0107 µeq/l). This variation may be of great ecological importance, given that these ionic modifications occur in the presence of the entire aquatic community. The opposite situation, which still represents a significant ionic variation, occurred in the Javaés River where the concentration of hydrogen ions in high water was about 5.5 times that recorded in low water ($[H^+]$ = 0.1549 µeq/l). In the lakes, the variation in the $[H^+]$ is almost 4 times in high water and only 1.5 times in low water conditions. The significance of this evaluation is that the lakes present the greatest variation in the concentration of hydrogen ions precisely at high water, when the hydrochemical differences between these two environments is tenuous. It can be seen that during a hydrological cycle the waters of the Araguaia River underwent profound modifications to its molar concentrations, which may be related to, for example, the incidence of, and/or influence the physiological processes of aquatic species in the region. In this analysis, when the influence of the rivers over the lakes is reduced (low water), the latter represent a more stable environment, with reference to the variability of the concentration of hydrogen ions. This may be a favourable point for the development and/or permanence of aquatic organisms in these environments.

The alkalinity of natural waters varies in wide ranges and is strongly related with the pH and dissolved chemicals (HCO_3^-, CO_3^{--}, OH^-). In Amazonian waters, the total alkalinity is basically due to the bicarbonate ion (SCHMIDT 1976; DARWICH 1995). In this study the variation in the proportions of HCO_3^-, with minimum values at high water and maximum at low water, corresponds to an accentuated increase in the alkalinity, reflecting less possibility of plugging during the high water phase, though equal to and/or greater during low water than those values recorded by SCHMIDT (1982) and DARWICH (1995) in the Amazon and Solimões Rivers. Or even greater than those recorded by SANTOS (1983) in the Tocantins River and lower Araguaia River.

The average carbon concentration in lakes in both phases of the hydrological cycle was always greater than that of rivers. The proportions had values similar to those found by SANTOS (1983) in the lower Araguaia River, though lower than those observed in the Solimões River by DARWICH (1995). FURCH (1984) mentions the existence of a difference between the carbon content of poor waters (e.g., Negro River) and those rich in electrolytes (e.g., Solimões River), though this difference is not significant. Higher concentrations of organic C were recorded in waters poor in electrolytes. Average values above 18 mg/l of total C were only recorded in lakes Volta Grande (high water) and Panela (low water). No marked variations in the total proportion of C were registered in these lakes in the two hydrological periods, with the exception of Lago Naru with 14.9 and 12 mg/l in the high and low water phases, respectively. The proportion of organic carbon in the lakes, contrary to the values recorded for other variables, was always less in low water than in high water and proportionally much less than that of the total C. For example, in Lago Naru the organic part was almost five times less than that of the total C during low water. However, in all lakes, the C content was always greater than in rivers for both phases of the hydrological cycle. It can be seen that there was greater variation in the measured proportions between the surface and lake bottom than in the longitudinal axis of the rivers. The average organic carbon was higher in Lago Volta Grande (11±1.1 mg/l) and lower in Lago Panela (4±0.2 mg/l), measured in high and low water phases, respectively. As in the rivers, the variation in the proportion of organic C between the two phases of the hydrological cycle was similar to that of the total C, but the range of this variation was much greater.

The area of the study (mid Araguaia, lower Javaés and the lakes in the basins of these rivers) is within the geochemical province located marginally south of the ecological classification of FITTKAU for Amazonia. It is a region characterized by soils and water relatively poor in nutrients (FITTKAU 1970). The waters studied always exhibited the good oxygen and temperature conditions, characteristic of the large Amazonian rivers. In general, the measured carbon, as well as the proportions of bicarbonates and hydrogen ions, showed concentrations similar to those of the white water rivers, sometimes with lower values and sometimes with higher. On the other hand, the measured electrical conductivity was always lower than that recorded in the Amazonian white water rivers, though higher compared to than that of the black water rivers. It can also be seen that water transparency was always greater than that of the white water rivers, though with lower values compared to clear and black water rivers. Thus, considering all the analysed variables, we can suggest that the waters studied can be defined as clear waters according to SIOLI (1950, 1984).

The results obtained in the survey of sponges in the Araguaia River demonstrated some important facts: the significant incidence of a seasonal fauna, in the exposed rocky river bottom and in the várzea lakes, a marked distinction between the assemblages in the two environments, which extends throughout Central Amazonia. Of particular interest is the occupation by the sponges of hard substrates, such as the tree trunks, branches, twigs and leaves of the flooded forest, and the periodically submerged rocky outcrops of the river beds.

Since all sponges sampled, in both the river benthos and the várzea lakes were dry, full of gemmules and exposed to the air, it is logical to associate the limnological requirements of gemmular eclosion and growth of these seasonal sponge assemblages to the quality of the river and várzea lakes water in the high water (Fig. 9). Lower temperatures, generally acid pH and above all higher levels of water transparency, reflecting less material in suspension and therefore facilitacion of filtration are generaly recognised as ideal for freshwater sponges (HARRISON 1974). On the other hand, higher levels of total carbon and organic carbon indicate organic production and decomposition suggesting the presence of a greater natural bacterial population in the waters. It is known that the volume of bacteria represent the most important filtered element in the sponge diet (SIMPSON 1984).

The assemblages surveyed, given their wide dispersal in Central Amazonia, can now be considered indicators of rocky-river bottom and floodplain lake environments, particularly of clear water rivers, for the purposes of paleoecological studies in the region.

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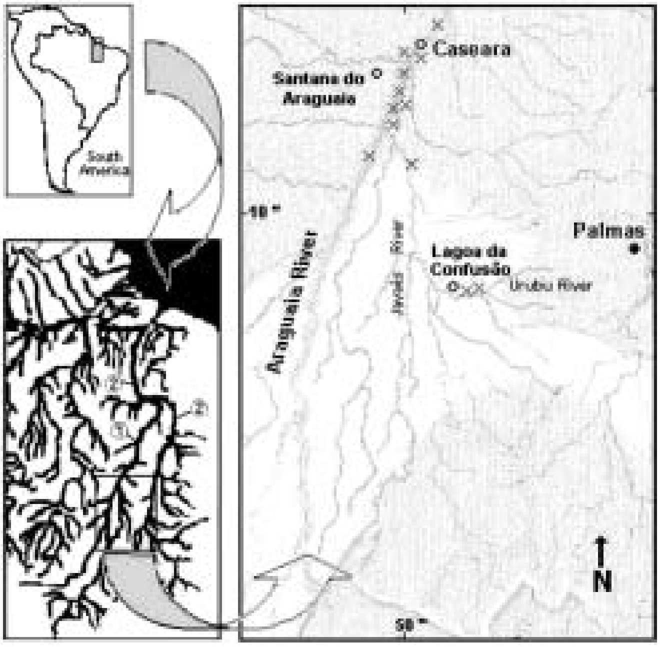


Fig. 1:
Map indicating the area of the spongological and limnological surveys (x) at Araguaia River basin. **1**: Araguaia River; **2**: Tocantins River.

Fig. 2:
Exposed rocky bottom stretch of Araguaia River where the survey for sponges took place. All the rocks are seen to exhibit a withish covering by sponge crusts (photo T.C.A. BATISTA).

Fig. 3:
Forest seasonally flooded around Lagoa da Mata photographed at low water. At this site sponge crusts were collected from the aerial roots to the trunks and leaves (photo T.C.A. BATISTA).

Fig. 4:
Remnant water at a várzea lake at the end of the low water season (Lagoa dos Jacarés, Urubu River). Several sponge specimens were collected from the surrounding forest flooded at high water periods (photo T.C.A. BATISTA).

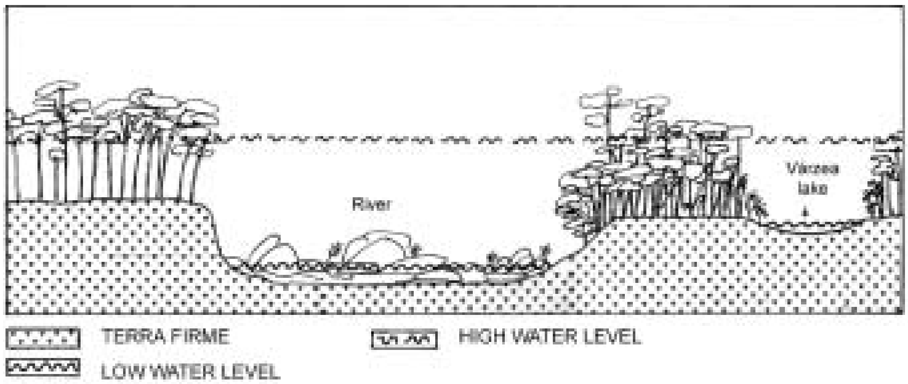


Fig. 5:
Schematic drawing of a várzea lake depicting its position and water level by the main river in low and high waters.

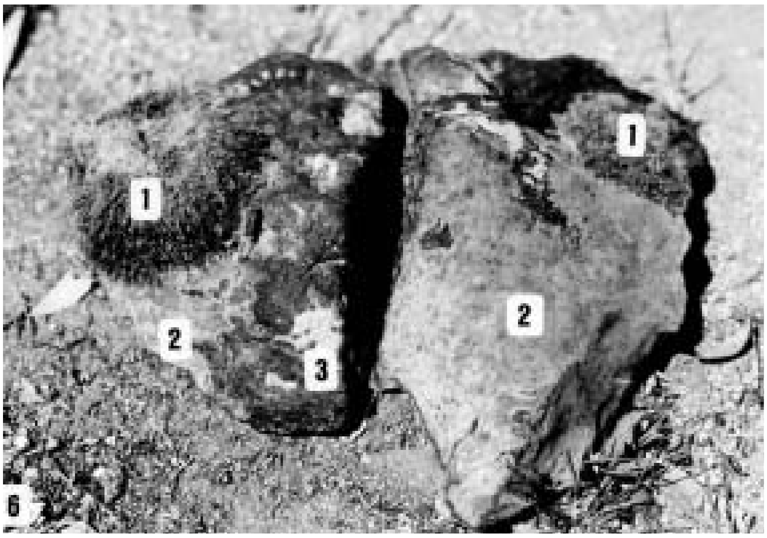
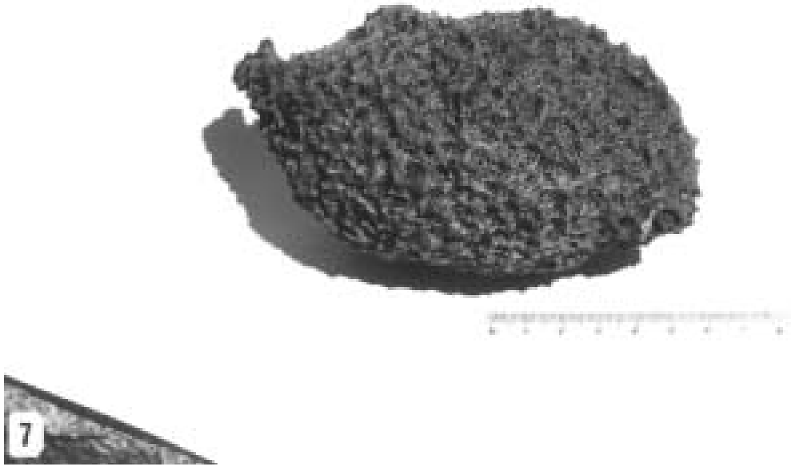


Fig. 6:
Specimens of *Drulia uruguayensis* (**1**), *Trochospongilla repens* (**2**) and *Oncosclera navicella* (3), collected from the exposed rocky bottom of Araguaia River seen in figure 2 (photo M.C.M. TAVARES).



Figs. 7, 8:
Dry specimens of *Metania reticulata*, encrusting twigs taken form the surveyed Várzea lakes. Tuberous (**7**) or branched (**8**) sponge shapes resulting from adaptation to the arboreal substrates are seen (photo M.C.M. TAVARES).

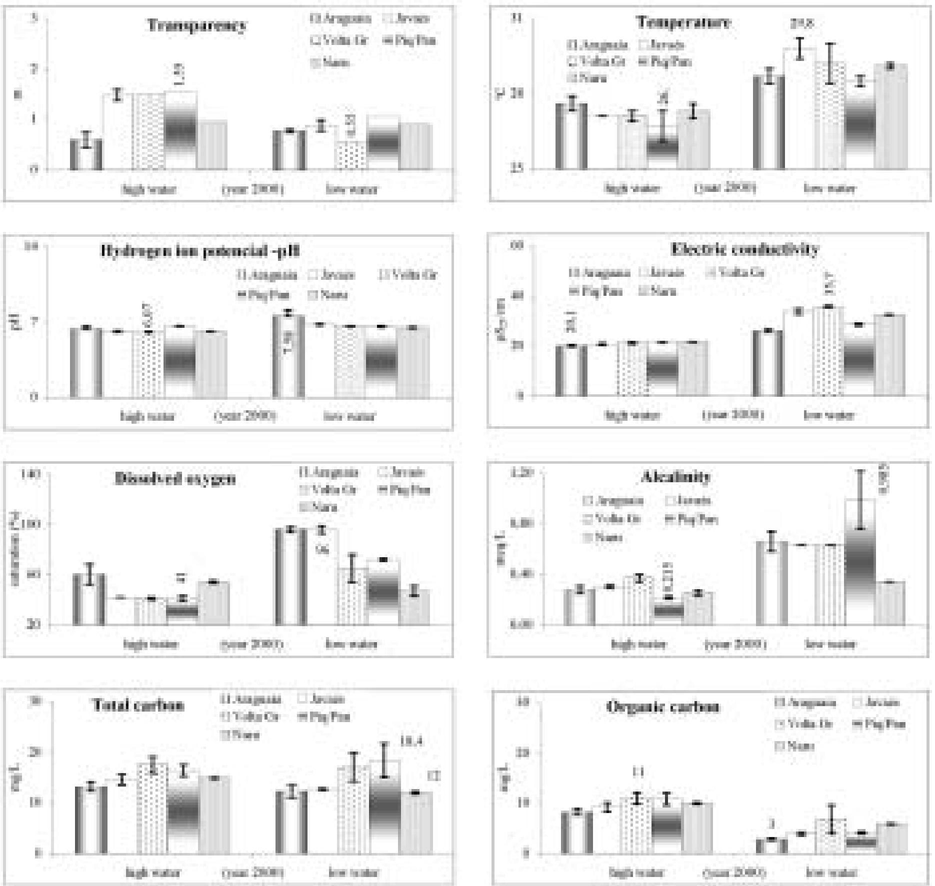


Fig. 9:
Limnological parameters: average values for the Araguaia and Javaés Rivers (sub-superficial values) and floodplain lakes Naru, Piquizeiro/Panela and Volta Grande (sub-superficial and bottom values). Hydrological cycle of 2000.

Table 1: Incidence of species found on the rocky bed of the Araguaia River, calculated over the total number of randomly sampled specimens.

Species	Number of specimens	%
Family Spongillidae		
Corvospongilla seckti	30	36,1 %
Trochospongilla repens	15	18,1 %
Family Potamolepidae		
Oncosclera navicella	15	18,1 %
Oncosclera spinifera	08	9,6 %
Family Metaniidae		
Drulia uruguayensis	13	15,7 %
Drulia cristata	02	2,4 %
Total	**83**	**100 %**

Table 2: Incidence of sponge species found in the várzea lakes of both Araguaia and Urubu Rivers, calculated over the total number of randomly sampled specimens.

Sites Species	Araguaia River (52 specimens) Lagoa da Mata	 Lagoa da Queimada	 % subtotal	Urubu River (44 specimens) Lagoa dos Jacarés	 Lagoa 2	 % subtotal	total (96 spec.)	%
Family Spongillidae								
Corvospongilla seckti	02		3,8 %				02	2,1 %
Radiospongilla amazonensis	01		1,9 %		01	2,3 %	02	2,1 %
Saturnospongilla carvalhoi	01	02	5,8 %	01		2,3 %	04	4,2 %
Trochospongilla gregaria	03	01	7,7 %	05	07	27,3 %	16	16,7 %
T. paulula	03	01	7,7 %	06	04	22,7 %	14	14,6 %
T. lanzamirandai	01		1,9 %		01	2,3 %	02	2,1 %
T. delicata		01	1,9 %				01	1,0 %
Family Potamolepidae								
Oncosclera navicella	02	01	5,8 %	02		4,5 %	05	5,2 %
Family Metaniidae								
Acalle recurvata	03		5,8 %	03	01	9,1 %	07	7,3 %
Drulia browni	04	02	11,5 %				06	6,2 %
Metania reticulata	13	11	46,2 %	06	07	29,5 %	37	38,5 %
Total	33	19	100 %	23	21	100 %	96	100 %