

New records of testate lobose amoebae (Protozoa, Arcellinida) for the Upper Paraná River floodplain.

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ABSTRACT: New records of testate lobose amoebae (Protozoa, Arcellinida) for the Upper Paraná River floodplain. Until the present study, 91 infrageneric testate amoebae taxa were recorded in the plankton of the Upper Paraná River floodplain. This study aimed to describe and illustrate new testate amoebae taxa for this floodplain, as well as to contribute to the knowledge of the biodiversity and distribution of these organisms in Brazilian freshwater ecosystems. Sampling was performed each trimester during 2000 and 2002, and semesterly during 2003 and 2004, in lotic and lentic environments of this floodplain. Subsurface samples were taken from the pelagic region; 600 L of water were filtered for each sample using a motorized pump and 68 μm mesh plankton net. In the present study, 24 taxa of six families were described and illustrated. The Diffugiidae family exhibited the highest species richness (14 taxa), followed by Arcellidae and Centropyxidae (3 taxa each family). Eleven taxa were found only in lentic environments, six in lotic environments, and seven in both environments. Among taxa, *Arcella vulgaris* f. *elegans*, *Diffugia amphoralis* var. *globosa*, *D. helvetica* var. *multilobata*, *D. lobostoma* var. *tuberosa*, *D. muriformis* f. *crucilobata*, *D. parva*, and *D. ventricosa* f. *recticaulis* represent the first records in Brazil.

Key-words: testate amoebae, zooplankton, floodplain, Paraná River.

RESUMO: Novos registros de amebas testáceas (Protozoa, Arcellinida) para a planície de inundação do alto rio Paraná. Até o momento foram registrados 91 táxons infra-genéricos de amebas testáceas no plâncton da planície de inundação do alto rio Paraná. Dessa forma, este trabalho teve como objetivo, descrever e ilustrar novos táxons de tecamebas para essa planície, bem como contribuir para o conhecimento sobre a biodiversidade e a distribuição desses organismos em ambientes aquáticos continentais brasileiros. As coletas foram realizadas trimestralmente, no período 2000 a 2002 e, semestralmente, em 2003 e 2004, em ambientes lóticos e lênticos dessa planície. As amostragens foram feitas à sub-superfície da região pelágica, sendo filtrados 600 litros de água por amostra, com auxílio de moto-bomba e rede de plâncton com 68 μm de abertura de malha. Neste trabalho, foram descritos e ilustrados 24 táxons, distribuídos em seis famílias. Diffugiidae foi a mais especiosa (14 táxons), seguida por Arcellidae e Centropyxidae (3 táxons cada). Onze táxons foram encontrados apenas em ambientes lênticos, seis foram registrados somente em ambientes lóticos e sete nos dois tipos de ambientes. Dentre os táxons, *Arcella vulgaris* f. *elegans*, *Diffugia amphoralis* var. *globosa*, *D. helvetica* var. *multilobata*, *D. lobostoma* var. *tuberosa*, *D. muriformis* f. *crucilobata*, *D. parva* e *D. ventricosa* f. *recticaulis* representam o primeiro registro para o Brasil.

Palavras chave: tecamebas, zooplâncton, planície de inundação, rio Paraná.

Introduction

The term 'testate lobose amoebae' is given to those amoebae (Protozoa, Arcellinida) whose cytoplasm is enclosed within a discrete test or shell. These organisms are present in a wide range of moist and freshwater habitats (Ogden & Hedley, 1980). According to Hardoim (1997), testate amoebae are important contributors to energy flow and nutrient cycling through direct consumption of microorganisms and detritus.

Some authors suggest that the presence of testate amoebae in plankton must be ascribed to hydrodynamic processes, as organisms drift from the bottom and marginal vegetation (Green, 1975; Lena & Zaidenweg, 1975). Nevertheless, recent studies found high densities of these organisms in the plankton compartment, suggesting that they must occur in this environment in some phase of their life cycles. In addition, these studies revealed predictable patterns of testate amoebae that

are typically associated with the structure and composition of other planktonic groups (Velho et al., 2003).

In Brazil, primary studies of testate amoebae in plankton samples were carried out by Daday (1905), Prowazek (1910), and Cunha (1913, 1916), focusing mainly on taxonomy and species distribution. Roughly 60 years later, these organisms were examined in plankton samples of varzea lagoons from the Suia Missu River watershed, State of Mato Grosso, with concentrations on taxonomic and ecological aspects (Green, 1975). Since 1990, these organisms have been included more frequently in studies of the planktonic community, including species richness, composition, and abundance (Dabés, 1995; Velho & Lansac-Tôha, 1996; Velho et al., 1996, 2003, 2004; Lansac-Tôha et al., 2000, 2004a, 2004b; Panarelli et al., 2003; Cardo-

so & Motta Marques, 2004; Fulone et al., 2005).

These later studies recorded 91 infrageneric taxa of these protozoans in plankton from the Upper Paraná River floodplain (Lansac-Tôha et al., 2004a, 2004b). This study aimed to describe and illustrate new testate amoebae taxa from this floodplain, as well as to contribute to the knowledge about the occurrence and distribution of these organisms.

Material and methods

Sampling was performed every three months during 2000 and 2002, and semesterly during 2003 and 2004, in lotic and lentic environments of the Upper Paraná River floodplain (22°40' - 22°50' S and 53°10' - 53°40'W) (Fig. 1).

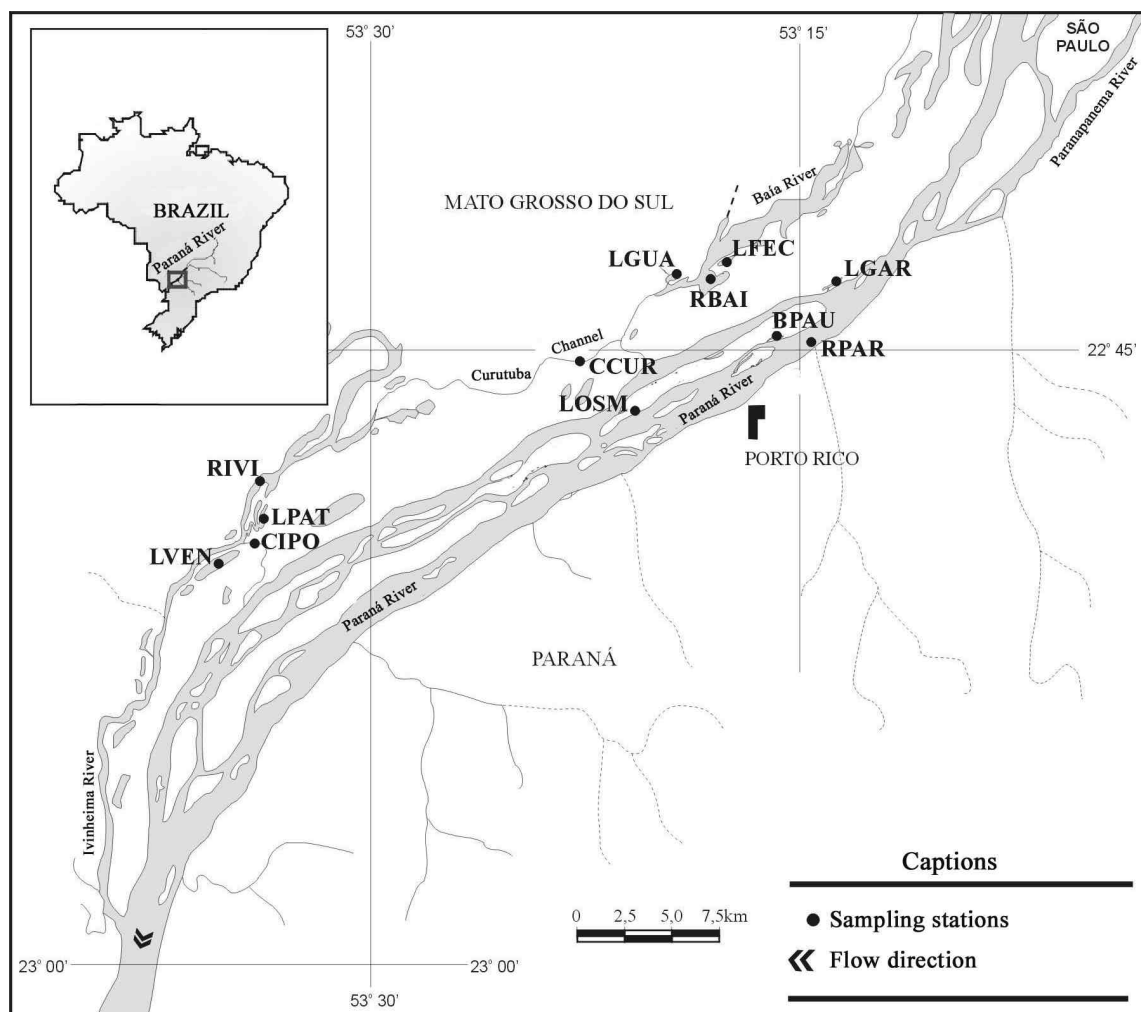


Figure 1: Study area and sampling sites in the Upper Paraná River floodplain. RPAR: Paraná River; RBAI: Baía River; RIVI: Ivinheima River; CIPO: Ipoitã Channel; CCUR: Curutuba Channel; BPAU: Pau Veio Backwater; LGAR: Garças Lagoon; LPAT: Patos lagoon; LFEC: Fechada Lagoon; LGUA: Guaraná Lagoon; LVEN: Ventura Lagoon; and LOSM: Osmar Lagoon.

This study was based on samples taken at 12 sampling stations, distributed among three rivers (Paraná, Baía, and Ivinheima), two channels (Ipoitã and Curutuba), three lagoons connected permanently to main rivers (open lagoons),

three lagoons without connections to a main river but associated with it by groundwater (isolated lagoons), and a backwater (lentic environment formed by sediment settlement at one river bank) (Table 1).

Table 1: List of the sampling environments in the High Paraná River floodplain: classification category (r= river, c= channel, b= backwater, ol= open lagoon, and il= isolated lagoon), environment type (lo=lentic and le=lentic), area, and mean depth.

| Environment | Category | Type | System | Area (ha) | Mean depth (m) |
|-------------------------|----------|------|-----------|-----------|----------------|
| Rivers | | | | | |
| Paraná | r | lo | Paraná | - | 4.0 |
| Ivinheima | r | lo | Ivinheima | - | 3.9 |
| Baía | r | lo | Baía | - | 3.2 |
| Channels | | | | | |
| Ipoitã | c | lo | Ivinheima | - | 3.2 |
| Curutuba | c | lo | Baía | - | 2.7 |
| Backwater | | | | | |
| Pau Véio | b | le | Paraná | 3.0 | 1.8 |
| Open lagoons | | | | | |
| Garças | ol | le | Paraná | 14.10 | 2.0 |
| Dos Patos | ol | le | Ivinheima | 113.80 | 3.5 |
| Guaraná | ol | le | Baía | 4.20 | 2.1 |
| Isolated lagoons | | | | | |
| Osmar | il | le | Paraná | 0.006 | 1.1 |
| Ventura | il | le | Ivinheima | 89.80 | 2.16 |
| Fechada | il | le | Baía | 7.50 | 2.46 |

Samples were obtained at the pelagic region subsurface using a motorized pump and plankton net (68 mm mesh size) to filter 600 liters for each sample. Afterwards, samples were fixed with formaldehyde (4%) buffered with calcium carbonate. Analyses were made in Sedgwick-Rafter chambers with an optical microscope. Exemplars were removed from samples and set up in slides with glycerin for posterior identification. The taxonomic classification used was based on that proposed by Loeblich & Tappan (1964).

Figures from different species presented were elaborated from images acquired with a digital camera (CoolSnap Pro) and image capture system (ImagePro express) coupled to an optical microscope (Olympus BX51).

The studied material is stored in a collection of the Zooplankton Laboratory of Núcleo de Pesquisas em Limnologia, Ictiologia and Aquicultura (Nupélia) of Uni-

versidade Estadual de Maringá, State of Paraná.

Results and discussion

ARCELLIDAE Ehrenberg, 1830

Arcella arenaria Greeff, 1866
(Pl. I, Fig. 1)

Pénard, 1902:406; Deflandre, 1928:247-249, figs. 293-297; Chardez, 1967: pl. I, fig. 18; Ogden & Hedley, 1980: 24, .pl., figs. A-E.; Ogden, 1984: 242.

Synonyms: *Arcella aureola* Maggi, 1888.
Arcella microstoma Pénard, 1890.

Description: From the apical view, the shell is circular and presents two concentric circles; the outermost circle corresponds to the bucal tube brim and the inner represents the aperture.

Laterally, the dorsal shell face is divided. The pseudostome is small, circular, and

frequently surrounded by pores. Shell color is brown.

| Authors | Measurements (µm) | | | |
|--------------------------|-------------------|--------------|----------------------|-------------|
| | Shell diameter | Shell height | Pseudostome diameter | Bucal depth |
| Deflandre (1928) | 70-91 | 25-38 | 14-18 | 8-11 |
| Ogden & Hedley (1980) | 79-130 | 21-50 | 22-28 | - |
| Ogden (1984) | 99 | 30 | 16 | - |
| Present study (6 shells) | 90-105 | 12-35 | 18-26 | 6-8* |

* Bucal depth measure was possible only for two specimens, as analyzed organisms presented a very dark color, making measurement difficult.

Comments: This is a rare species and occurred at low densities. It was recorded in both lotic (Baía and Ivinheima Rivers) and lentic (Ventura lagoon) environments. It was recorded in Brazil only in moss samples in the States of Rio de Janeiro (Wailles, 1913) and Paraná (Hoogenraad & Groot, 1951), and in plankton samples of the Cuiabá River, State of Mato Grosso (Silva-Neto, 2001).

pH: 6.2-7.2; Dissolved Oxygen (%): 79.4-97.3; Conductivity (ms.cm⁻¹): 27.7- 59.5; Temperature (°C): 18.4-27.2.

Arcella gibbosa var. *mitriformis*
Deflandre, 1928
(Pl. I, Fig. 2)
Deflandre, 1928: 230, figs. 208-218;

Chardez, 1967: pl. 1, fig. 15; Grospietsch, 1972: 8; Vucetich, 1973a: 291, pl. I, fig.5.

Synonyms: *Arcella vulgaris* Leidy, 1879
? *Arcella mitrata* var. *angulata* Playfair, 1918.

Description: In lateral view, dorsal shell face is nearly hemispheric with marked undulations. It differs from the typical form by the absence of an expansion in its oral part. Maximum diameter is located in the middle of shell height. The oral face exhibits a circular pseudostome with a well-developed bucal tube. The color of the shell is dark brown.

| Authors | Measurements (µm) | | | |
|--------------------------|-------------------|--------------|----------------------|-------------|
| | Shell diameter | Shell height | Pseudostome diameter | Bucal depth |
| Deflandre (1928) | 60-88 | 52-72 | 17-28 | 10-18 |
| Vucetich (1973a) | 80-95 | 65-90 | 18-26 | 12-18 |
| Present study (4 shells) | 74-82 | 54-58 | 23-26 | 10-15 |

Comments: This species was found at low abundance in the Ivinheima River and in Osmar lagoon. It was recorded in Brazil only in the State of Mato Grosso in plankton samples of the Cuiabá River (Silva-Neto, 2001).

pH: 5.4-6.7; Dissolved Oxygen (%): 40.5-79.8; Conductivity (ms.cm⁻¹): 34.5-64.2; Temperature (°C): 26.9-31.8.

Arcella vulgaris f. *elegans* Deflandre, 1928

(Pl. I, Fig. 3)

Deflandre, 1928: 222, figs. 171-172; Chardez, 1967, pl. I, fig. 11; Grospietsch, 1972: 9-10; Vucetich, 1978: 85.

Description: Laterally, the dorsal face of the shell is high and regular. It differs from the typical form by presenting, in the lateral view, an expansion in the oral part which develops a brim. The aperture is circular with a well-developed bucal tube.

| Authors | Measurements (µm) | | | |
|--------------------------|-------------------|--------------|----------------------|-------------|
| | Shell diameter | Shell height | Pseudostome diameter | Bucal depth |
| Deflandre (1928) | 126-145 | 62-73 | 30-40 | 17-24 |
| Vucetich (1978) | 157-166 | 84-86 | 36,7-41 | - |
| Present study (4 shells) | 174-195 | 74-105 | 38-50 | 25-33 |

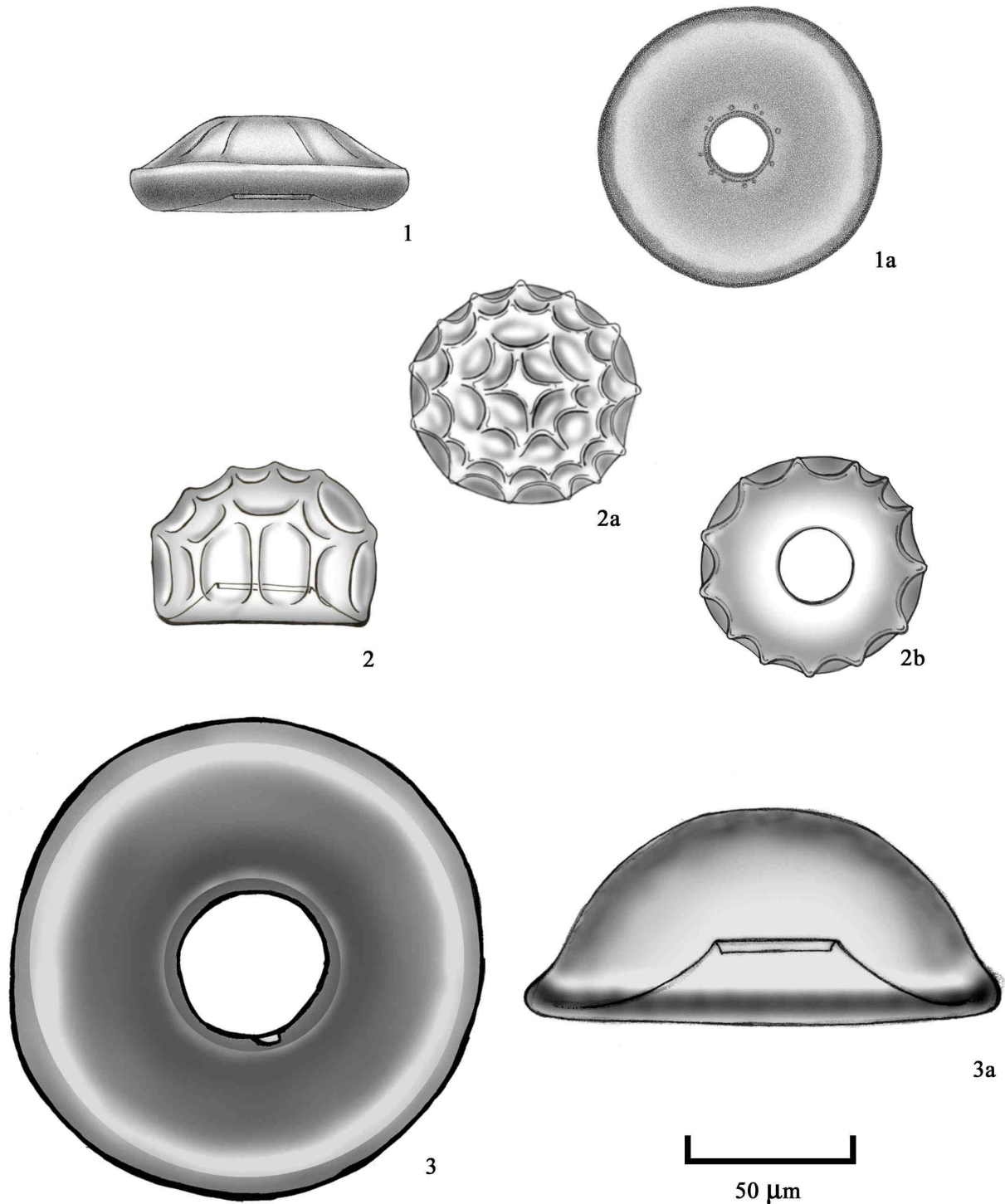


Plate I: Fig. 1. *Arcella arenaria*, lateral view; Fig. 1a. apical view; Fig. 2. *A. gibbosa* var. *mitriformis*, lateral view; Fig. 2a. dorsal view; Fig. 2b. apical view; Fig. 3. *A. vulgaris* f. *elegans*, apical view; 3a. lateral view.

Comments: This taxon was recorded only in lentic environments (Guaraná and Patos lagoons and Pau Véio backwater). It is the first record of the taxon in Brazil.

pH: 6.1-6.5; Dissolved Oxygen (%): 55.7-78.8; Conductivity (ms.cm^{-1}): 26.7-69.7; Temperature ($^{\circ}\text{C}$): 19.1-29.8.

CENTROPYXIDAE Deflandre, 1953

Centropyxis aerophila var. *sphagnicola* Deflandre, 1929

(Pl. II, Fig. 4)

Deflandre, 1929: 333-334, figs. 25-30;

Chardez, 1967: pl. II, fig. 47; Grospietsch, 1972: 11; Vucetich, 1973a: 319, pl. VII, fig. 60; Schönborn, 1975: fig. 3j; Mitchel, 2003: 1-2.

Description: It differs from *C. aerophila* because, from a frontal view, it has a circular shape and in the lateral view, the shell is lower than the typical form. Laterally, the shell narrows slightly towards the anterior region. The pseudostome is invaginated, oval, and sub-terminal. The shell revetment is made of a few quartz particles.

Measurements (μm)

| Authors | Shell length | Shell breadth | Shell height | Pseudostome length |
|--------------------------|--------------|---------------|--------------|--------------------|
| Deflandre (1929) | 49-66 | 25-37 | - | - |
| Vucetich (1973a) | 50-52 | - | - | 28-35 |
| Present study (5 shells) | 90-95 | 87-90 | 51-56 | 36-38 |

Comments: All examined individuals had dimensions greater than those observed in the literature. It is a rare species with low densities. The taxon was only registered in lentic environments (Fechada and Osmar lagoons). It was recorded in Brazil only in plankton samples of the Cuiabá River in the State of Mato Grosso (Silva-Neto, 2001), and macrophyte samples of the Jequitinhonha River basin, Minas Gerais State (Souza, 2005).

pH: 6.1-6.3; Dissolved Oxygen (%): 45.7-86.5; Conductivity (ms.cm^{-1}): 20.4-64.2; Temperature ($^{\circ}\text{C}$): 19.1-31.8.

Centropyxis gibba Deflandre, 1929 (Pl. II, Fig. 5)

Deflandre, 1929: 357-358, figs. 118-120; Schönborn, 1975, fig. 3c, m.

Description: In frontal view, the shell is elliptical and irregular. Pseudostome is eccentric and elliptical. Laterally, the dorsal face is very high, suddenly narrowing towards the aperture. The posterior part of the shell is ornamented with a variable number of spines which are distributed at different heights. The revestment of the shell has sand particles of variable sizes.

Measurements (μm)

| Authors | Shell length | Shell breadth | Shell height | Pseudostome length | Spines length |
|--------------------------|--------------|---------------|--------------|--------------------|---------------|
| Deflandre (1929) | 96-114 | 85-95 | 87-95 | - | - |
| Present study (2 shells) | 102-120 | 88 | 67-70 | 33-55 | 30-33 |

Comments: *C. gibba* is a rare species with low densities, occurring only in the Ivinheima River. Some individuals observed by Deflandre (1929) exhibited diatom frustules in the shell. In Brazil, it was recorded by Silva-Neto (2001) in plankton samples of the Cuiabá River in the State of Mato Grosso, and by Souza (2005) in macrophyte samples of the Jequitinhonha River basin, Minas Gerais State.

pH: 6.8-7.4; Dissolved Oxygen (%): 79.4-94.1; Conductivity (ms.cm^{-1}): 35.5-41.7; Temperature ($^{\circ}\text{C}$): 19.7-20.0.

Centropyxis spinosa (Cash, 1905) (Pl. II, Fig. 6)

Deflandre, 1929: 353-354, figs. 108-111; Chardez, 1967. pl. II, fig. 9; Grospietsch, 1972: 12, fig. 13; Lena & Zaidenweg, 1975, pl. I, fig. 1; Ogden & Hedley, 1980: 62, pl. XX, figs. A-D; Lena, 1983, pl. 2, figs. 13-16; Fenchel, 1987, fig. 9. 4a; Haridoim, 1997: 222, fig. 72.; Alekperov & Snegovaya, 2000: 140, fig. 10; Mitchel, 2003: 1-2.

Synonym: *Centropyxis aculeata* var. *spinosa* Cash, 1905

Description: In frontal view, the shell is ovoid or circular, and composed of exogenous particles, although part of the

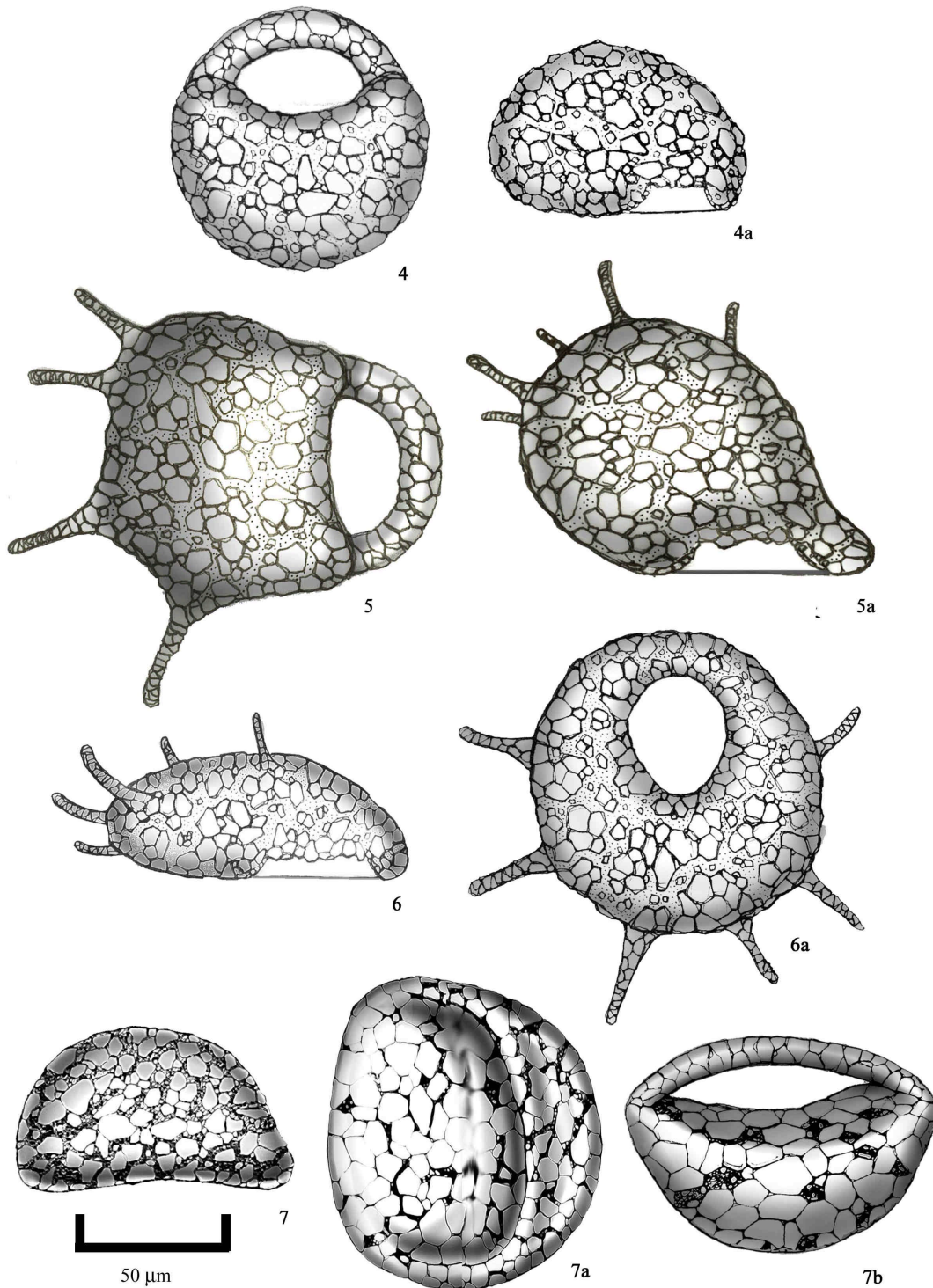


Plate II: Fig. 4. *Centropyxis aerophila* var. *sphagnicola*, ventral view; Fig. 4a. lateral view; Fig. 5. *C. gibba*, ventral view; Fig. 5a. lateral view; Fig. 6. *C. spinosa*, lateral view; 6a. ventral view; Fig. 7. *Plagiopyxis callida*, lateral view; Fig. 7a. ventral view; Fig. 7b. pseudostome.

shell can be constituted only by organic material. Laterally, *C. spinosa* is low, narrowing towards the anterior region. The posterior part of the shell is ornamented

with spines of variable length and number, and distributed at different heights. The pseudostome is approximately circular and eccentric.

| Authors | Measurements (mm) | | | | |
|---------------------------|-------------------|---------------|--------------|--------------------|---------------|
| | Shell length | Shell breadth | Shell height | Pseudostome length | Spines length |
| Deflandre (1929) | 120-140 | 30-40 | - | - | - |
| Ogden & Hedley (1980) | 105-141 | 84-137 | - | 27-51 | - |
| Present study (10 shells) | 73-133 | 70-128 | 26-51 | 30-56 | 20-46 |

Comments: This taxon is frequent but with low densities. It occurred in lotic (Paraná, Ivinheima, and Baía Rivers) and lentic environments (Guaraná and Garças lagoons and Pau Véio backwater). It was registered in Brazil, in the states of Rio Grande do Sul (Torres, 1996), Mato Grosso (Hardoim & Heckman, 1996; Hardoim, 1997; Silva-Neto, 2001), Minas Gerais (Souza, 2005), and Pará (Robertson et al., in prep.).

pH: 6.0-7.0; Dissolved Oxygen (%): 27.8-94.0; Conductivity (ms.cm⁻¹): 28.2-55.7; Temperature (°C): 17.1-26.1.

PLAGIOPYXIDAE Bonnet, 1959

Plagiopyxis callida Pénard, 1910 (Pl. II, Fig.7)

Pénard, 1910: 252, fig. 1; Grospietsch, 1958: 321; Vucetich, 1973a: 323, pl. IX, fig. 68.

Description: Ventrally, the profile of the shell is nearly circular with a diameter greater than length. In lateral view, the dorsal face is round. The ventral shell wall suddenly invaginates, narrowing towards the aperture and almost touching the dorsal wall. The aperture is narrow and elongate.

| Authors | Measurements (µm) | | |
|-------------------------|-------------------|---------------|--------------------|
| | Shell length | Shell breadth | Pseudostome length |
| Grospietsch (1958) | 69-72 | 59-64 | - |
| Vucetich (1973a) | 65-85 | 70-85 | - |
| Present study (1 shell) | 95 | 105 | 52 |

Comments: Shell dimensions found in the present study were greater than those observed in the literature. It was a rare species registered only in one lotic environment (Ipoitã channel). In Brazil, this species was recorded in the Cuiabá River, Mato Grosso State (Silva-Neto, 2001) and in the Jequitinhonha River basin, Minas Gerais State (Souza, 2005).

pH: 7.2; Dissolved Oxygen (%): 56.9; Conductivity (ms.cm⁻¹): 56.9; Temperature (°C): 29.8.

DIFFLUGIIDAE Awerintzew, 1906

Diffflugia acutissima Deflandre, 1931 (Pl. III, Fig. 8)

Deflandre, 193: 84, pl. XII, figs. 1-3; Gauthier-Lièvre & Thomas, 1958: 317, fig. 40a-d; Chardez, 1967, pl. IV, fig. 15; Dioni, 1970: 211-212, pl. III, fig. 27; Ogden & Zivkovic, 1983: 342-344, fig. 1; Todorov & Golemansky, 1998: 84 e 86; Dabés & Velho, 2001: 303; Golemansky et al., 2005, fig. 6.

Description: Laterally, the shell is approximately fusiform, ending in a short horn. The shell widens progressively from the posterior region to the aperture. The pseudostome is circular with a collar few evidenced. Shell revetment is composed of sand particles of variable size with smaller particles in the aperture region and terminal horn. The shell has hyaline coloration.

| Authors | Measurements (µm) | | |
|---------------------------------|-------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 190-233 | 100-110 | 40-45 |
| Dioni (1970) | 200-220 | 85-100 | 40-45 |
| Present study (1 shell) | 220 | 133 | 61 |

Comments: *D. acutissima* was a rare species registered only in one lentic environment (Osmar lagoon). It was recorded before in Brazil in plankton and macrophytes samples of the São Francisco River basin, Minas Gerais State (Dabés, 1995, 1999; Dabés & Velho, 2001) and in plankton samples of one lake of Rio Grande do Sul State (Cardoso & Motta Marques, 2004).

pH: 6.0; Dissolved Oxygen (%): 27.8; Conductivity (ms.cm⁻¹): 46.8; Temperature (°C): 17.1.

Diffflugia amphoralis var. *globosa*

Gauthier-Lièvre & Thomas, 1958

(Pl. III, Fig. 9)

Gauthier-Lièvre & Thomas, 1958: 300-301, fig. 29a,b,c.; Chardez, 1967, pl. V, fig. 5; Ogden, 1984: 244.

Description: Laterally, the shell is ovoid and slightly elongate. It exhibits a dilated collar that expands towards the exterior. It differs from *D. amphoralis* by presenting a regular round base. The pseudostome is circular and the shell is covered by sand particles of variable size; collar has smaller particles.

| Authors | Measurements (µm) | | |
|---------------------------------|-------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 180-228 | 105-120 | 50-75 |
| Present study (1 shell) | 187 | 134 | 59 |

Comments: *D. amphoralis* var. *globosa* is a rare taxon, recorded in only one lentic environment (Pau Véio backwater). It is the first recorded in Brazil.

pH: 6.5; Dissolved Oxygen (%): 75.2; Conductivity (ms.cm⁻¹): 60.8; Temperature (°C): 29.8.

Diffflugia angulostoma Gauthier-Lièvre & Thomas, 1958

(Pl. III, Fig. 10)

Gauthier-Lièvre & Thomas, 1958: 253-254, fig. 1; Vucetich, 1973a: 303, pl. III, fig. 27.

Description: The globular shell is covered with variable material, such as sand and quartz particles embedded in transparent cement. It has smaller particles surrounding an aperture which, in lateral view, exhibits a sinuous contour. The pseudostome is large and approximately pentagonal.

| Authors | Measurements (µm) | | |
|---------------------------------|-------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 60-95 | 60-95 | 30-45 |
| Vucetich (1973a) | - | 50-60 | 17,5-20 |
| Present study (2 shells) | 65-70 | 60-65 | 30 |

Comments: *D. angulostoma* exemplars exhibited approximately pentagonal apertures in accordance with Gauthier-Lièvre & Thomas (1958). Vucetich (1973a) observed individuals with hexagonal apertures. It is a rare species recorded only in the Baía River. In Brazil, it was registered in macrophyte samples in Rio Grande do Sul (Torres, 1996) and Minas Gerais States (Dabés & Velho, 2001), and in plankton samples of Mato Grosso State (Silva-Neto, 2001).

pH: 6.3; Dissolved Oxygen (%): 82.5; Conductivity (ms.cm⁻¹): 21.9; Temperature (°C): 20.7.

Diffflugia bicruris Gauthier-Lièvre & Thomas, 1958

(Pl. III, Fig. 11)

Gauthier-Lièvre & Thomas, 1958: 328, fig. 45d-p; Todorov & Golemansky, 1998: 86; Golemansky et al., 2005, fig. 8.

Description: In lateral view, the shell has an oval contour and is elongate. In frontal view, the shell exhibits nearly parallel flanks. Each side terminates in a straight and tubular horn. The horns are separated by an arch. In apical view, the aperture is circular. The shell revetment comprises small, orderly stones.

| Authors | Measurements (μm) | | | |
|---------------------------------|---------------------------------|-----------------|-------------------|-------------------------|
| | Shell height (without spine) | Spine length | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 158-160 | 30-33 | 77-86 | 33-35 |
| Present study (1 shell) | 152 | 20 | 90 | 50 |

Comments: *D. bicruris* is a rare species registered only in the Baía River and in a lagoon associated with this river (Guaraná lagoon). A unique record of this species in Brazil was made by Silva-Neto (2001) in plankton samples of the Cuiabá River, Mato Grosso State.

pH: 5.8-6.3; Dissolved Oxygen (%): 70.3-82.5; Conductivity (ms.cm^{-1}): 21.1-21.9; Temperature ($^{\circ}\text{C}$): 19.3-20.7.

Diffugia difficilis Thomas, 1955
(Pl. III, Fig. 12)
Thomas, 1955: 354, pl. I, figs. 4-5;

Gauthier-Lièvre & Thomas, 1958: 282-283, fig. 16a-c; Chardez, 1967, pl. IV, fig. 22; Godeanu, 1971, fig. 1e; Lena & Zaidenweg, 1975, pl. IV, fig. 4; Ogden & Zivkovic, 1983: 349, fig. 5; Todorov & Golemansky, 1998: 86.

Description: Viewed laterally, the shell has an oval contour ending in a protuberance few evident. In apical view, the shell has a circular section. The flanks converge toward the aperture, forming a small collar. Shell aperture is circular and coated with exogenous material embedded in hyaline cement.

| Authors | Measurements (μm) | | |
|---------------------------------|--------------------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 90-100 | 53-63 | 18-20 |
| Present study (1 shell) | 108 | 84 | 36 |

Comments: It is a rare species recorded only in one lentic environment (Guaraná lagoon). *D. difficilis* was registered in Brazil in plankton samples of the Peruaçu River by Dabés (1999), in macrophyte samples from the Jequitinhonha River basin of Minas Gerais State (Souza, 2005), and by Silva-Neto (2001) in the Cuiabá River in Mato Grosso State.

pH: 6.2; Dissolved Oxygen (%): 78.8; Conductivity (ms.cm^{-1}): 28.2; Temperature ($^{\circ}\text{C}$): 26.5.

Diffugia helvetica var. *multilobata* Gauthier-Lièvre & Thomas, 1958
(Pl. III, Fig. 13)
Gauthier-Lièvre & Thomas, 1958: 260-261, fig. 4.

Description: In lateral view, the shell is globular and transparent with a discrete collar. The shell revetment is very specific, represented by nearly ovoid disks. In apical view, the aperture exhibits six irregular and few deep lobes.

| Authors | Measurements (μm) | | |
|---------------------------------|--------------------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 68-120 | 60-87 | 15-30 |
| Present study (3 shells) | 90-92 | 90-92 | 28-38 |

Comments: The specimens observed had similar measurements, being distinct only in the aperture measurement. It is a rare taxon in the study area, recorded in only one lentic environment (Osmar lagoon). It is the first record in Brazil.

pH: 6.0; Dissolved Oxygen (%): 27.8; Conductivity (ms.cm^{-1}): 46.8; Temperature ($^{\circ}\text{C}$): 17.1.

Diffugia lobostoma var. *cornuta*

Gauthier-Lièvre & Thomas, 1958
(Pl. IV, Fig. 14)
Gauthier-Lièvre & Thomas, 1958: 267, pl. IX, fig. H; Fulone et al., 2005, fig. 3.

Description: Seen laterally, the shell has an ovoid contour. Shell revetment contains exogenous material. In apical view, the pseudostome has three lobes and present a few evident collar. The base of the shell exhibits two empty, short horns.

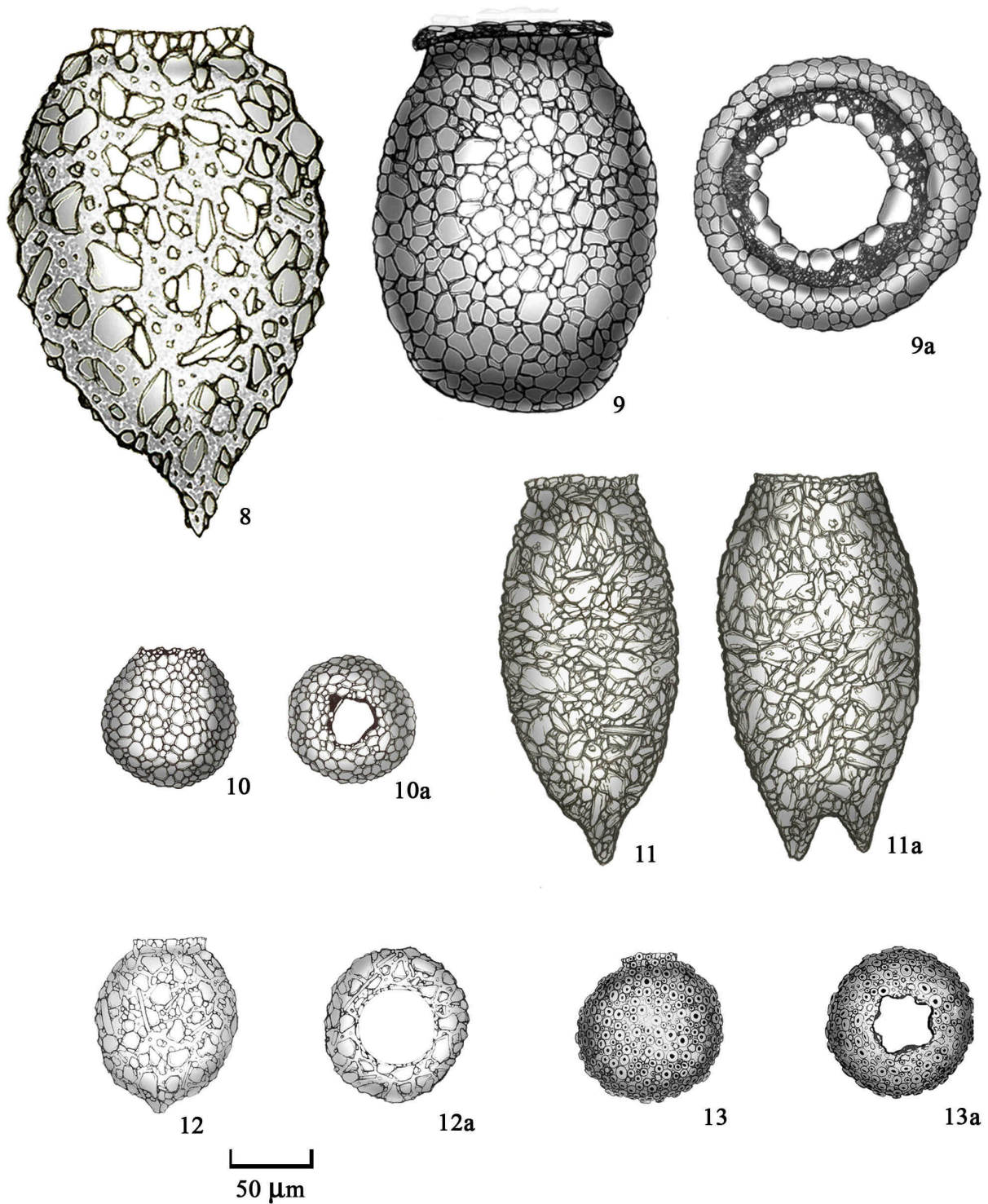


Plate III: Fig. 8. *Diffugia acutissima*, lateral view; Fig. 9. *D. amphoralis* var. *globosa*, lateral view; Fig. 9a. apical view; Fig. 10. *D. angulostoma*, lateral view; 10a. apical view; Fig. 11 *D. bicurvis*, lateral view; Fig. 11a. frontal view; Fig. 12. *D. difficilis*, lateral view Fig. 12a. apical view; Fig. 13. *D. helvetica* var. *multilobata*, lateral view; Fig. 13a. apical view.

| Authors | Measurements (µm) | | | |
|---------------------------------|------------------------------|--------------|----------------|----------------------|
| | Shell height (without spine) | Spine length | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 95-120 | 10-12 | 72-90 | 25-40 |
| Fulone et al. (2005) | 81 | - | 60 | - |
| Present study (4 shells) | 80-95 | 8-12 | 60-69 | 15-20 |

Comments: All individuals presented two horns in the shell base. Gauthier-Lièvre & Thomas (1958) found specimens with two and three horns. This taxon was registered in lotic (Ivinheima River) and lentic environments (Guaraná and Osmar lagoons), always at low frequency. A unique occurrence in Brazil was made in plankton samples of two streams in the São Paulo State (Fulone et al., 2005).

pH: 6.0-6.8 Dissolved Oxygen (%): 27.8-79.4; Conductivity (ms.cm⁻¹): 33.5-46.8; Temperature (°C): 17.1-20.1.

Diffflugia lobostoma var. *tuberosa*

Gauthier-Lièvre & Thomas, 1958 (Pl. IV, Fig. 15)

Gauthier-Lièvre & Thomas, 1958: 268, pl. IX, fig. 1.

Description: Viewed laterally, the shell is nearly circular and slightly flattened in the pseudostome region. Tubercles for all shell. The pseudostome has three regular lobes without a collar. How typical form, the collar absence permits to observe, laterally, the incision characteristic from lobes. The shell is coated with stones embedded in a yellow and sinuous cement.

| Authors | Measurements (µm) | | |
|---------------------------------|-------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 80-140 | 70-110 | 18-32 |
| Present study (4 shells) | 133-166 | 102-148 | 33-55 |

Comments: The specimens observed always had three lobes. Gauthier-Lièvre & Thomas (1958) observed individuals with three and four lobes. This taxon was registered in lotic (Baía and Ivinheima Rivers) and lentic environments (Guaraná lagoon) at low frequency. It is the first record in Brazil.

pH: 6.1-7.1; Dissolved Oxygen (%): 70.5-95.8; Conductivity (ms.cm⁻¹): 26.1-49.1; Temperature (°C): 19.1-27.2.

Diffflugia microclaviformis (Kourov, 1925) (Pl. IV, Fig. 16)

Gauthier-Lièvre & Thomas, 1958: 347, fig. 55a-b (like *D. oblonga* var. *microclaviformis*); Chardez, 1967, pl. III, fig. 13 (like *D. oblonga* var. *microclaviformis*);

Stepánek, 1967, fig. 10.2, 10.4, 10.5, 10.7-8, 11.1; Ogden, 1983: 35-38, fig. 24; Ogden & Zivkovic, 1983: 356; Dabés & Velho, 2001: 303, fig. 4c.

Synonym: *Diffflugia oblonga* var. *microclaviformis* Kourov, 1925

Description: Laterally, the shell is elongate with an approximately pyriform contour, slightly wider at the base and narrowing towards the anterior region. The shell base has a little rounded spine. The shell is coated with a few sand particles embedded in a transparent cement. The pseudostome is circular, provided of a small collar.

| Authors | Measurements (µm) | | |
|---------------------------------|-------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 190-215 | 75-95 | 18-25 |
| Present study (4 shells) | 190-225 | 67-80 | 28-30 |

Comments: *D. microclaviformis* was found in lotic (Baía River and Curutuba Channel) and lentic environments (Garças lagoon), but at low density. In Brazil, it was registered

by Dabés & Velho (2001) in periphyton samples of one marginal lagoon of São Francisco River, Minas Gerais State and by Souza (2004), in plankton samples of lotic

environments of the Araguari River basin.
 pH: 6.5-7.5; Dissolved Oxygen (%): 78.4-99.1; Conductivity (ms.cm^{-1}): 26.5-67.6; Temperature ($^{\circ}\text{C}$): 21.2-26.6.

Diffflugia muriformis f. *crucilobata*
 Gauthier-Lièvre & Thomas, 1958
 (Pl. IV, Fig. 17)
 Gauthier-Lièvre & Thomas, 1958: 272,
 pl. X, figs. d-e.

Description: In lateral view, the shell is nearly spherical with regular protuberances, similar to the typical form. Pseudostome contains four regular lobes. It has an evident collar with waves which indicate pseudostome lobes. The shell revetment comprises regular sand particles, which are smaller around the pseudostome.

| Authors | Measurements (μm) | | | |
|---------------------------------|--------------------------------|----------------|---------------|----------------------|
| | Shell height | Shell diameter | Collar height | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 119-149 | 100-150 | 3-10 | 43-50 |
| Present study (1 shell) | 102 | 75 | 7 | 22 |

Comments: The specimen observed here exhibited characteristics reported by Gauthier-Lièvre & Thomas (1958) but had inferior dimensions. It is a rare taxon, found in only one lentic environment (Guaraná lagoon). It is the first record in Brazil.
 pH: 6.2; Dissolved Oxygen (%): 78.8; Conductivity (ms.cm^{-1}): 28.2; Temperature ($^{\circ}\text{C}$): 26.5.

Diffflugia nebeloides Gauthier-Lièvre & Thomas, 1958

(Pl. IV, Fig. 18)
 Gauthier-Lièvre & Thomas, 1958: 341-342, fig. 54

Description: Laterally, the shell is slim and pyriform. It has a circular pseudostome. The base of the shell has a larger diameter than the anterior region. The shell is coated with a fine and delicate chitinous membrane that is transparent with particles of variable size which are also transparent.

| Authors | Measurments (μm) | | |
|---------------------------------|-------------------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 165-210 | - | - |
| Ogden (1984) | 168-224 | 77-103 | 24-40 |
| Present study (2 shells) | 138-151 | 84-85 | 25-26 |

Comments: *D. nebeloides* exhibited characteristics reported by Gauthier-Lièvre & Thomas (1958) but had greater dimensions. It was recorded in only one lentic environment (Guaraná lagoon). In Brazil, it was recorded in plankton samples of the Cuiabá River, Mato Grosso State (Silva-Neto, 2001).

pH: 5.8; Dissolved Oxygen (%): 70.5; Conductivity (ms.cm^{-1}): 21.1; Temperature ($^{\circ}\text{C}$): 19.3.

Diffflugia parva (Thomas, 1954)
 (Pl. IV, Fig. 19)
 Thomas, 1954: 258, pl. 3, fig. 1;
 Gauthier-Lièvre & Thomas, 1958: 345-346,
 fig. 55c, d (like *Diffflugia oblonga* var. *parva*);
 Schönborn, 1965: 303, fig. 7a; 1975:131,
 1k (like *Diffflugia oblonga* var. *parva*);

Chardez, 1967, pl. III, fig. 5 (like *D. oblonga* var. *parva*); Lena, 1983, pl. 3, fig. 13 (like *D. pyriformis* f. *parva*); Ogden, 1984: 250, figs. 21-22.

Synonyms: *Diffflugia oblonga* var. *parva* Thomas, 1954

D. pyriformis var. *parva* Chardez e Decloitre, 1973

Description: Viewed laterally, the shell has a pyriform contour. In apical view, the shell has a circular section. The posterior region of the shell is slightly larger than the anterior region. The pseudostome is nearly circular. The shell is coated with large, angular sand particles that normally exceed the shell contour, especially in the anterior region.

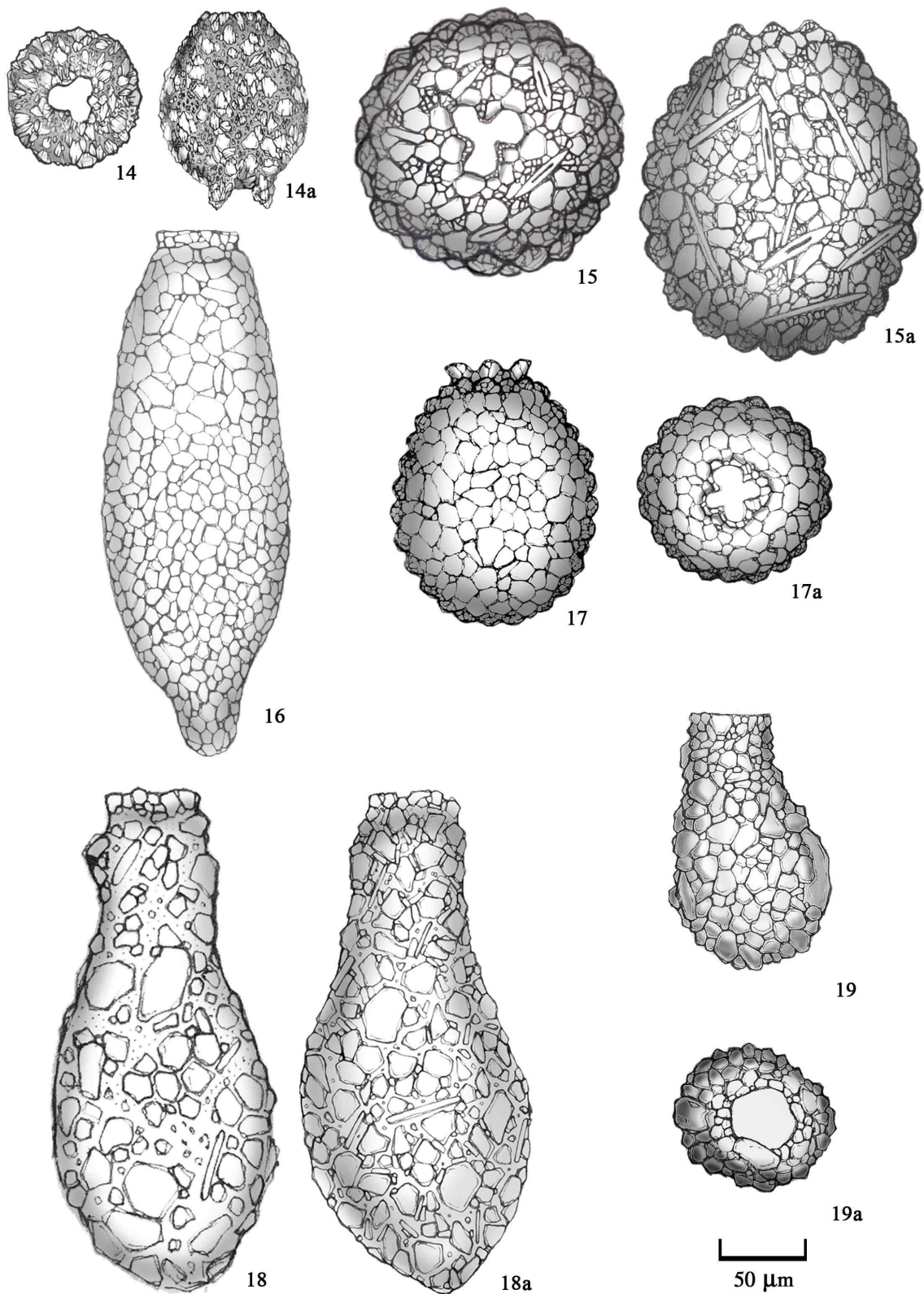


Plate IV: Fig. 14. *Diffflugia lobostoma* var. *cornuta*, apical view; Fig. 14a. lateral view; Fig. 15. *D. lobostoma* var. *tuberosa*, apical view; Fig. 15a. lateral view; Fig. 16. *D. microclaviformis*, lateral view; Fig. 17. *D. muriformis* f. *crucilobata*, lateral view; Fig. 17a. apical view; Fig. 18 e 18a. *D. nebeloides*, lateral view; Fig. 19. *D. parva*, lateral view; Fig. 19a. apical view.

| Authors | Measurements (μm) | | |
|---------------------------------|--------------------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 165-210 | - | - |
| Ogden (1984) | 168-224 | 77-103 | 24-40 |
| Present study (2 shells) | 138-151 | 84-85 | 25-26 |

Comments: A rare species found in lotic (Ivinheima River) and lentic environments (Osmar lagoon). It is the first record in Brazil.

pH: 6.1-6.7; Dissolved Oxygen (%): 45.7-77.8; Conductivity (ms.cm^{-1}): 46.0-48.9; Temperature ($^{\circ}\text{C}$): 20.1-30.7.

Diffflugia ventricosa Deflandre, 1926 (Pl. V, Fig. 20)

Deflandre, 1926: 520, figs. 6-7; Gauthier-Lièvre & Thomas, 1958: 322, fig. 43; Chardez, 1967, pl. IV, fig. 7; Ogden,

1983: 41, fig. 27; 1984: 254; Todorov & Golemansky, 1998: 87.

Description: Laterally, the shell has a pyriform contour. The anterior region of the shell is nearly cylindrical, widening suddenly to form an ovoid body. The shell base has a curved conical spine. Circular pseudostome without collar. The shell revetment is transparent with a few thick mineral particles fixed in a chitinous membrane.

| Authors | Measurements (μm) | | | |
|---------------------------------|--------------------------------|--------------|----------------|----------------------|
| | Shell total height | Spine length | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 160-184 | - | 55-60 | 25-28 |
| Ogden (1984) | 221-237 | - | 191-219 | 85-114 |
| Present study (2 shells) | 237-242 | 25 | 80-90 | 30 |

Comments: Rare species found only in the Baía River. It is the second record in Brazil, having been found before in sediment samples of Pantanal do Poconé, Mato Grosso State (Hardoim & Heckman, 1996).

pH: 6.3; Dissolved Oxygen (%): 82.5; Conductivity (ms.cm^{-1}): 21.9; Temperature ($^{\circ}\text{C}$): 20.7.

Diffflugia ventricosa f. *recticaulis* Dioni, 1970

(Pl. V, Fig. 21)

Dioni, 1970: 216, pl. II, fig. 18.

Description: It differs from the typical form in that the base spine is proportionally greater in relation to total shell length. The pseudostome contains small and irregular stones; some lack these stones. The shell is transparent with a few sand particles. Particles are frequent in the neck.

| Authors | Measurements (μm) | | | |
|-------------------------|--------------------------------|--------------|----------------|----------------------|
| | Shell total height | Spine length | Shell diameter | Pseudostome diameter |
| Dioni (1970) | 350 | 50-80 | 110 | 50 |
| Present study (1 shell) | 221 | 67 | 60 | 21 |

Comments: This taxon was found in only one lentic environment (Guaraná lagoon). It is the first record in Brazil.

pH: 5.8; Dissolved Oxygen (%): 65.7; Conductivity (ms.cm^{-1}): 27.7; Temperature ($^{\circ}\text{C}$): 25.4.

LESQUEREUSIIDAE Jung, 1942

Netzelia oviformis (Cash, 1909) (Pl. V, Fig. 22)

Oye 1931: 59, fig. 4 (like *Diffflugia oviformis*), Gauthier-Lièvre & Thomas, 1958: : 273, fig. 9a-e (like *D. oviformis*); Grospietsch, 1958: 319 (like *D. oviformis*); Chardez, 1967, pl. IV, fig. 46 (like *D. oviformis*); Vucetich, 1975: 110-111, fig.11 (like *D. oviformis*); Ogden, 1979: 206; Ogden & Hedley, 1980: 150, pl. LXIV, figs. A-D (like *D. oviformis*); Ogden & Meisterfeld, 1989: 123-126; Hardoim, 1997: 255, fig. 89; Missawa, 2000, pl. VI, fig. 64; Dabés & Velho, 2001: 303.

Synonym: *Diffflugia oviformis* Cash, 1909.

Description: Laterally, the shell has an ovoid contour. The revetment of the shell is of endogenous nature, incorporating ir-

regular plates in a transparent cement. The pseudostome exhibits four lobes rounded by a thick brim of organic cement. Short collar.

| Authors | Measurements (μm) | | |
|---------------------------------|--------------------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 65-120 | 30-90 | 15-30 |
| Ogden & Hedley (1980) | 79-87 | 57-67 | 25-26 |
| Present study (1 shell) | 192 | 174 | 61 |

Comments: *N. oviformis* exhibited characteristics similar to those reported in the literature but had greater dimensions. The specimen observed exhibited four lobes. Gauthier-Lièvre & Thomas (1958) observed individuals with four and five lobes. Ogden & Hedley (1980) observed specimens with three and four lobes. This species was found in only one lentic environment (Guaraná lagoon). In Brazil, it was found in sediment samples of Rio Grande do Sul State (Cardoso & Motta Marques, 2003, like *Diffflugia oviformis*), in sediment and aquatic macrophyte samples of Pantanal do Poconé of Mato Grosso State (Hardoim & Heckman, 1996; Hardoim, 1997), in plankton samples of the Cuiabá River (Missawa, 2000; Silva-Neto, 2001), in macrophyte samples of one marginal lagoon from the São Francisco River basin in Minas Gerais State (Dabés & Velho, 2001), and in plankton samples of Curuá-Una reservoir in Pará State (Robertson et al., in prep.).

pH: 5.8; Dissolved Oxygen (%): 70.3; Conductivity (ms.cm^{-1}): 21.1; Temperature ($^{\circ}\text{C}$): 19.3.

Netzelia wailesi (Wailes, 1912)
(Pl. V, Fig. 23)

Wailes, 1912: 124 (like *Diffflugia tuberculata* var. minor); Gauthier-Lièvre & Thomas, 1958: 280-281, fig. 14c-e (like *Diffflugia tuberculata* var. minor); Ogden, 1980:130, 133, fig. 23-25 (like *D. wailesi*); Hardoim, 1997: 260-261, fig. 91; Meisterfeld, 2000: 850, fig. 56.

Synonyms: *Diffflugia tuberculata* var. minor Wailes, 1912.

D. oviformis Netzel, 1972.

D. wailesi Ogden, 1980.

Description: Ovoid and transparent shell coated with quartz particles and diatom frustules embedded in an organic cement. Pseudostome polygonal with four bevels. Short collar with a base strangulation.

| Authors | Measurements (μm) | | |
|---------------------------------|--------------------------------|----------------|----------------------|
| | Shell height | Shell diameter | Pseudostome diameter |
| Gauthier-Lièvre & Thomas (1958) | 70-120 | 50-70 | 20-25 |
| Hardoim (1997) | 52-96 | 52-68 | 20-32 |
| Present study (1 shell) | 162 | 118 | 51 |

Comments: Gauthier-Lièvre & Thomas (1958) observed individuals with nearly hexagonal pseudostomes. Ogden (1980) observed exemplars with five and six bevels. Species dimensions observed in this study were larger than those observed by Gauthier-Lièvre & Thomas (1958) and Hardoim (1997), however the proportions among them were similar to those in the literature. Although *N. wailesi* had exhibited characteristics similar to those reported in the literature our specimens showed greater dimensions. Found in only one lentic

environment (Fechada lagoon). In Brazil, it was recorded in moss samples from Rio de Janeiro, (Wailes, 1913) and in plankton samples from Rio Grande do Sul State (Cardoso & Motta Marques, 2004), both similar to *Diffflugia tuberculata* var. minor.

pH: 5.5; Dissolved Oxygen (%): 56.2; Conductivity (ms.cm^{-1}): 21.7; Temperature ($^{\circ}\text{C}$): 25.4.

HYALOSPHEIIDAE Schulze, 1877

Nebela penardiana Deflandre, 1936
(Pl.V, Fig. 24)

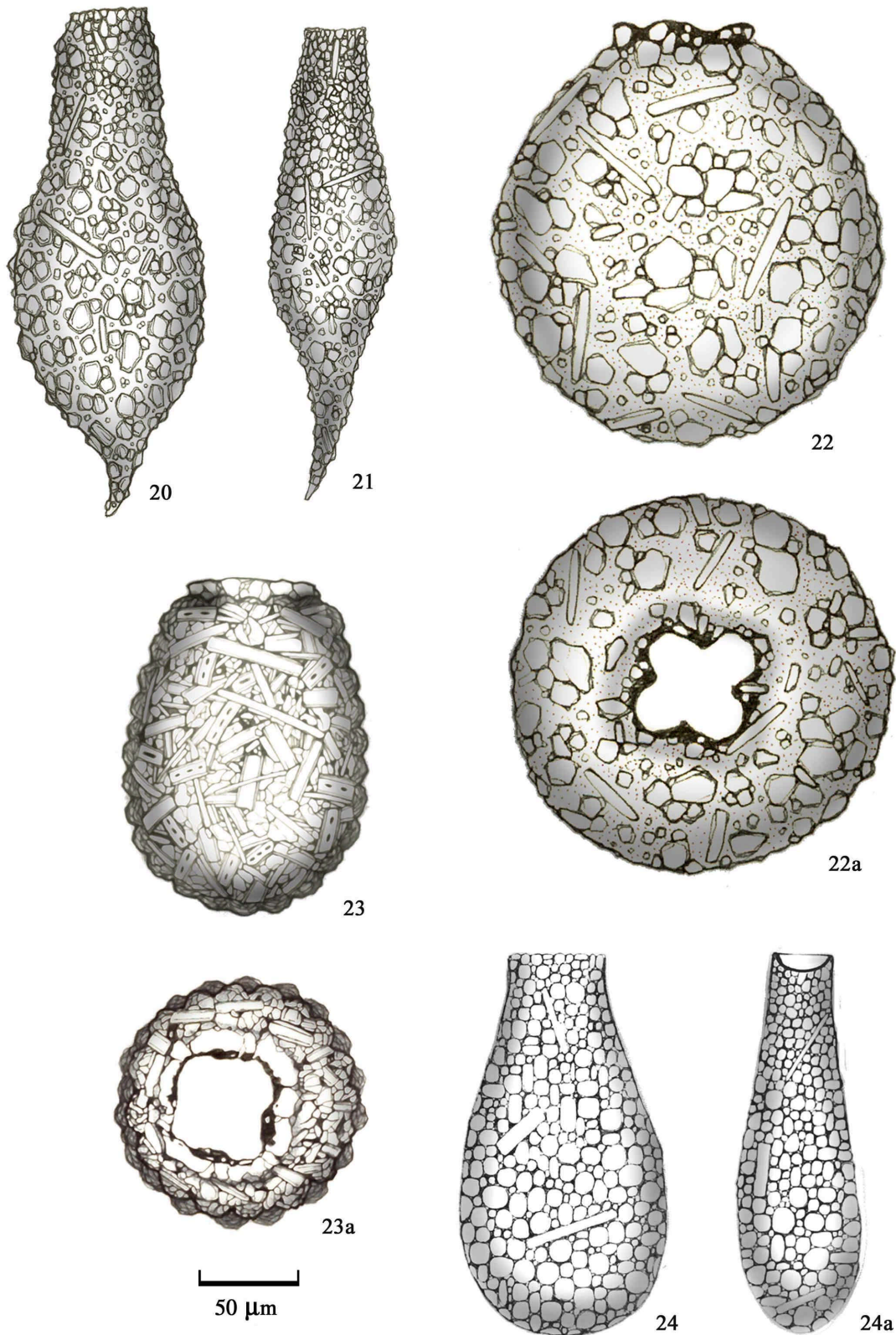


Plate V: Fig. 20. *Diffflugia ventricosa*, lateral view; Fig. 21. *D. ventricosa* f. *reticulata*, lateral view; Fig. 22. *Netzelia oviformis*, lateral view; Fig. 22a. *N. oviformis*, apical view; Fig. 23. *N. walesi*, lateral view; Fig. 23a. *N. walesi*, apical view; Fig. 24. *Nebela penardiana*, frontal view; Fig. 24a. *N. penardiana*, lateral view.

Deflandre, 1936: 257-258, figs. 87-89 e pl. XIX, figs. 1-9, pl. XX, figs. 1-2, 4-5 e 7; Hoogenraad & Groot, 1948: 39, fig. 15; Gauthier- Lièvre, 1953: 349-350, fig. 13A-H; Schönborn, 1966: 539, fig. 6 i-k; Godeanu, 1970, fig. 2d; Vucetich, 1973b, fig. 16; Ogden & Hedley, 1980: 106, pl.XLII, figs. A-D; Ogden, 1984: 258; Rhoden & Pitoni, 1999: 101, fig. 16; Mitchel, 2003:1-8.

Description: In lateral view, the shell is elongate, pyriform, and compressed. The flanks of the shell converge toward the anterior region. Pseudostome with oval contour, laterally concave and rounded by a collar. Shell coated with oval, circular, and quadrangular plates.

| Authors | Measurements (µm) | | |
|--------------------------|-------------------|----------------|--------------------|
| | Shell height | Shell diameter | Pseudostome length |
| Deflandre (1936) | 140-175 | 65-75 | 30-35 |
| Ogden & Hedley (1980) | 115-161 | 65-80 | 23-34 |
| Ogden (1984) | 99-169 | 50-86 | 17-32 |
| Present study (2 shells) | 175-186 | 87-92 | 35-38 |

Comments: *N. penardiana* was found only in lotic environments (Ipoitã Channel and Ivinheima River). Records of this species in Brazil were made in sphagnum samples from Rio Grande do Sul State (Rhoden & Pitoni, 1999), in plankton samples of the Cuiabá River in Mato Grosso State (Silva-Neto, 2001), and in macrophyte samples from the Jequitinhonha River basin in Minas Gerais State (Souza, 2005).

pH: 6.7-6.9; Dissolved Oxygen (%): 58.7-77.8; Conductivity (ms.cm⁻¹): 34.4-48.9; Temperature (°C): 28.0-30.7.

Final considerations:

We described and illustrated 24 taxa, distributed in six families. The Diffugiidae Family had the highest species richness (14 species). Arcellidae and Centropyxidae contained 3 species each. Among these taxa, 11 were found only in lentic, six only in lotic, and seven in both types of environment. *Arcella vulgaris* f. *elegans*, *Diffugia amphoralis* var. *globosa*, *D. helvetica* var. *multilobata*, *D. lobostoma* var. *tuberosa*, *D. muriformis* f. *crucilobata*, *D. parva*, and *D. ventricosa* f. *recticaulis* represent the first records in Brazil.

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