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On the occurrence of testate amoebae (Protozoa, Rhizopoda) in Brazilian inland waters. I. Family Arcellidae

Fábio Amodêo Lansac-Tôha*, Luiz Felipe Machado Velho, Maria Cláudia Zimmermann-Callegari and Cláudia Costa Bonecker

*Núcleo de Pesquisas em Limnologia, Ictiologia e Aqüicultura (Nupélia), Universidade Estadual de Maringá, Av. Colombo, 5790, 87020-900, Maringá-Paraná, Brazil. *Author for correspondence.*

ABSTRACT. The purpose of this paper is to increase the knowledge on testate amoebae in Brazilian inland waters, specifically the family Arcellidae (Protozoa, Amoebozoa, Rhizopoda). In this paper the current occurrence and geographical distribution of this family in Brazil is discussed. A total of 26 infra-generic taxa was recorded, among them 24 taxa belong to the genus *Arcella* and 2 to *Pyxidicula*. *Arcella vulgaris* Ehrenberg, *A. gibbosa* Pénard, *A. megastoma* Pénard, *A. dentata* Ehrenberg, *A. discoides* Ehrenberg, *A. brasiliensis* Cunha and *A. crenulata* Deflandre were the species with greater number of records. Some taxonomic information is also provided.

Key words: Testate amoebae, Arcellidae, *Arcella, Pyxidicula*, geographical distribution, Brazil.

RESUMO. Ocorrência de tecamebas (Protozoa, Rhizopoda) em águas continentais brasileiras. I. Família Arcellidae. O objetivo desse trabalho é incrementar o conhecimento sobre as tecamebas em ambientes aquáticos continentais brasileiros, especificamente, a Família Arcellidae (Protozoa, Amoebozoa, Rhizopoda). Um total de 26 taxa infra-genéricos foi registrado, sendo 24 de *Arcella* e 2 de *Pyxidicula*. As espécies com maior número de registros são *Arcella vulgaris* Ehrenberg, *A. gibbosa* Pénard, *A. megastoma* Pénard, *A. dentata* Ehrenberg, *A. discoides* Ehrenberg, *A. brasiliensis* Cunha e *A. crenulata* Deflandre. Algumas informações taxonômicas são fornecidas.

Palavras-chave: Tecamebas, Arcellidae, *Arcella, Pyxidicula*, distribuição geográfica, Brasil.

The designation testate amoebae (Protozoa, Amoebozoa, Rhizopoda) refers to a group of organisms, but it is artificial, heterogeneous and very polyphiletic. These organisms have their cytoplasm inside a shell or test (Vucetich, 1973). There is little and sparse information on this group in Brazil. Ehrenberg (1841), Daday (1905), Prowazek (1910), Wailes (1913), Cunha (1913, 1916) and Pinto (1925) provided the first records of these organisms in Brazil. These studies were very descriptive with emphasis on taxonomy and species distribution. After a long time, Closs and Madeira (1962, 1967) and Closs and Medeiros (1965, 1967) studied testate amoebae from coastal lagoon sediments in the state of Rio Grande do Sul, with the same purpose as the prior studies.

Later studies included taxonomy, but also incorporated some aspects of ecology. Among them, the works of Green (1975), Walker (1982), Dabés (1995), Hardoim and Heckman (1996), Torres (1996), Velho *et al.* (1996), Velho and Lansac-Tôha (1996), Hardoim (1997), Lansac-Tôha *et al*. (1997), Bonetti and Eichler (1997), Eichler-Coelho *et al.* (1997), Oliveira (1999) and Velho *et al*.(1999) must be mentioned.

Testate amoebae are numerically important, play an important role in freshwater systems, but there is still little information on their taxomomic status in Brazil. The purpose of this paper is to increase the knowledge on this group, specifically the Arcellidae. In this paper the current occurrence and distribution of this Family in Brazil are discussed.

Material and methods

With respect to previous registers of occurrence and distribution of Arcellidae species we considered only those in scientific publications (journals, papers in congresses and symposiums), dissertations and theses.

For each species we list, if not all, the principal pertinent taxonomic references and thus provide an

update on the state of the art of the identification of Arcellidae species in Brazil.

Arcellidae Ehrenberg, 1830

Arcella arenaria Greeff, 1866

Pénard, 1890: 154, pl. V, figs. 75-77 (as *A. microstoma*); 1902: 406; Deflandre, 1928: 247-249, figs. 293-297; Ogden and Hedley, 1980: 24, pl. 1, figs. A-E; Hennuy and Chardez, 1988: 183, fig. 1.

Comments: In Brazil this species has been registered only in mosses samples by Wailes (1913), state of Rio de Janeiro, and by Hoogenraad and Groot (1951), state of Paraná (Figure 1).

Arcella brasiliensis Cunha, 1913

Cunha, 1913: 108-109, pl. IX, fig. 1a-b; Deflandre, 1928: 242-243, figs. 263-265; Velho *et al.*, 1996: 39, pl. I, fig. 4.

Comments: In Brazil this species has been recorded in Manguinhos and Angra dos Reis, state of Rio de Janeiro (Cunha, 1913, 1916); floodplain lakes of the São Francisco River basin, state of Minas Gerais (Dabés, 1995); Corumbá reservoir and tributaries, state of Goiás (Lansac-Tôha *et al.*, 2000); upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996; Lansac-Tôha *et al.*, 1997), and in a reservoir in Porto Alegre, state of Rio Grande do Sul (Torres, 1996) (Figure 1).

Arcella catinus Pénard, 1890

Pénard, 1890: 154-155, pl. V, figs. 78-92; Deflandre, 1928: 243-245, figs. 274-291; Grospietsch, 1954, pl. II, fig. 12a-b; Vucetich, 1973: 296, pl. II, fig. 15; Kudo, 1975: 443, fig. 203e-f; Ogden and Hedley, 1980: 30, pl. IV, figs. A-D.

Comments: In Brazil this species has been recorded only in the plankton of Volta Grande Reservoir and Grande River, states of Minas Gerais and São Paulo (Rolla *et al.*, 1990, 1992) (Figure 1).

Arcella conica (Playfair, 1917)

Playfair, 1917: 640, figs. 16-17; Deflandre, 1926, fig. 1; 1928: 238-240, figs. 244-255; Grospietsch, 1972: 7; Vucetich, 1972: 273-274, pl. I, fig. 2; 1973: 293, pl. I, fig. 8; Ogden and Hedley, 1980: 32, pl. V, figs. A-C; Velho *et al*., 1996: 40, pl. I, fig. 8; Hardoim, 1997: 169, fig. 49.

Comments: In Brazil this species has been recorded in the state of Mato Grosso (Green, 1975; Hardoim and Heckman, 1996; Hardoim, 1997); state of Goiás (Lansac-Tôha *et al.*, 2000); (state of Minas Gerais (Dabés, 1995); states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996, 1999; Lansac-Tôha *et al.,* 1997), and state of Rio Grande do Sul (Torres, 1996) (Figure 1).

Arcella costata Ehrenberg, 1847

Deflandre, 1928: 240-241, figs. 257-258; Franken, 1933: 192, pl. I, fig. 45; Chardez, 1967, pl. I, fig. 45; Vucetich, 1973: 293, pl. I, fig. 9; Velho *et al.*, 1996: 40, pl. I, fig. 7

Comments: The species has been recorded in the states of Rio de Janeiro and São Paulo (Prowazek, 1910; Cunha, 1913); state of Mato Grosso (Green, 1975; Hardoim, 1997); state of Minas Gerais (Dabés, 1995); state of Goiás (Lansac-Tôha *et al.,* 1999, 2000), and states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996, 1999; Lansac-Tôha *et al.,* 1997) (Figure 1).

Arcella crenulata Deflandre, 1928

Deflandre, 1928: 225-226, fig. 187a-b; Vucetich, 1978: 85, pl. I, fig. 11; Ogden and Hedley, 1980: 34, pl. VI, figs. A-D; Velho *et al.*, 1996: 40, pl. I, fig. 6; Rhoden and Pitoni, 1999: 94, fig. 2.

Comments: The species has been registered in plankton samples by Green (1975) in lakes of the Suia Missu River basin, state of Mato Grosso; by Bonecker *et al.* (1996) in Doce river, state of Minas Gerais; by Lansac-Tôha *et al.*(1999, 2000) in Corumbá reservoir and tributaries, state of Goiás; by Velho *et al.(*1996) and Lansac-Tôha *et al.* (1997) in upper Paraná river floodplain, states of Mato Grosso do Sul and Paraná, and in samples of *Sphagnum*, state of Rio Grande do Sul (Rhoden and Pitoni, 1999) (Figure 1).

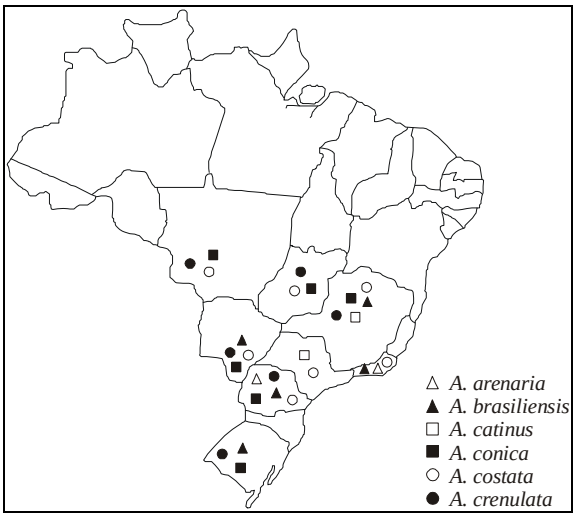

Figure 1. Geographic distribution of the species *Arcella arenaria, A. brasiliensis, A. catinus, A. conica, A. costata* and *A. crenulata* in the Brazilian inland waters

***Arcella dentata* Ehrenberg, 1838**

Ehrenberg, 1838, pl. IX, fig. 7a; Pénard, 1902: 411; Deflandre, 1928: 252, figs. 307, 310-314; 1953, fig. 89D-E; Hoogenraat and Groot, 1937, fig. 31; Green, 1963, fig. 4a-b; Chardez, 1967, pl. I, fig. 42; Grospietsch, 1972: 7, fig. 7; Vucetich, 1973: 295, fig. 13; Kudo, 1975; 443-444, fig. 203g-i; Velho *et al.*, 1996: 40-41, pl. I, fig. 9; Hardoim, 1997: 174, fig. 51.

Comments: In Brazil this species has been collected in plankton from the São Francisco River basin, states of Pernambuco and Minas Gerais (Neumann-Leitão and Nogueira-Paranhos, 1987; Dabés, 1995); Broa reservoir, state of São Paulo (Neumann-Leitão *et al*., 1990); Tibagi River, state of Paraná (Lopes, 1993); upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996; Lansac-Tôha *et al.,* 1997), Pantanal, state of Mato Grosso do Sul (Bonecker *et al*., 1998), Corumbá Reservoir and tributaries, state of Goiás (Lansac-Tôha *et al.,* 1999, 2000), and in the periphyton of a reservoir located in the state of Rio Grande do Sul (Torres, 1996), and Pantanal do Poconé, state of Mato Grosso (Hardoim and Heckman, 1996; Hardoim, 1997) (Figure 2).

***Arcella discoides* Ehrenberg, 1843**

Pénard, 1890: 153, pl. V, figs. 70-74; 1902: 403, figs. 1-2; Deflandre, 1928: 256-257, figs. 324-326; Chardez, 1967, pl. I, fig. 23; Dioni, 1970: 264, pl. I, fig. 1a-b; Grospietsch, 1972: 7, fig. 8; Vucetich, 1972: 275; 1973: 297, pl. II, fig. 16; Boltovskoy and Lena, 1974, pl. V, fig. 12; Lena and Zaidenwerg, 1975, pl. III, fig. 1a-b; Kudo, 1975: 443, fig. 203c; Ogden and Hedley, 1980: 36, pl. VII, fig. A-D; Torres and Jebram, 1994: 68 and 70; fig. 2A-B; Velho *et al.*, 1996: 43, pl. II, fig. 14; Hardoim, 1997: 176, fig. 52.

Comments: This species has been recorded in the state of Ceará (Cunha, 1913); state of Rio de Janeiro (Cunha, 1913; Wailes, 1913); state of Mato Grosso (Green, 1975; Hardoim and Heckman, 1996; Hardoim, 1997); state fo Goiás (Lansac-Tôha *et al.*, 2000); state of Minas Gerais (Rolla *et al.*, 1992; Dabés, 1995) state of São Paulo (Durigan *et al.*, 1992; Oliveira *et al.*, 1992; Sipaúba-Tavares *et al.*, 1995), state of Mato Grosso do Sul (Daday, 1905; Velho *et al.,* 1996, 1999; Lansac-Tôha *et al.,* 1997; Bonecker *et al*., 1998) and state of Paraná (Lopes, 1993; Nunes *et al*., 1996; Velho *et al.,* 1996, 1999; Lansac-Tôha *et al.,* 1997) (Figure 2).

***Arcella gibbosa* Pénard, 1890**

Pénard, 1890: 155, pl. V, figs. 96-99, pl. VI, fig. 1; Deflandre, 1928: 227-229, figs. 190-206; 1953, fig. 89F; Chardez, 1967, pl. I, fig. 13; Stepánek, 1967, fig. 2. 1,2; Dioni, 1971, fig. 1; Grospietsch, 1972: 7, fig. 1; Vucetich, 1973: 291, pl. I, fig. 4; Laminger, 1972, fig. 12.3a-b; Chardez and Hellebaut, 1978, fig. 6; Ogden and Hedley, 1980: 38, pl. VIII, figs. A-D; Torres and Jebram, 1994: 71, fig. 3C-D; Velho *et al.*, 1996: 39, pl. I, fig. 5; Hardoim, 1997: 178, fig. 53.

Comments: This species has been registered in samples from mosses in the state of Rio de Janeiro (Wailes, 1913); in plankton from lakes of the Suia Missu River basin, and in aquatic macrophytes samples from the Pantanal do Poconé, state of Mato Grosso (Green, 1975; Hardoim, 1997); in plankton from Doce River basin, state of Minas Gerais (Bonecker *et al.*, 1996, 1997); in plankton from Corumbá Reservoir and tributaries, state of Goiás (Lansac-Tôha *et al.*, 1999, 2000); in plankton from the upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996, 1999; Lansac-Tôha *et al.*, 1997), and in aquatic macrophytes samples from the state of Rio Grande do Sul (Torres and Jebram, 1994; Torres, 1996) (Figure 2).

***Arcella gibbosa* var *microsoma* Torres and Jebram, 1993**

Torres and Jebram, 1993: 22-23, figs. 1-2.

Comments: The original description of this variety of *A. gibbosa* was provided from material collected in a stream of Porto Alegre, state of Rio Grande do Sul, and infusions in laboratory (Torres and Jebram, 1993). This is the only record for Brazil (Figure 2).

***Arcella hemisphaerica* Perty, 1852**

Pénard, 1890, pl. V, figs. 93-95; Deflandre, 1928: 212-214, figs. 107-121; Chardez, 1967, pl. I, fig. 35; Grospietsch, 1972: 8, fig. 6; Vucetich, 1972: 272, pl. I, fig. 8; 1973: 289, pl. I, fig. 1; Lena and Zaidenwerg, 1975, pl. II, fig. 14 a-b; Ogden and Hedley, 1980: 40, pl. IX, figs. A-C; Hardoim, 1997: 180, fig. 54.

Comments: *A. hemisphaerica* has been registered in plankton samples (Green, 1975), and in the bottom and aquatic macrophytes samples (Hardoim and Heckman, 1996; Hardoim, 1997) from the state of Mato Grosso; in the plankton from the state of Minas Gerais (Dabés, 1995); in the plankton from the state of Goiás (Lansac-Tôha *et al.* 1999, 2000); and in plankton collected in the state of São Paulo (Gomes, 1991) (Figure 2).

***Arcella hemisphaerica* f. *undulata* Deflandre, 1928**

Deflandre, 1928: 214, figs. 122-124; Chardez, 1967, pl. I, fig. 37; Godeanu, 1970: 294, fig. 2; Vucetich,

1972: 272-273, pl. I, fig. 7; 1973: 290, pl. I, fig. 3; Hardoim, 1997: 183, fig. 55.

Comments: This taxon has been registered in the Pantanal, state of Mato Grosso, in samples from aquatic macrophytes (Hardoim and Heckman, 1996; Hardoim, 1997), and in the Doce River, state of Minas Gerais, in plankton samples (Bonecker *et al*., 1996) (Figure 2).

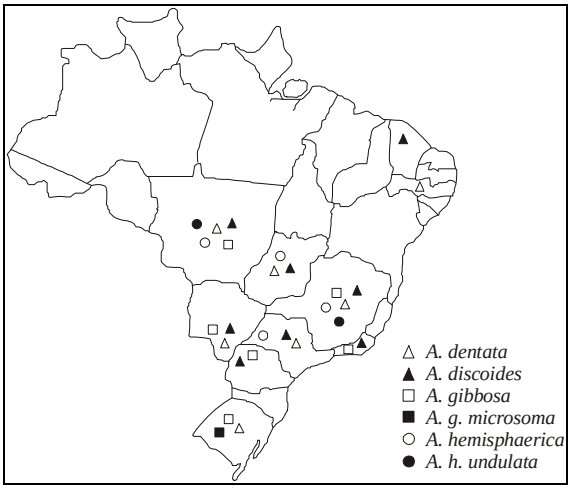

Figure 2. Geographic distribution of the species *Arcella dentata, A. discoides, A. gibbosa, A. g. microsoma, A. hemisphaerica* and *A. h. undulata* in the Brazilian inland waters

***Arcella irregularis* Motti, 1941**

Motti, 1941: 88, figs. 1-2; Vucetich, 1972: 275; 1973: 294, pl. I, fig. 10; Decloitre, 1976: 297, fig. 22

Comments: The only record of this species in Brazil was provided in the state of Rio Grande do Sul, from the periphyton of a reservoir (Torres, 1996) (Figure 3).

***Arcella lobostoma* Deflandre, 1928**

Deflandre, 1928: 217-218, figs. 149-154; Hardoim, 1997: 185, fig. 56.

Comments: *A. lobostoma* has been recorded only in plankton from a marginal lake of São Francisco River basin, state of Minas Gerais (Dabés, 1995), and in aquatic macrophytes samples in the Pantanal do Poconé, state of Mato Grosso (Hardoim, 1997) (Figure 3).

***Arcella megastoma* Pénard, 1902**

Pénard, 1902: 409; Wailes, 1913: 204-205, pl. XV, figs. 1-2; Deflandre, 1928: 267-268, figs. 363-372; Chardez, 1967, pl. I, fig. 22; Dioni, 1967: 121; 1970: 204, pl. I, fig. 3; Godeanu, 1970: 295, fig. 3; Vucetich, 1972: 274; 1973: 298, pl. II, fig. 18; Velho *et al.,* 1996: 43 pl. II, fig. 15; Hardoim, 1997: 187, fig. 57.

Comments: In Brazil, records of this species are from samples of mosses, state of Rio de Janeiro (Wailes, 1913); in plankton from a lake of the Suia Missu River basin and aquatic macrophytes samples from the Pantanal, state of Mato Grosso (Green, 1975; Hardoim and Heckman, 1996; Hardoim, 1997); in a lake of São Francisco River basin, state of Minas Gerais (Dabés, 1995); in plankton of the Corumbá Reservoir and tributaries, state of Goiás (Lansac-Tôha *et al*., 1999, 2000); in plankton from fish ponds, state of São Paulo (Sipaúba-Tavares *et al.*, 1995); in plankton samples from the upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.,* 1996, 1999; Lansac-Tôha *et al.,* 1997), and periphyton samples from a reservoir, state of Rio Grande do Sul (Torres, 1996) (Figure 3).

***Arcella mitrata* Leidy, 1879**

Leidy, 1879: 29, figs. 1-8, 12-13; Deflandre, 1928: 270-272, figs. 376-385; Franken, 1933: 192, pl. I, fig. 2a-b; Grospietsch, 1972: 8, fig. 10; Vucetich, 1973: 298, pl. II, fig. 19; Kudo, 1975: 443, fig. 203d; Velho *et al.*, 1996: 41, pl. II, fig. 12.

Comments: There are only seven citations of the occurrence of this species in Brazil: Cunha (1913) in Manguinhos, state of Rio de Janeiro; Rolla *et al.* (1992) in plankton samples from the Grande River, states of São Paulo and Minas Gerais; Lansac-Tôha *et al.*(2000), in plankton samples from the Corumbá reservoir, state of Goiás; Velho *et al.* (1996, 1999) and Lansac-Tôha *et al.* (1997) in plankton samples from the states of Mato Grosso do Sul and Paraná; and Torres (1996) in the periphyton from a reservoir, located in Porto Alegre, state of Rio Grande do Sul (Figure 3).

***Arcella mitrata* var. *spectabilis* Deflandre, 1928**

Deflandre, 1928: 273-274, figs. 388-391; Chardez, 1967, pl. I, fig. 46; Dioni, 1970: 204-205, pl. I, fig. 4; Velho *et al.*, 1996: 43, pl. II, fig. 13.

Comments: This taxon has been registered in Brazil only in plankton from the upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996, 1999; Lansac-Tôha *et al.,* 1997), and Corumbá Reservoir and tributaries, state of Goiás (Lansac-Tôha *et al.,* 2000) (Figure 3).

***Arcella nordestina* Vucetich, 1973**

Vucetich, 1973: 299-300, pl. II, fig. 20; Decloitre, 1976: 301, fig. 30; Torres and Jebram, 1994: 70, fig. 2C-D; Velho *et al.*, 1996: 41, pl. II, fig. 11.

Comments: In Brazil, this species has been registered in periphyton samples from the state of Rio

Grande do Sul (Torres and Jebram, 1994; Torres, 1996), and in plankton samples from the upper Paraná River floodplain, state of Mato Grosso d Sul (Velho *et al.*, 1996; Lansac-Tôha *et al.,* 1997) (Figure 3).

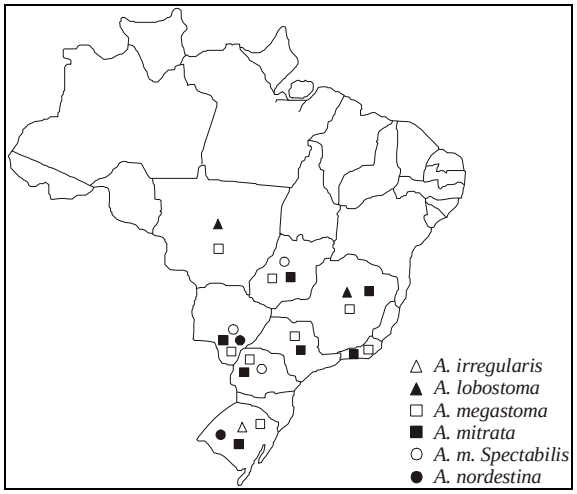

Figure 3. Geographic distribution of the species *Arcella irregulares, A. lobostoma, A. megastoma, A. mitrata, A. m. spectabilis* and *A. nordestina* in the Brazilian inland waters

plankton from the Suia Missu River basin (Green, 1975) and in the periphyton from the Pantanal do Poconé (Hardoim, 1997) (Figure 4).

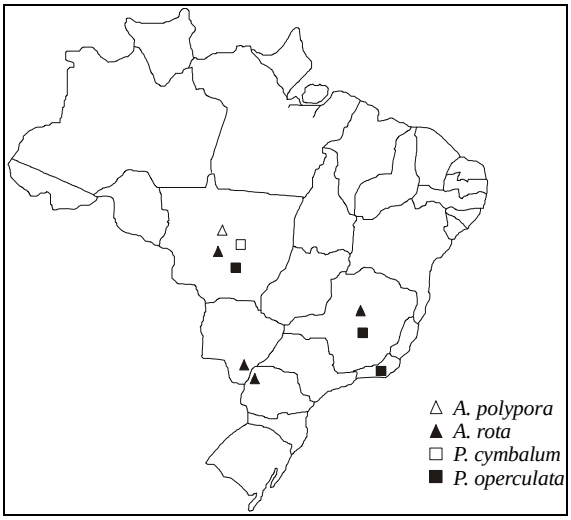

Figure 4. Geographic distribution of the species *Arcella polypora, A. rota, Pyxidicula cymbalum* and *P. operculata* in the Brazilian inland waters

Arcella polypora Pénard, 1890

Pénard, 1890: 156, pl. VI, figs. 2-9; 1902: 408-409, figs. 1-2; Deflandre, 1928: 264-265, figs. 354-356; Ogden and Hedley, 1980: 42, pl. X, figs. A-D; Hardoim, 1997: 189, fig. 58.

Comments: This species has been registered in Brazil only by Hardoim (1997) in periphyton samples from the Pantanal do Poconé, state of Mato Grosso (Figure 4).

Arcella rota Daday, 1905

Daday, 1905: 9, pl. I, figs. 1-4; Deflandre, 1928: 255-256, figs. 320-323; Vucetich, 1973: 296, pl. II, fig. 14; Velho *et al.*, 1996: 41, pl. II, fig. 10; Hardoim, 1997: 191, fig. 59.

Comments: *A. rota* has been registered in plankton from the São Francisco River basin, state of Minas Gerais (Dabés, 1995) and from the upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996; Lansac-Tôha *et al.,* 1997), and from the periphyton of the Pantanal do Poconé, state of Mato Grosso (Hardoim, 1997) (Figure 4).

Arcella rotundata Playfair, 1917

Playfair, 1917, pl. XXXIV, fig. 1; Deflandre, 1928: 233, fig. 223; Grospietsch, 1972: 9; Hardoim, 1997: 193, fig. 60.

Comments: In Brazil, this species has been registered only in the state of Mato Grosso in

Arcella vulgaris Ehrenberg, 1830

Pénard, 1890: 151, pl. V, figs. 56-66; 1902: 398, figs. 1-2; De la Rua, 1912: 45, fig. 1; Wailes, 1913, pl. XV, fig. 5; Deflandre, 1928: 219-221, fig. 156-164; Franken, 1933: 191, pl. I, fig. 1a-b; Seckt, 1940: 78; Chardez, 1967, pl. I, fig. 8; 1968, pl. I, fig. 4; Dioni, 1967: 121; 1970: 295, pl. I, fig. 7; Stepánek, 1967, fig. 2.5; Grospietsch, 1972: 9, fig. 9; Vucetich, 1972: 274; 1973: 292, pl. I, fig. 6; Lena and Cachi, 1972: 378, pl. I, figs. 28-32; Ogden and Hedley, 1980: 44, pl. II, figs. A-D; Torres and Jebram, 1994: 71, fig. 3A-B; Velho *et al.*, 1996: 37, pl I, fig. 1; Hardoim, 1997: 195, fig. 61.

Comments: *A. vulgaris* is the species of Arcellidae with more records in Brazil: state of Rio de Janeiro (Prowazek, 1910; Cunha, 1913, 1916); state of Mato Grosso (Daday, 1905; Green, 1975; Hardoim and Heckman, 1996; Hardoim, 1997); states of Bahia and Pernambuco (Neumann-Leitão and Nogueira-Paranhos, 1987); state of Minas Gerais (Rolla *et al.*, 1990, 1992; Dabés, 1995; Bonecker *et al.*, 1996, 1997); state of São Paulo (Prowazek, 1910; Neumann-Leitão *et al*, 1990; Rolla *et al.*, 1990); state of Goiás (Lansac-Tôha *et al.*, 1999, 2000); state of Mato Grosso do Sul (Velho *et al.*, 1996, 1999; Lansac-Tôha *et al.*, 1997; Bonecker *et al.*, 1998); state of Paraná (Velho *et al.*, 1996, 1999; Nunes *et al.*, 1996; Lansac-Tôha *et al.*, 1997); and state of Rio Grande do Sul (Closs and Medeiros, 1965; 1967;

Madeira-Falcetta, 1974; Torres and Jebram, 1994; Torres, 1996) (Figure 5).

***Arcella vulgaris* f. *undulata* Deflandre, 1928**

Deflandre, 1928: 221, figs. 165-170; Chardez, 1967, pl. I, fig. 9; Vucetich, 1970: 43, figs. 1-2; 1973: 292, pl. I, fig. 7; Laminger, 1973, fig. 8m-n; Velho *et al.*, 1996: 39, pl. I, fig. 3.

Comments: *A. vulgaris undulata* has been registered only in plankton from the upper Paraná River floodplain, states of Mato Grosso do Sul and Paraná (Velho *et al.*, 1996; Lansac-Tôha *et al.,* 1997), and from Corumbá Reservoir and tributaries, state of Goiás (Lansac-Tôha *et al.*, 2000) (Figure 5).

***Arcella vulgaris* var. *penardi* Deflandre, 1928**

Deflandre, 1928: 224-225, figs. 180-186; Grospietsch, 1972: 10; Velho *et al.*, 1996: 39, pl. I, fig. 4.

Comments: In Brazil, it has been registered only in the upper Paraná River floodplain, state of Mato Grosso do Sul (Velho *et al.*, 1996; Lansac-Tôha *et al.*, 1997) and in the Corumbá reservoir, state of Goiás (Lansac-Tôha *et al.*, 2000) (Figure 5).

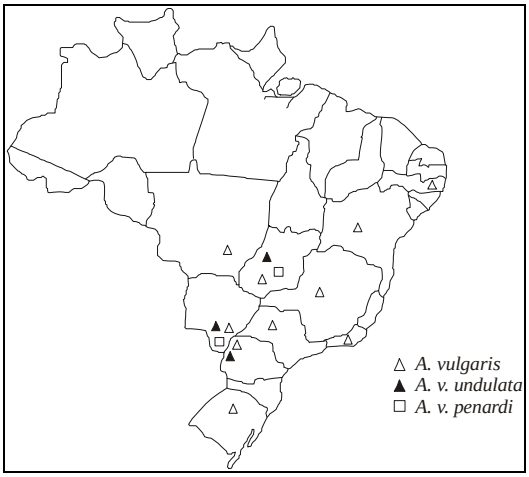

Figure 5. Geographic distribution of the species *Arcella vulgaris, A. v. undulata, A. v. penardi* in the Brazilian inland waters

***Pyxidicula cymbalum* Pénard, 1901**

Comments: This species has been registered in Brazil only in samples of aquatic macrophytes from the Pantanal, state of Mato Grosso (Hardoim and Heckman, 1996) (Figure 4).

***Pyxidicula operculata* (Agardh, 1827)**

Pénard, 1902: 413, figs. 1-3; Deflandre, 1953, fig. 89H-J; Kudo, 1975: 444, fig. 204a-b; Ogden, 1987: 158, figs. 1-9; Hardoim, 1997: 202, fig. 64.

Comments: Records of this species in Brazil were made only in the states of Rio de Janeiro, Minas Gerais (Cunha, 1913) and Mato Grosso (Hardoim and Heckman, 1996; Hardoim, 1997) (Figure 4).

Discussion

Species richness of testate amoebae it still not conclusive. Surveys conducted in order to study this group are still scarce. However, some information is avaliable for these organisms in different habitats (sediments, plankton, fauna associated with macrophytes) but these studies are limited to few regions.

There is an important study on this group in the litter of creeks in the Amazon region (Walker, 1982), but the author did not identify the organisms to species level. However he reported the number of morphotypes (119). This number indicates the great species richness of this group in that region.

Studies conducted in Northeastern Brazil are also scarce. Cunha (1913, 1916) studied the group in the states of Ceará and Piauí; Neumann-Leitão and Nogueira-Paranhos (1987) in the states of Bahia and Pernambuco, and Zucon and Loyola e Silva (1992) in the state of Sergipe.

Among the 26 infra-generic taxa of Arcellidae identified by now in Brazil, 21 taxa were registered in samples from plankton and aquatic macrophytes. This results shows contradiction in relation to species richness by habitats, because formary authors the plankton is a habitat that testate amoebae are less adapted to (Lena and Zaindewerg, 1974). But the sediment, considered by some authors as the preferential habitats for this group, is the habitat that presents the smaller at species richness of Arcellidae in Brazilian inland waters, at least considering the studies conducted up to now.

These results have to be considered with caution. First, because most of the studies on testate amoebae analyzed plankton samples, including reservoirs, temporary lagoons, channels, tributaries and large rivers as the Paraná river. Second, because most of the studies from sediments were conducted in estuaries or coastal lagoons, where salinity is a limitant factor to the occurrence of these organisms (Eichler-Coelho *et al*., 1997; Oliveira, 1999). However, another possible explanation for the greater richness in plankton samples may be the material that forms the test. In this family, the test is composed by ctenoid material, secreted by the organism, that is less dense, and together with the formation of gaseous vacuoles probably improve the hability for flotation, consequently allowing to

remain more time in the water column (Velho *et al*., 1999).

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