Available online at www.sciencedirect.com
SCIENCE DIRECT®
Veterinary Parasitology 137 (2006) 253–261
veterinary parasitology
www.elsevier.com/locate/vetpar

Henneguya garavelli n. sp. and *Myxobolus peculiaris* n. sp. (Myxozoa: Myxobolidae) in the gills of *Cyphocharax nagelli* (Osteichthyes: Curimatidae) from Rio do Peixe Reservoir, São José do Rio Pardo, São Paulo, Brazil

M.L. Martins [a,*], E.M. Onaka [b]

[a] *Aquaculture Department, Federal University of Santa Catarina-UFSC, Rod. SC 404, km 03, C.P. 476, 88040-900 Itacorubi, Florianópolis, SC, Brazil*
[b] *Aquaculture Center, Paulista State University-UNESP, Jaboticabal, SP, Brazil*

Received 8 June 2003; received in revised form 1 June 2005; accepted 5 December 2005

Abstract

The present work describes myxozoans found in *Cyphocharax nagelli* (Characiformes: Curimatinae) commonly called ''sagüiru'' collected from Rio do Peixe Reservoir, São José do Rio Pardo, São Paulo, Brazil. From a total of 38 examined fish, 24 were infected with *Henneguya garavelli* n. sp. (63% prevalence) and two with *Myxobolus peculiaris* n. sp. (5% prevalence) in the gills. Spores were studied by staining and fresh spores were observed by differential interference contrast optics. *Henneguya garavelli* n. sp. differs from *Henneguya iheringi*, *Henneguya occulta*, *Henneguya cesarpintoi*, *Henneguya santae*, *Henneguya pisciforme*, *Henneguya amazonica*, *Henneguya striolata*, *Henneguya leporinicola* and *Henneguya chydadea* in spore length and from *Henneguya travassosi*, *Henneguya adherens*, *Henneguya malabarica*, *Henneguya piaractus* and also *Henneguya chydadea* in polar capsule length and tail length. *Myxobolus peculiaris* n. sp. was very different when compared to other species of *Myxobolus* in its morphology and the biggest size of spore body. The authors present tables with comparative measurements of Brazilian myxozoan parasites.
© 2006 Elsevier B.V. All rights reserved.

Keywords: *Henneguya garavelli* n. sp.; *Myxobolus peculiaris* n. sp.; Brazilian fish; *Cyphocharax nagelli*; Species comparison

1. Introduction

In Brazil, Pinto (1928a,b) described *H. linearis* in the gills of *Rhamdia sebae* and *Pseudoplatystoma fasciatum*, *Henneguya occulta* in Callichthyidae fish, *H. wenyoni* in *Astyanax fasciatus* and *Henneguya iheringi* in *Serrasalmus spillopleura*. Guimarães and Bergamin (1934) observed *Henneguya santae* in *Tetragonopterus santae*. Azevedo and Matos (1989) have studied *Henneguya* infection in the gills of *Hoplosternum litorale* while Rocha et al. (1992)

* Corresponding author.
E-mail address: mlaterca@cca.ufsc.br (M.L. Martins).

0304-4017/$ – see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.vetpar.2005.12.023

observed *Henneguya amazonica* in *Crenicichla lepidota*. *Henneguya adherens* was present in *Acestrorhynchus falcatus* (see Azevedo and Matos, 1995) and *Henneguya malabarica* in *Hoplias malabaricus* (see Azevedo and Matos, 1996). Gioia and Cordeiro (1996) assembled Brazilian myxosporean in a checklist. Martins and Souza (1997) reported *Henneguya piaractus* in the gills of *Piaractus mesopotamicus* and reported severe mortality caused by *Henneguya* infections in the gills of *P. mesopotamicus* (Martins et al., 1997). The genus *Myxobolus* harbour a great number of described species, most of them in fishes from Eurasia and North America (Molnár and Békési, 1993). Until now, 20 species occurs in wild and cultured Brazilian fish. Thus, 18 species were reported in wild fish while *M. colossomatis* was observed in cultivated *P. mesopotamicus*, hybrid tambacu (*P. mesopotamicus* male × *Colossoma macropomum* female) and *Astyanax bimaculatus* (Martins et al., 1998, 1999b).

The present work describes new species of *Henneguya* Thélohan, 1892 and *Myxobolus* Bütschli, 1882 in native freshwater fish *Cyphocharax nagelli* from Rio do Peixe Reservoir in Brazil.

2. Material and methods

Thirty eight specimens were collected with net from the Rio do Peixe Reservoir in the City of São José do Rio Pardo, SP, Brazil in September 29, 2000 and transported to laboratory in ice. Four hours after capture the fish were examined. The gills were placed on Petri plates with 0.65% saline solution for microscopic observation. Gill fragments were compressed between a slide and a cover slip for smear preparation. The smear was air-dried at room temperature, fixed by immersion in undiluted methylic alcohol and stained by 1:9 Giemsa solution for 10 min. Myxozoan identification was performed according to Lom and Noble (1984), Lom and Arthur (1989) and Martins et al. (1999a). For the visualization of the iodophilic vacuole, the spores were fixed in a 10% buffered formalin solution and stained by Lugol's solution. A total of 20 cysts, 70 spores of *Henneguya* and 30 spores of *Myxobolus* were measured (μm) and drawn with a camera lucida and a light microscope. Forty spores of *Henneguya* and 20 spores of *Myxobolus* were measured in fresh conditions. For measurement and description, fresh spores were mounted in glycerine gelatine for observation by differential interference contrast optics with an Olympus BX 60 microscope. Prevalence was calculated according to Bush et al. (1997).

3. Results

3.1. Henneguya garavelli n. sp.

Cyst: the cysts presented dark colour with circular to ellipsoidal shape of 60.9 ± 13.7 (42.8–63.2) length and 34.7 ± 7.3 (24.5–42.8) width (Figs. 1–3).

Spore characteristics: the parasitological examination showed, from a frontal view, elongated spindle-shape spores, provided with long bifurcated tail when observed in fresh conditions. Two polar capsules situated on the anterior extremity with insignificant difference in size, each of them contained an anterior polar filament. The sporoplasm and an iodophilic vacuole in the interior of the spore stained by Lugol were observed. The spore

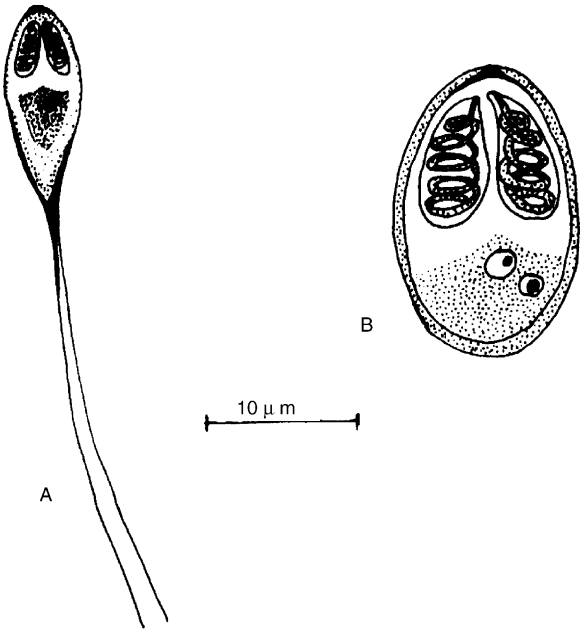

Fig. 1. Line drawing in frontal view of *Henneguya garavelli* n. sp. (A) and *Myxobolus peculiaris* n. sp. (B) from the gills of *Cyphocharax nagelli* collected in Rio do Peixe Reservoir, São Paulo, Brazil.

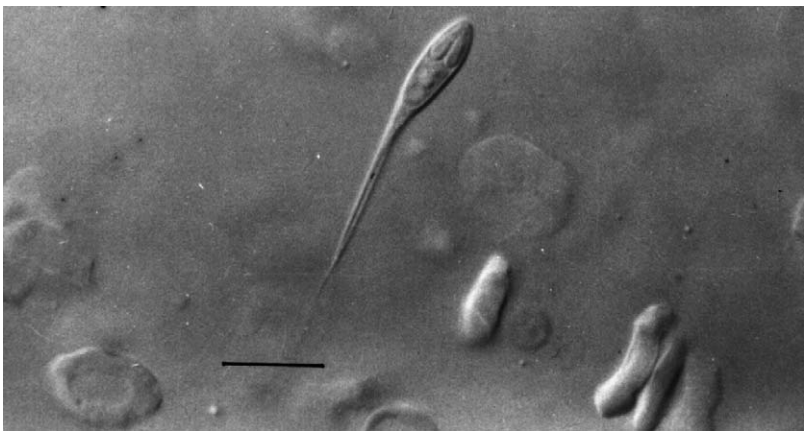

Fig. 2. A mature spore of *Henneguya garavelli* n. sp. observed by differential interference contrast optics. Note bifurcated tail. Fresh mount (bar = 10 μm).

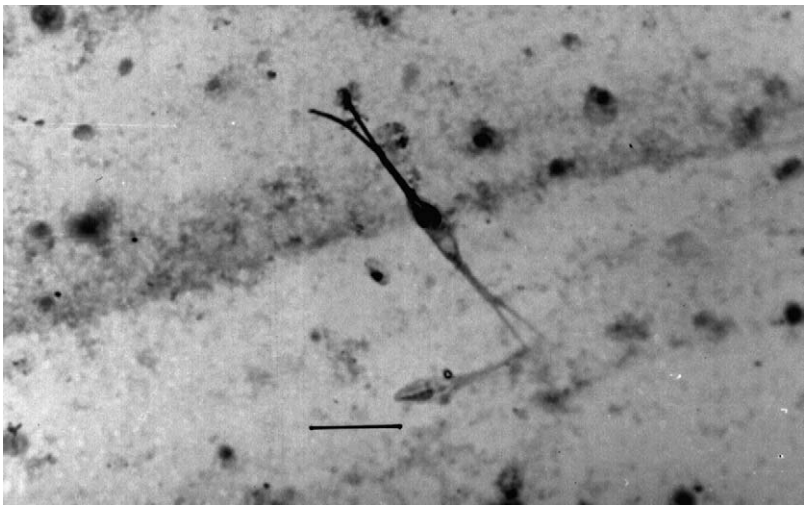

Fig. 3. Spore of *Henneguya garavelli* n. sp. showing extruded polar filament. Stained by Giemsa (bar = 10 μm).

characteristics were: total length with tail 28.9 ± 2.5 (24.8–31.6); body spore length 11.5 ± 1.4 (8.8–13.6); body spore width 5.0 ± 1.2 (4.0–7.2); polar capsule length 4.3 ± 0.3 (3.6–4.8); polar capsule width 1.5 ± 0.2 (1.2–1.7); number of coils of polar filament 8–9; distance of anterior extremity of the spore to the polar capsule 0.8 ± 0.2 (0.5–1.6); tail length 17.4 ± 2.4 (12.8–20.8). Polar filament length 29.5 ± 3.7 (24.0–32.8).

Fresh spore characteristics: total length with tail 46.6 ± 2.4 (41.2–51.5); body spore length 13.6 ± 1.0 (12.0–14.4); body spore width 4.0 ± 0.1 (3.9–4.1); polar capsule length 5.4 ± 0.4 (4.8–6.0); polar capsule width 1.2 ± 0.1 (1.0–1.5); tail length 33.0 ± 2.6 (29.2–37.5); in a sutural view the spores are flattened with 3.2 ± 0.5 (2.4–4.0) thickness.

The name *H. garavelli* n. sp. is proposed to homage Dr. Julio Cesar Garavello (Federal University of São Carlos, SP, Brazil). The comparison of fresh and fixed spores with those Brazilian species described on fish is shown in Table 1.

Type host: *Cyphocharax nagelli* Steindachner, 1881
Site of infection: gill filaments (prevalence 63%)
Locality: Rio do Peixe Reservoir, São Paulo, Brazil
Specimens deposited: FIOCRUZ-Av. Brasil 4365, 21045-900, Rio de Janeiro, Brazil. CHIOC no. 34986, fixed gills 34818

Table 1
Comparative measurements of species of *Henneguya* described in fish, in Brazil

Species	Total *L*	Spore *L*	Spore *W*	P.C.L.	P.C.W.	I.V.	Tail *L*	Host	Locality	Author
H. iheringi	–	22.0	6.0	3.4	2.0	Yes	–	*Serrasalmo spilopleura*	São Paulo	Pinto (1928a)
H. occulta	38.0	18.0	9.0	8.0	–	–	20.0	*Loricaria* sp.	Rio de Janeiro	Pinto (1928b)
H. wenyoni	21.0	10.2	5.2	3.7	1.5	Yes	10.8	*Astyanax fasciatus*	São Paulo	Pinto (1928b)
H. cesarpintoi	–	13.5	4.2	2.6	0.8	No	–	*Astyanax fasciatus*	São Paulo	Guimarães (1931)
H. travassosi	27.3 ± 0.7	10.6 ± 0.2	4.3 ± 0.3	3.6 ± 0.3	–	No	16.7 ± 0.8	*Astyanax fasciatus* and *Leporinus copelandi*	São Paulo	Guimarães and Bergamin (1933)
H. santae	21.0 ± 1.1	9.6 ± 0.5	5.3 ± 0.4	3.0 ± 0.3	–	Yes	11.8 ± 1.1	*Tetragonopterus santae*	São Paulo	Guimarães and Bergamin (1934)
H. psorospermica	–	–	–	–	–	–	–	*Carp, lambari* and *tilapia*	Paraná	Schönhofen et al. (1983)
H. pisciforme	31.0 ± 1.4	20.4 ± 1.5	6.1 ± 0.5	4.3 ± 0.6	1.7 ± 0.4	Yes	10.6 ± 1.3	*Hypressobrycon anisitsi*	São Paulo	Cordeiro et al. (1983/1984)
H. theca	40.6–52.6	20.3–28.4	3.0–4.1	9.8–12.5	1.0–1.5	Yes	20.3–24.2	*Eigemannia virescens*	Brazil	Kent and Hoffman (1984)
H. intracornea	66.7 ± 2.2	42.4 ± 2.3	6.6 ± 0.7	8.6 ± 0.6	2.4 ± 0.3	Yes	24.3 ± 2.1	*Astyanaz scabripinnis*	São Paulo	Gioia et al. (1986)
Henneguya sp.	–	–	–	–	–	–	–	*Mugil liza* and *M. curema*	São Paulo	Godinho et al. (1988)
Henneguya sp.	58.7[a]	13.5	5.3	–	–	–	45.2	*Hoplosternum littorale*	Amazonas	Azevedo and Matos (1989)
Henneguya sp.	49.9	14.2	5.0	5.8	1.8	–	35.7	*Pimelodus maculatus*	São Paulo	Cordeiro et al. (1989)
H. amazonica	59.3 ± 3.0[a]	13.9 ± 1.0	5.7 ± 0.4	3.3 ± 0.1	1.5 ± 0.2	No	45.4 ± 3.3	*Crenicichla lepidota*	Amazonas	Rocha et al. (1992)
H. adherens	30.7–35.1[a]	10.5–13.8	5.1–6.5	2.8–3.5	1.0–1.6	–	18.0–21.7	*Acestrorhynchus falcatus*	Pará	Azevedo and Matos (1995)
H. malabarica	26.6–29.8	11.8–13.1	4.8x3.6	3.0–4.3	1.6–2.2	Yes	16.2–18.9	*Hoplias malabaricus*	Amazonas	Azevedo and Matos (1996)
H. testicularis	27.0–28.5	14.0–14.5	6.0–6.5	8.5–9.5	2.0–2.5	–	13.0–14.5	*Moenkhausia oligolepis*	Pará	Azevedo et al. (1997)
H. piaractus	47.6–56.3	11.8–13.6	3.2–3.9	6.3–7.1	0.9–1.6	Yes	39.7–43.6	*Piaractus mesopotamicus*	São Paulo	Martins and Souza (1997)
H. striolata	39.3–45.6[a]	14.4–17.0	4.9–5.9	5.1–7.0	1.1–1.3	No	23.6–29.8	*Serrasalmus striolatus*	Amazonas	Casal et al. (1997)
H. leporinicola	18.4–40.9	5.5–8.7	3.6–4.9	2.0–3.5	1.2–2.0	Yes	12.9–32.2	*Leporinus macrocephalus*	São Paulo	Martins et al. (1999a)
H. curimata	34.2–36.1	16.0–17.4	5.8–6.6	6.3 ± 0.3	1.2 ± 0.2	–	18.3–19.9	*Curimata inormata*	Pará	Azavedo and Matos (2002)
H. astyanax	47.8 ± 0.7	15.2 ± 0.8	5.7 ± 0.7	5.0 ± 0.1	1.5 ± 0.1	–	32.6 ± 1.1	*Astyanax keithi*	Pará	Vita et al. (2003)
H. chydadea	17.6–20.0	8.8–11.2	3.2–5.6	3.2–4.4	1.2–1.6	No	8.0–9.6	*Astyanax altiparanae*	São Paulo	Barassa et al. (2003)
H. curvata	41.7 ± 2.7	16.4 ± 0.8	4.7 ± 0.2	7.8 ± 0.3	1.4 ± 0.2	Yes	25.3 ± 2.3	*Serrasalmus spilopleura*	São Paulo	Barassa et al. (2003)
H. friderici	28.7–39.3	9.6–11.8	4.8–6.6	4.2–5.9	1.6–2.6	–	19.1–28.7	*Leporinus friderici*	Pará	Casal et al. (2003)
H. garavelli	46.6 ± 2.4[a]	13.6 ± 1.0[a]	4.0 ± 0.1[a]	5.4 ± 0.4[a]	1.2 ± 0.1[a]	Yes	33.0 ± 2.6[a]	*Cyphocharax nagelli*	São Paulo	Present work

L, length; *W*, width; P.C., polar capsule; I.V., presence or not of iodophilic vacuole.
[a] Measurements of fresh spores.

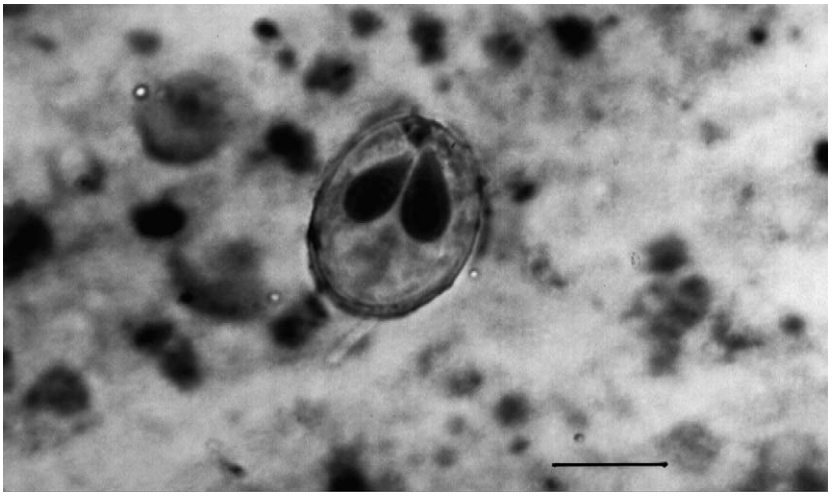

Fig. 4. Spore of *Myxobolus peculiaris* n. sp. from the gills of *Cyphocharax nagelli* collected in Rio do Peixe Reservoir, São Paulo, Brazil. Stained by Giemsa (bar = 10 μm).

3.2. *Myxobolus peculiaris n. sp.*

The gill smears revealed a few number of myxozoan parasites of the genus *Myxobolus* Bütschli, 1882. The sporoplasm and an iodophilic vacuole were found in the interior of the spore stained by Lugol. The spore characteristics were: spore length 23.1 ± 0.1 (23.0–23.2); spore width 14.8 ± 0.4 (14.4–15.2); the two polar capsules are of equal size with 10.7 ± 0.1 (10.5–10.9) length and 4.4 ± 0.4 (4.0–4.8) width; the distance of anterior extremity of the spore to the polar capsule is 1.6 ± 0.0 (1.6). The polar filament was easily visible with the microscopic examination showing four to five coils in the polar capsule (Figs. 1 and 4).

Fresh spore characteristics: spore length 25.2 ± 0.15 (25.0–25.3) and spore width 15.4 ± 0.36 (15.0–15.5).

The name *M. peculiaris* n. sp. is proposed from the size of body spores compared to other descriptions. The comparison of fresh and fixed spores with those species already described on fish gills, in Brazil, is shown in Table 2.

Type host: *Cyphocharax nagelli* Steindachner, 1881
Site of infection: gill filaments (prevalence 5%)
Locality: Rio do Peixe Reservoir, São Paulo, Brazil
Specimens deposited: FIOCRUZ,
CHIOC no. 34987, fixed gills 34834

4. Discussion

Little information is found about myxozoan prevalence in fish collected from the nature or aquaculture in Brazil. Some data revealed prevalences of 20% *Henneguya pisciforme* in *Hyphessobrycon anisitsi* (Cordeiro et al., 1983/1984); 11.5% *Henneguya intracornea* in *Astyanax scabripinis* (Gioia et al., 1986); 55.5% *H. adherens* in *A. falcatus* (Azevedo and Matos, 1995); 6.7% *H. malabarica* in *Hoplias malabaricus* (Azevedo and Matos, 1996); 5.6–97.3% *H. piaractus* in cultivated *P. mesopotamicus*, *Colossoma macropomum* and the hybrid tambacu (*P. mesopotamicus* male × *C. macropomum* female (Martins et al., 1999b); 28% *H. testicularis* in *Moenkhausia oligolepis* (Azevedo et al., 1997); 2.5–8.3% *M. absonus* and *M. porofilus* in *Pimelodus maculatus* and *Prochilodus lineatus* (Cellere et al., 2002; Adriano et al., 2002) and 88.3% *H. chydadea* in *Astyanax altiparanae* (Barassa et al., 2003). Studies with parasite fauna of bream (*Abramis brama*) a common fish of Central Europe (Lake Balaton and Kis-Balaton Reservoir) showed 38.0% of prevalence of *M. bramae* in the gills (Molnár and Székely, 1999). Later, Molnár (2000) reported prevalences of 11.5% of *M. margitae*, 14.0% of *M. alburni* and 15.5% of *M. obesus* in the gills and fin of bleak (*Alburnus alburnus*) fish collected from the River Danube and Lake

Table 2
Comparative measurements of species of *Myxobolus* described in fish, in Brazil

Species	Spore *L*	Spore *W*	P.C.L.	P.C.W.	Host	Locality	Author
M. noguchii	13.6	8.5	6.8	2.2	*Serrasalmo spilopleura*	São Paulo	Pinto (1928a)
M. stokesi	8.5	5.3	3.4	1.7	*Pimelodella* sp.	São Paulo	Pinto (1928a)
M. inaequalis	5.2	3.3	–	–	*Piramutaba blochi* and *Synodontis schall*	South America	Pinto (1928b)
M. lutzi	10.0	7.0	–	–	*Poecilia vivipara*	Rio de Janeiro	Pinto (1928b)
M. chondrophilus	6.0	4.5	3.0	–	*Sardinella anchovina*	Rio de Janeiro	Pinto (1928b)
M. associates	15.0	10.0	7.0	–	*Leporinus mormyrops*	Minas Gerais	Pinto (1928b)
M. cunhai	9.0–11.0	4.0–6.0	–	–	*Pygocentris piraya* and *Pimelodus clarias*	Mato Grosso	Pinto (1928b)
M. pygocentris	15.0–16.0	9.0–11.0	9.0–11.0	3.0–4.0	*Pygocentris piraya*	Mato Grosso	Pinto (1928b)
M. kudoi	8.5–8.9	6.5–7.3	3.5–4.2	1.3–2.0	*Nematognatha* sp.	São Paulo	Guimaraes and Bergamin (1938) cited by Walliker (1969)
M. serrasalmi[a]	12.5–18.0	7.0–10.0	6.0–9.0	2.5–4	*Serrasalmus rhombeus*	Amazonas	Walliker (1969)
M. serrasalmi[b]	7.0–9.5	3.5–5.0	5.0–7.5	1.0–2.0	*Serrasalmus rhombeus*	Amazonas	Walliker (1969)
Myxobolus sp.	9.0–11.0	5.0–6.5	5.0–6.0	1.5–2.0	*Serrasalmus* sp.	Amazonas	Walliker (1969)
Myxobolus sp.	8.0–10.0	4.0–7.0	3.5–5.0	1.0–2.5	*Colossoma bidens*	Amazonas	Walliker (1969)
M. inaequus	15.6–22.0	7.8–9.3	9.4–13.0 3.9–5.5	3.1–3.9	*Eigemannia virescens*	Brazil	Kent and Hoffman (1984)
Myxobolus sp.	8.2	5.6	3.8	1.9	*Pimelodus maculatus*	São Paulo	Cordeiro et al. (1989)
M. colossomatis	11.4–12.2	6.6–7.2	5.8–6.6	1.8–2.5	*Colossoma macropomum*	Ceará	Molnár and Békési (1993)
M. braziliensis	10.2 ± 0.5	5.3 ± 0.3	5.3 ± 0.2	1.4 ± 0	*Bunocephalus coracoideus*	Pará	Casal et al. (1996)
M. macroplasmodialis	10.5–12.0	8.0–9.0	4.0–5.0	2.0–3.0	*Salminus maxillosus*	São Paulo	Molnár et al. (1998)
M. colossomatis	12.7–13.6	5.5–6.2	6.6–7.3	1.4–1.7	*Hybrid tambacu*	São Paulo	Martins et al. (1998)
M. colossomatis	12.7–13.5	5.8–6.2	6.4–7.2	1.2–1.7	*Astyanax bimaculatus*	São Paulo	Martins et al. (1998)
M. absonus	15.7 ± 1.5	10.2 ± 0.7	6.4 ± 0.7 4.2 ± 0.6	3.6 ± 0.5 2.5 ± 0.5	*Pimelodus maculatus*	São Paulo	Cellere et al. (2002)
M. porofilus	5.7 ± 0.3	4.8 ± 0.2	1.6 ± 0.1	1.1 ± 0.1	*Prochilodus lineatus*	São Paulo	Adriano et al. (2002)
M. maculatus	19.7–23.0	7.9–9.5	11.8–13.8	3.0–3.6	*Metynnis maculatus*	Pará	Casal et al. (2002)
M. peculiaris	25.2 ± 0.1[c]	15.4 ± 0.4[c]	10.7 ± 0.1	4.4 ± 0.4	*Cyphocharax nagelli*	São Paulo	Present work

L, length; W, width; P.C., polar capsule.
[a] Macrospores.
[b] Microspores.
[c] Measurements of fresh spores.

Balaton, Hungary. The prevalence observed in this work (63%) was higher than the majority observed in natural environment as stated above.

Comparing to the present species, considerable difference was observed in the spore length of *H. iheringi* (Pinto, 1928a), *H. occulta* (Pinto, 1928b), *H. cesarpintoi* (Guimarães, 1931), *H. santae* (Guimarães and Bergamin, 1934), *H. pisciforme* (Cordeiro et al., 1983/1984), *Henneguya* sp. (Azevedo and Matos, 1989; Cordeiro et al., 1989), *H. amazonica* (Rocha et al., 1992), *H. striolata* (Casal et al., 1997) and *H. leporinicola* (Martins et al., 1999a) (Table 1) and total length, polar capsule length and tail of *Henneguya chydadea* (Barassa et al., 2003). Similar measurements were found when compared to *H. travassosi* (Guimarães and Bergamin, 1933), *H. adherens*, *H. malabarica* and *H. piaractus* (Azevedo and Matos, 1995, 1996; Martins and Souza, 1997) but differ in the polar capsule length and tail length. Moreover, the cyst appearance was also different when compared to the others described species. Finally, the present description differs from others in the World such as *H. postexilis* (Minchew, 1977), *H. exilis* (Minchew, 1977), *H. shaharini* (Shariff, 1982), *H. mystusia* (Sarkar, 1985), *H. bopeleti* (Fomena and Bouix, 1987), *H. waltairensis* (Narasinhamurti and Kalavati, 1975) and *H. sebasta* (Moser and Love, 1975) in total length, spore length, polar capsule length and tail length. Once more, difference in measurements among length of the body spores, total length of the spore and length of the polar capsule were related by Pavanelli et al. (1998) fish from the Paraná River.

It can also be observed that *M. peculiaris* n. sp. differ in all measurements of species described from the other countries and localities (Table 2). *Myxobolus basilamellaris* (Lom and Molnár, 1983), *Myxobolus inaequus* (Kent and Hoffman, 1984) and *Myxobolus nuevoleonensis* (Segovia-Salinas et al., 1995) were different in size and morphology of the polar capsule when compared to *M. peculiaris*. In spite of similar shape of *M. cultus* described by Yokoyama et al. (1995); *Myxobolus macroplasmodialis* by Molnár et al. (1998), *Myxobolus magellanicus* by Flores and Viozzi (2001), *Myxobolus porofilus* (Adriano et al., 2002) spore length, spore width, polar capsule length and polar capsule width were smaller than the present description. Our specimens also differ from *Myxobolus maculatus* described by Casal et al. (2002) and *Myxobolus absonus* described by Cellere et al. (2002) in spore shape, higher length and width and by having equal polar capsules. Comments on the size of the body spores of *M. peculiaris* n. sp. are needed. Until then we have not observed spores of *Myxobolus* with this size, characteristics confirmed by differential interference contrast optics. This fact is important because of the considerable difference in size of *M. peculiaris* n. sp. when compared to the other described species.

Acknowledgements

We are grateful to Gastão Reis and Heloisa P. Laterça for the correction of the manuscript translation.

References

Adriano, E.A., Arana, S., Ceccarelli, P.S., Cordeiro, N.S., 2002. Light and scanning electron microscopy of *Myxobolus porofilus* sp. n (Myxosporea: Myxobolidae) infecting the visceral cavity of *Prochilodus lineatus* (Pisces: Characiformes: Prochilodontidae) cultivated in Brazil. Folia Parasitol. 49, 259–262.

Azevedo, C., Matos, E., 1989. Some ultrastructural data on the spore development in a *Henneguya* sp. parasite of the gill of a Brazilian fish. Parasitol. Res. 76, 131–134.

Azevedo, C., Matos, E., 1995. *Henneguya adherens* n. sp. (Myxozoa, Myxosporea), parasite of the Amazonian fish, *Acestrorhynchus falcatus*. J. Euk. Microbiol. 42, 515–518.

Azevedo, C., Matos, E., 1996. *Henneguya malabarica* sp. n. (Myxozoa, Myxobolidae) in the Amazonian fish *Hoplias malabaricus*. Parasitol. Res. 82, 222–224.

Azavedo, C., Matos, E., 2002. Fine structure of the Myxosporean, *Henneguya curimata* n. sp., parasite of the Amazonian fish, *Curimata inormata* (Teleostei, Curimatidae) J. Eukariot. Microbiol. 49 (3), 197–200.

Azevedo, C., Corral, L., Matos, E., 1997. Light and ultrastructural data on *Henneguya testicularis* n. sp. (Myxozoa, Myxobolidae), a parasite from the testis of the Amazonian fish *Moenkhausia oligolepis*. Syst. Parasitol. 37, 111–114.

Barassa, B., Cordeiro, N.S., Arana, S., 2003. A new species of *Henneguya*, a gill parasite of *Astyanax altiparanae* (Pisces: Characidae) from Brazil, with comments on histopathology and seasonality. Mem. Inst. Oswaldo Cruz 98 (6), 761–765.

Bush, A.O., Lafferty, K.D., Lotz, J.M., Shostak, W., 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. J. Parasitol. 83 (4), 575–583.

Casal, G., Matos, E., Azevedo, C., 1996. Ultrastructural data on the life cycle stages of *Myxobolus braziliensis* n. sp., parasite of an Amazonian fish. Eur. J. Protistol. 32, 123–127.

Casal, G., Matos, E., Azevedo, C., 1997. Some ultrastructural aspects of *Henneguya striolata* sp. n. (Myxozoa, Myxosporea), a parasite of the Amazonian fish *Serrasalmus striolatus*. Parasitol. Res. 83, 93–95.

Casal, G., Matos, E., Azevedo, C., 2002. Ultrastructural data on the spore of *Myxobolus maculatus* n. sp. (Phylu Myxozoa), parasite from the Amazonian fish *Metynnis maculatus* (Teleostei) Dis. Aquat. Org. 51, 107–112.

Casal, G., Matos, E., Azevedo, C., 2003. Light and electron microscopic study of the *myxosporean*, *Henneguya friderici* n. sp. from the Amazonian teleostean fish, Leporinus friderici. Parasitology 126, 313–319.

Cellere, E.F., Cordeiro, N.S., Adriano, E.A., 2002. *Myxobolus absonus* sp. n. (Myxozoa: Myxosporea) parasitizing *Pimelodus maculatus* (Siluriformes: Pimelodidae), a South American freshwater fish. Mem. Inst. Oswaldo Cruz 97 (1), 79–80.

Cordeiro, N.S., Artigas, P.T., Gióia, I., Lima, R.S., 1983/1984. *Henneguya pisciforme* n. sp., mixosporídeo parasito de brânquias do lambari *Hyphessobrycon anisitsi* (Pisces, Characidae) Mem. Inst. Butantan 47–48, 61–69.

Cordeiro, N.S., Gióia, I., Cellere, E.F., 1989. Myxosporen parasites of *Pimelodus maculatus* Lacépède, 1803. Mem. Inst. Oswaldo Cruz 84 (2), 170.

Flores, V., Viozzi, G., 2001. Redescription, seasonality and distribution of *Myxobolus magellanicus* (Myxosporea) in *Galaxias maculatus* (Osmeriformes, Galaxiidae) from Patagonian Andean lakes (Argentina). Acta Parasitol. 46 (3), 159–163.

Fomena, A., Bouix, G., 1987. Contribution à ĺétude dês Myxosporidies dês poissons d́eau douce du Cameroun. III-Espéces nouvelles dês genres *Henneguya Thélohan*, 1892 et *Thelohanellus* Kudo, 1933. Revue Zool. Afr. 101, 43–53.

Gioia, I., Cordeiro, N.S., 1996. Brazilian myxosporidians' check-list (Myxozoa). Acta Protozool. 35, 137–149.

Gioia, I., Cordeiro, N.S., Artigas, P.T., 1986. *Henneguya intracornea* n. sp. (Myxozoa: Myxosporea) parasita do olho do lambari, *Astyanax scabripinis* (Jenyns, 1842) (Osteichthyes, Characidae) Mem. Inst. Oswaldo Cruz 81, 401–407.

Godinho, H.M., Serralheiro, P.C.S., Scorvo, F.J.D., 1988. Revisão e discussão de trabalhos sobre as espécies do gênero *Mugil* (Teleostei, Perciformes, Mugilidae) da costa brasileira (Lat. 3S-33S) Bol. Inst. Pesca 15, 67–80.

Guimarães, J.R.A., 1931. Myxosporideos da ictiofauna brasileira. Thesis. Faculty of Medicine, São Paulo, Brazil, pp. 1–50.

Guimarães, J.R.A., Bergamin, F., 1933. Considerações sobre as ictioepizootias produzidas pelos mixosporídeos do gênero *Henneguya* Thélohan, 1892. Rev. Ind. Anim. 10, 1151–1156.

Guimarães, J.R.A., Bergamin, F., 1934. *Henneguya santae* sp. n., um novo mixosporídeo parasito de *Tetragonopterus* sp. Rev. Ind. Anim. 12, 110–113.

Kent, M.L., Hoffman, G.L., 1984. Two new species of Myxozoa, *Myxobolus inaequus* sp. n. and *Henneguya theca* sp. n. from the brain of a South American knife fish, *Eigemannia virescens* (V.) J. Protozool. 31 (1), 91–94.

Lom, J., Molnár, K., 1983. *Myxobolus basilamellaris* sp. n. (Myxozoa: Myxosporea), a parasite of the gills of common carp (*Cyprinus carpio* L.) Folia Parasitol. 30, 1–3.

Lom, J., Noble, E.R., 1984. Revised classification of the class Myxosporea Bütschli, 1881. Folia Parasitol. 31, 193–205.

Lom, J., Arthur, J.R., 1989. A guideline for the preparation of species descriptions in Myxosporea. J. Fish. Dis. 12, 151–156.

Martins, M.L., Souza, V.N., 1997. *Henneguya piaractus* n. sp. (Myxozoa: Myxobolidae), a gill parasite of *Piaractus mesopotamicus* Holmberg, 1887 (Osteichthyes: Characidae), in Brazil. Rev. Brasil. Biol. 57, 239–245.

Martins, M.L., Souza, V.N., Moraes, F.R., Moraes, J.R.E., Costa, A.J., 1997. Pathology and behavioral effects associated with *Henneguya* sp. (Myxozoa: Myxobolidae) infections of captive pacu *Piaractus mesopotamicus* in Brazil. J. World Aquacult. Soc. 28, 297–300.

Martins, M.L., Souza, V.N., Moraes, F.R., 1998. Infecção por *Myxobolus colossomatis* (Myxozoa: Myxobolidae) em alevinos de ''tambacus'' oriundos de piscicultura commercial. ''Lambaris'' como possível fonte de infecção. Ars Vet. 14 (3), 324–330.

Martins, M.L., Souza, V.N., Moraes, J.R.E., Moraes, F.R., 1999a. Gill infection of *Leporinus macrocephalus* Garavello & Britski, 1998 (Osteichthyes: Anostomidae) by *Henneguya leporinicola* n. sp. (Myxozoa: Myxobolidae). Description, Histopathology and Treatment. Rev. Bras. Biol. 59 (3), 527–534.

Martins, M.L., Souza, V.N., Moraes, J.R.E., Moraes, F.R., Costa, A.J., 1999b. Comparative evaluation of the susceptibility of cultivated fishes to the natural infection with Myxosporean parasites and tissue changes in the host. Rev. Bras. Biol. 59 (2), 263–269.

Minchew, C.D., 1977. Five new species of *Henneguya* (Protozoa: Myxoxporea) from ictalurid fishes. J. Protozool. 24 (2), 213–220.

Molnár, K., 2000. Survey on *Myxobolus* infection of the bleak (*Alburnus alburnus* L.) in the river Danube and in Lake Balaton. Acta Vet. Hung. 48 (4), 421–432.

Molnár, K., Békési, L., 1993. Description of a new *myxobolus* specie, M. colossomatis n. sp. from the teleost Colossoma macropomum of the Amazon River Basin. J. Appl. Ichthyol. 9, 57–63.

Molnár, K., Székely, C., 1999. *Myxobolus* infection of the gills of common bream (*Abramis brama* L.) in Lake Balaton and in the Kis-Balaton Reservoir, Hungary. Acta Vet. Hung. 47 (4), 419–432.

Molnár, K., Ranzani-Paiva, M.J., Eiras, J.C., Rodrigues, E.L., 1998. *Myxobolus macroplasmodialis* sp. n. (Myxozoa: Myxosporea), a parasite of the abdominal cavity of the characid teleost, *Salminus maxillosus*, in Brazil. Acta Protozool. 37, 241–245.

Moser, M., Love, M.S., 1975. *Henneguya sebasta* sp. n. (Protozoa, Myxosporida) from California rock fish, *Sebastes* spp. J. Parasitol. 61 (3), 481–483.

Narasinhamurti, C.C., Kalavati, C., 1975. A new myxoxporidian parasite, *Henneguya waltairensis* n. sp. from the gills of *Ophiocephalus punctatus* Bl. Riv. Parassitol. 36 (4), 255–259.

Pavanelli, G.C., Eiras, J.C., Saraiva, A., 1998. *Henneguya* spp. (Myxozoa, Myxosporea, Myxobolidae) parasitizing fishes from Paraná river, Brazil. Acta Sci. 20 (2), 161–163.

Pinto, C., 1928a. *Myxobolus noguchii*, M. stokesi e *Henneguya iheringi*, espécies novas de mixosporídeos de peixes de água doce do Brasil. Bol. Biol. 12, 41–44.

Pinto, C., 1928b. Mixosporídeos e outros protozoários intestinais de peixes observados na América do Sul. Arch. Inst. Biol. 1, 101–126.

Rocha, E., Matos, E., Azevedo, C., 1992. *Henneguya amazonica* n. sp. (Myxozoa, Myxobolidae), parasitizing the gills of *Crenicichla lepidota* Heckel, 1840 (Teleostei, Cichlidae) from Amazon River. Eur. J. Protistol. 28, 273–278.

Sarkar, N.K., 1985. Myxosporidian *Henneguya mystusia* sp. n. (Myxozoa: Myxosporea) from the gill of a freshwater teleost fish *Mystus* sp. Acta Protozool. 24 (1), 55–58.

Schönhofen, C.A., Garcia, R.G.F., Garcia, M.M.P.F., 1983. Ocorrência de *Henneguya psorospermica* em peixes no Paraná. Acta Biol. Par. 12, 141–144.

Segovia-Salinas, F., Jimenez-Guzman, F., Ramirez-Bon, E., 1995. Redescription and ultrastructure of *Myxobolus nuevoleonensis* (Myxoxporea: Bivalvulea), a parasite of the shortfin molly and guppy. J. Aquat. Anim. Health 7, 70–74.

Shariff, M., 1982. *Henneguya shaharini* sp. nov. (Protozoa: Myxozoa) a parasite of marble goby *Oxyeleotris marmoratus* (Bleeker) J. Fish Biol. 5, 37–45.

Vita, P., Corral, L., Matos, E., Azevedo, C., 2003. Ultrastructural aspects of the myxosporean *Henneguya astyanax* n. sp. (Myxozoa: Myxobolidae), a parasite of the Amazonian teleost *Astyanax keithi* (Characidae) Dis. Aquat. Org. 53, 55–60.

Walliker, D., 1969. Myxosporidea of some Brazilian freshwater fishes. J. Parasitol. 55 (5), 942–948.

Yokoyama, H., Ogawa, K., Wakabayashi, H., 1995. *Myxobolus cultus* n. sp. (Myxosporea: Myxobolidae) in the goldfish *Carassius auratus* transformed from the actinosporean stage in the oligochaete *Branchiura sowerbyi*. J. Parasitol. 81 (3), 446–451.