Description of new myxozoan parasite *Myxobolus awadhii* sp. nov from the gills of freshwater catfish *Clarias batrachus* Linn.

Naireen Fariya¹ · Rehana Abidi¹ · U. K. Chauhan²

Received: 24 February 2018 / Accepted: 3 October 2018 / Published online: 19 October 2018
© Indian Society for Parasitology 2018

Abstract Parasitic infestations are one of the major problems in freshwater fish production. *Clarias batrachus* Linnaeus, 1758 (Clariidae) is a commercially important native catfish mainly used for food as it has very high iron content and other minerals. Unfortunately, it is difficult to breed in captivity and is highly prone to parasitic infections particularly the *Myxobolus* sp. The present article discusses a new species of *Myxobolus* identified as *Myxobolus awadhii* from the gills of *C. batrachus*. Plasmodia were found on the gill filaments with the intensity of infection to be moderate as indicated by gill plasmodial index (GPI = 6). The mature myxospores were oval to ellipsoidal in shape measuring 8.82–11.68 (10.57 ± 0.50) $\times$ 5.76–7.37 (6.70 ± 0.36) μm in size. The present species was compared with species found from the same host and other resembling species as *M. acanthorhodi*, *M. bhadurius*, *M. bilineatum*, *M. chrysichthyi*. Present article deals with morphological and morphometric description of *M. awadhii* sp. nov. Morphological comparisons of the mature myxospores were done with the similar myxospores and species reported earlier from *C. batrachus*.

Keywords Catfish · *Clarias batrachus* · Gills · *Myxobolus awadhii* · Myxozoan

Introduction

India is enriched with fish biodiversity with 9th position regarding freshwater aquaculture in which approximately 672 fishes occupies freshwater habitats in Indian waters (Srivastava and Singha 2015). The air-breathing catfish *Clarias batrachus*, belongs to the family Claridae and is a commercially important native fish widely used for food but some variegated and albino varieties are reared for ornamental purposes also (Abidi et al. 2015). It is raised in mass culture with preferential habitat in derelict, shallow and swampy water which produces highly stressful environment for fish (Kumari and Sahoo 2006). The fish exposed in traumatic environment prone to many kinds of diseases (Abidi 1999, 2000). *Clarias batrachus* has higher risk to parasitic infestations particularly myxozoans (Abidi et al. 2015).

Feist (2008) reported that genus *Myxobolus* are the fatal parasite causing high mortalities and economic losses to the valuable edible farmed fishes. Myxozoans parasites infect almost all organs of the fish with cosmopolitan distribution (Seenappa and Manohar 1980). Eiras et al. (2005) listed approximately 744 species of *Myxobolus* followed by 112 species in the year of 2014, from all over the world (Eiras et al. 2014). Several workers have reported different species of *Myxobolus* from *Clarias batrachus* in India (Abidi et al. 2015; Abidi 2000; Kaur 2014; Kaur and Singh 2012; Kalavati and Nandi 2007; Narasimhamurti and Kaavati 1986; Chakravarty 1943; Hemananda et al. 2009; Gupta and Saraswat 1993). Investigations on the occurrence of myxozoans in fishes have huge significance, because of serious pathogenicity of these parasites and host mortality associated with them (Bandyopadhyay et al. 2006/2007; Székely et al. 2015; Fariya et al. 2018). The

✉ Naireen Fariya
n_fariya@yahoo.com

¹ Parasitology Lab, Fish Health Management Division, National Bureau of Fish Genetic Resources, Canal Ring Road, Dilkusha, Telibagh, Lucknow 226002, India

² School of Environmental Sciences, A.P.S. University, Rewa, M.P., India

present article describes a new species *Myxobolus awadhii* sp. nov. collected from the gills of *Clarias batrachus*.

Material and methods

During the study, sampling and collection of fish was done from river Gomti and Kaisarbagh fish market of Lucknow. Total 70 fishes with average length 15–18 cm and 275–400 gm were screened where two fishes were infected with the present species. Detailed screening of all internal organs and gills were done. Gills were infected with several cysts. Plasmodia was removed and teased on the slide for the fresh and stained preparations. The fresh myxospores were observed through a Nikon E600 microscope with various magnifications (with the immersion oil). Myxospores in fresh wet mount were treated with 12% KOH solution for the extrusion of polar (Fariya et al. 2018). For permanent preparations, air-dried smears, were stained with Geimsa. Drawings were made from fresh and stained material with the aid of Camera Lucida and Corel Draw 17.0 software. Morphometric measurements of fresh spores ($n = 63$) were done with the help of software NIS-E-Br. Description of new species is prepared according to the guidelines by Lom and Arthur (1989). All measurements are taken in micrometers while ranges values followed by mean $\pm$ SD in parentheses.

Results

Parasite: *Myxobolus awadhii* sp. nov

Parasite profile

Host—*Clarias batrachus*

Locality—Lucknow, Uttar Pradesh, India.

Type specimen—Holotype (slide no. GPR-NI/14/Cb-G/155/25.5.2010)

Paratypes—Catalogue no. GPR-NI/14/Cb-G/25.5.2010) collected of Parasitology Lab.

Site of Infection—Gills

Prevalence of Infection—2.86%

Etymology—The species name *M. awadhii* sp. nov. is derived from the ‘Awadh’ old name of the Lucknow city from where the host fish was collected.

Description

Observation of fish revealed beautiful white plasmodia embedded in the gill filaments of the gills. The plasmodia measured ranging between 0.28 to 0.39 mm (0.34 ± 0.04 mm) (Fig. 1). Each plasmodia had hundreds

Fig. 1 Plasmodia of *Myxobolus awadhii* sp. nov. in the infected gill

of myxospores. The mature myxospores are oval to ellipsoidal in shape with slightly pointed anterior end in valvular view measuring $8.82\text{--}11.68$ (10.57 ± 0.50) $\times$ $5.76\text{--}7.37$ (6.70 ± 0.36) μm in size. Ratio of the myxospores were 1.58. The spores were lenticular in sutural view measuring the thickness $4.49\text{--}5.10$ (4.8 ± 0.21) μm . Two polar capsules are equal, pyriform, tapered anteriorly, united with suture but have a wide inter-capsular space at the posterior end measuring $3.70\text{--}5.89$ (4.65 ± 0.40) $\times$ width was $1.16\text{--}2.17$ (1.66 ± 0.20) μm in size (Figs. 2, 3). Polar filaments are coiled 5–7 times in the capsule along vertical capsular axis. Sporoplasm is homogeneous, having two nuclei and vacuoles and occupies the posterior half of the myxospore body below the polar capsules. The two nuclei of sporoplasm measured $1.22 \mu\text{m}$ and $1.35 \mu\text{m}$ respectively. An large iodophilous vacuole is present with diameter of iodophilous vacuole is $1.95 \pm 0.30 \mu\text{m}$ (Table 1).

The abbreviations used in the article are: *LS* Length of Spore; *WS* Width of Spore; *LPC* Length of Polar Capsule; *WPC* Width of Polar capsule.

Discussion

The new species *Myxobolus awadhii* sp. nov. was compared with species reported earlier from *Clarias batrachus*. *M. saraswatii* from kidney; *M. shaochingensis* from kidneys, intestine, stomach and *M. koumingensis* from gills, kidney, liver, spleen, gonads; *M. utlouensis* and *M. clariae* from cornea; *M. clarii* from liver, testes; *M. kwangtungensis* from gall bladder; *M. leqingensis* from gills, intestine; *M. magurii* from accessory respiratory organs; and *M. tripathii* from wall of gut and visceral organs of *Clarias*

Fig. 2 a Mature Myxospores of *Myxobolus awadhii* sp. nov. b Myxospores of *Myxobolus awadhii* sp. nov stained with Geimsa

Fig. 3 Line drawing of fresh mature myxospore of *Myxobolus awadhii* sp. nov. infecting gills of *C. batrachus* (Frontal and Sutural view)

batrachus are bigger than the present species and vary morphologically. *M. bivacuolatus* from intestinal wall of

Table 1 Morphometric characteristics of *Myxobolus awadhii* sp. nov

Characters	Range in μm	Mean in μm	St. deviation in μm
LS	8.82–11.68	10.57	0.50
WS	5.76–7.37	6.70	0.36
LPC	3.70–5.89	4.65	0.4
WPC	1.16–2.17	1.66	0.20
Ratio: LS/WS	–	1.58	–

Clarias batrachus is smaller in length and wider in comparison of the present species. While *M. lucknowii* from kidney of *Clarias batrachus* is smaller in length and wider in contrast to the present species with smaller length and wider polar capsule. Further *Myxobolus awadhii* sp. nov was compared with the other similar species including *M. acanthorhodi* from almost all organs of *Acheilognathus chankaensis*; *M. bhadurius* from gall-bladder of *Wallago attu*; *M. bilineatum* from brain of *Fundulus heteroclitus*; *M. chrysichthyi* from gills of *Chrysichthys auratus*; *M. coelii* from gall-bladder of *Chanos chanos*; *M. cultus* from cartilage of *Carassius auratus*; *M. dongshanensis* from gills, liver, spleen of *Aristichthys nobilis*; *M. hosadurgensis* from gills, muscles of *Cirrhina mrigala*; *M. hyderabadense* from gills of *Barbus pinnauratus*; *M. nokoueensis* from gills of *Sarotherodon melanotheron*, but differ from all above species morphometrically (Table 2).

The study revealed that *Myxobolus awadhii* sp. nov differs from other species as *M. acanthorhodi*, *M. hosadurgensis* and *M. coelii* spores encompass unequal polar capsule. *M. bhadurius* and *M. bilineatum* varies morphometrically with non existence of intercapsular process. *M. chrysichthyi* possesses medium sized intercapsular process with relatively smaller and wider polar capsules in comparison to the present species. *M. cultus* spore has large intercapsular process while *M. dongshanensis* has no intercapsular process and both are comparatively bigger than the present species. *M. hyderabadensis* has bigger polar capsule while *M. nokoueensis* has smaller polar capsule in comparison of but both species have small intercapsular process (Eiras et al. 2014). Furthermore, present species was again compared with the *M. batae* with uninucleated sporoplasm, *M. puntiusii* having a lemon shape myxopore with unequal polar capsule and *M. filamentosus* had unequal polar capsules as well as iodophilous vacuole was absent. Based on above morphological and morphometric description and comparisons with earlier species it is inferred that present species is a new species which is named *Myxobolus awadhii* sp. nov.

Table 2 Comparative description of *Myxobolus awadhii* sp. nov with morphologically similar species

Species	Host	Site of infection	Spore		Polar capsule		Locality
			Length (µm)	Width (µm)	Length (µm)	Width (µm)	
<i>Myxobolus awadhii</i> sp. nov	<i>Clarias batrachus</i>	Gills	10.57 (8.82–11.68)	6.70 (5.76–7.37)	4.65 (3.70–5.89)	1.66 (1.16–2.17)	Lucknow, U.P. India
<i>M. saraswatii</i> (Gupta & Saraswat 1993)	<i>Clarias batrachus</i>	Kidneys	10–20	7.8–11	3.5–9.5	2–3.5	Rohilkhand, U.P. India
<i>M. shaochingensis</i> (Chen & Ma 1998)	<i>Clarias batrachus</i> , <i>C. argus</i>	Kidneys, intestine, stomach	14.6 (12–15.6)	8.5 (7.2–9.0)	6.4 (6.0–6.7)	2.7 (2.6–3.0)	China
<i>M. koumingensis</i> (Chen & Ma 1998)	<i>Clarias batrachus</i>	Gills, kidney liver, spleen gonads	15.8 (15–16.2)	9.9 (8.4–0.8)	7.1 (6–7.8)	3.5 (3–3.6)	China
<i>Myxobolus utlouensis</i> (Hemananda et al. 2009)	<i>Clarias batrachus</i>	Cornea	12.28 (11.9–12.6)	8.92 (8.5–9.2)	2.34 (1.7–2.4)	–	India
<i>Myxobolus clariae</i> (Hemananda et al. 2009)	<i>Clarias batrachus</i>	Cornea	10.53 (10.2–11.5)	7.03 (6.8–7.7)	3.67 (3.4–4.3)	2.38 (1.7–2.6)	India
<i>M. clarii</i> (Chakravarty 1943)	<i>Clarias batrachus</i>	Liver, testes	11.3–12.4	10.3	6.1	3.0	India
<i>M. kwangtungensis</i> (Chen and Ma 1998)	<i>Clarias batrachus</i>	Gall-bladder	17.0 (15.8–8.6)	11.9 (10.8–13)	8.4 (7.8–9.6)	3.8 (3.6–3.8)	China
<i>M. leqingensis</i> (Wu et al. 1998)	<i>Clarias batrachus</i>	Gills, intestine	13.6 (12.9–14.2)	9.4 (9–9.6)	4.9 (4.8–5.2)	2.0 (1.8–2.4)	China
<i>M. magurii</i> (Sarkar 1993)	<i>Clarias magur</i>	Accessory respiratory organ	14.13 (13–15)	7.75 (6.5–8)	7.53 (7–8)	2.34 (2–3)	Chinsurah, West Bengal, India
<i>M. tripathii</i> (Kalavati et al. 1981)	<i>Clarias</i> sp.	Wall of gut and visceral organs	10.1 (9.8–10.2)	13.0 (12.03.5)	5.5 (5–6)	2.5	Vishakhapatnam, Andhra Pradesh India
<i>M. bivacuolatus</i> Kalavati et al. 1981)	<i>Clarias batrachus</i>	Intestinal wall	8–11 (9.0)	–	3–4.5 (4.2)	2.6–4 (3.0)	Hoogly River, West Bengal, India
<i>Myxobolus lucknowii</i> (Abidi et al. 2015)	<i>Clarias batrachus</i>	Kidney	7.89 (7.14–9.1)	7.73 (7.03–8.42)	3.74 (3.18–4.21)	2.33 (2.12–2.66)	Lucknow, U.P. India
<i>M. acanthorhodi</i> (Nie & Li, 1973)	<i>Acheilognathus chankaensis</i>	Almost all organs	10.2 (9.6–10.8)	6.8 (6.0–7.2)	4.7 (3.8–5.4)	2.5 (2.4–2.6)	China
<i>M. bhadarius</i> (Sarkar, 1985)	<i>Wallago attu</i>	Gall-bladder	10.6 (8.8–11.2)	6.3 (4.8–6.7)	5.3 (4.0–6.4)	2.8 (2.4–3.2)	Padma River, West Bengal, India
<i>M. bilineatus</i> (Bond, 1938)	<i>Fundulus heteroclitus</i>	Brain	10.5 (10–12)	9–10	–	–	USA
<i>M. chrysichthys</i> (Negm-Eldim et al. 1999)	<i>Chrysichthys auratus</i>	Gills	10.2	6.2	4.6	2.4	Egypt
<i>M. coelii</i> (Haldar et al. 1996)	<i>Chanos chanos</i>	Gall-bladder	10.6 (8.3–14.9)	5.4 (4.1–8.4)	5.7 (4.1–9.1)	2.8 (1.7–2.3)	Chilka Lake, Orissa, India
<i>M. cultus</i> (Yokohama et al., 1995)	<i>Carassius auratus</i>	Cartilage	10.2 (9.3–11.3)	6.0 (5.2–7.2)	4.0 (3.1–4.9)	1.9 (1.5–2.1)	Japan
<i>M. dongshanensis</i> (Ma, 1998)	<i>Aristichthys nobilis</i>	Gills, liver, spleen	10.3 (9.8–11.4)	7.0 (6.5–8.2)	5.1 (4.8–6.5)	2.2 (1.6–3.3)	China

Table 2 continued

Species	Host	Site of infection	Spore		Polar capsule		Locality
			Length (µm)	Width (µm)	Length (µm)	Width (µm)	
<i>M. hosadurgensis</i> (Seenappa & Manohar 1981)	<i>Cirrhitina mirigala</i>	Gills, muscles	10.5 (9.0–11.0)	6.3 (5.0–8.0)	5.4 (4.0–6.0)	2.3 (2.0–3.0)	Vanivilasa farm, Karnataka, India
<i>M. hyderabadense</i> (Lalitha Kumari, 1969)	<i>Barbus pinnauratus</i>	Gills	10.1 (9.3–11.5)	5.9 (5.0–8.0)	5.8 (5.0–7.3)	2.2 (1.4–3.0)	Hyderabad, Andhra Pradesh; Vellayani Lake, Kerala, India
<i>M. nokouensis</i> (Sakiti et al., 1991)	<i>Sarotherodon melanotheron</i>	Gills	10.0 (8.1–11.5)	6 (5–7)	3.4 (2.5–4)	2 (1.6–2.7)	Benin
<i>M. batae</i> (Karamachandani, 1970)	<i>Labeo bata</i>	Gill filament	9.6–11.2	7.2–8.8	4.0–4.8	1.6	Cuttack, Orissa, India
<i>M. puntiusii</i> (Gupta & Kaur, 2016)	<i>Puntius sophore</i>	Caudal fin	7.76 (7.56–7.96)	5.36 (5.25–5.47)	3.0 (2.95–3.07); 1.71 (1.60–1.82)	1.83 (1.75–1.91); 0.94 (0.89–0.99)	Ranjit Sagar Wetland, Punjab, India
<i>M. filamentosus</i> (Halder et al., 1981)	<i>Puntius filamentosa</i>	Cartilage, brain	13.7 (11.2–17.3)	9.5 (8.1–2.2)	3.6 (4.0–7.1)	3.1 (2.0–4.0)	Kalyani, West Bengal, India

Acknowledgments The authors are thankful to the Director, National Bureau of Fish Genetic Resources, Lucknow, India for providing support, suggestion, materials and laboratory facility for conducting this study.

Author contributions NF Conducting and performing experimental and research work, writing the manuscript. RA Planning of the research work. UKC Editing of the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

Ethical approval As per the guidelines of Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), experimental practice on fishes does not require approval.

References

- Abidi R (1999) Common parasites of an air breathing catfish *Clarias batrachus*. In: 69th Annual Session of the National Academy of Sciences, India, Nov. 11–13, 1999, Abs -55
- Abidi R (2000) Protozoan parasites and their pathogenicity in Indian magur *Clarias batrachus*. In 14th National Congress of Parasitology; ISP & ICMR, New Delhi, April 23, 2000, Abs -14
- Abidi R, Fariya N, Irshan M, Chauhan UK (2015) A new species of myxozoan parasite, *Myxobolus lucknowii* sp. nov. in kidney of *Clarias batrachus* Linn. from river Gomti at Lucknow. Trends Parasitol Res 4(1):2319–3158
- Bandyopadhyay PK, Hemananda T, Mitra AK, Mohilal N (2006/2007) *Myxobolus dhanachandi* sp. n. (Myxozoa, Myxosporidia, Bivalvulida) from an Indian freshwater fish *Channa orientalis* (Bloch Schneider). Protistology 4(4):353–356
- Bond FF (1938) Cnidosporidia from *Fundulus heteroclitus* Lin. Trans Am Microsc Soc 57(2):107
- Chakravarty M (1943) Studies on myxosporidia from the common food fishes of Bengal. Proc Indian Acad Sci 18:21–35
- Chen QL, Ma CL (1998) Myxozoa, Myxosporidia. Fauna Sinica. Science Press, Beijing, pp 292–528 (in Chinese)
- Eiras JC, Molnar K, Lu YS (2005) Synopsis of the species of *Myxobolus* Butschli, 1882 (Myxozoa: Myxosporidia: Myxobolidae). Syst Parasitol 61:1–46
- Eiras JC, Zhang J, Molnar K (2014) Synopsis of the species of *Myxobolus* Butschli, 1882 (Myxozoa: Myxosporidia: Myxobolidae) described between 2005 and 2013. Syst Parasitol 88:11–36
- Fariya N, Abidi R, Chauhan UK (2018) *Myxobolus deformis* sp. nov. (myxozoa, myxosporidia, myxobolidae), a new myxosporidian parasite infesting the gills of *Cyprinus carpio*. Species 19:4–14
- Feist SW (2008) Myxozoan diseases. In: Eiras J, Segner K, Wahli T, Kapoor BG (eds) Fish diseases, vol 2. Science Publishers, Enfield
- Gupta A, Kaur H (2016) Morphological and molecular characterization of *Myxobolus puntiusii* n. sp. (Cnidaria: Myxosporidia) infecting *Puntius sophore* Hamilton, 1822 from Ranjit Sagar Wetland, Punjab (India). Turk J Zool. <https://doi.org/10.3906/zoo-1606-47>
- Gupta N, Saraswat H (1993) Haemoprotozoosis in *Clarias batrachus* (Linn) from freshwater ponds of Rohilkhand region, India. Himal J Environ Zool 7:47–52
- Halder DP, Mukherjee M, Kundu TK (1981) Observations on two new species of Myxosoma Thélohan, 1892 (Myxozoa: Myxosomatidae) from freshwater fishes. Archiv für Protistenkunde 124:244–251

- Haldar DP, SamalKK, Mukhopadhyaya D (1996) Studies on the protozoan parasites of fishes in Orissa: eight species of *Myxobolus* Bütschli (Myxozoa: Bivalvulida). J Bengal Nat Hist Soc 16:3–24
- Hemananda T, Mohilal N, Bandyopadhyay PK, Mitra AK (2009) Two new Myxosporidia (Myxozoa: Myxosporea) of the genus *Myxobolus* Bütschli, 1882 from cornea of *Clarias batrachus* (Linnaeus, 1758) caught from a fish farm in India. North-West J Zool 5(1):165–169
- Kalavati C, Nandi NC (2007) Handbook of myxosporidean parasites of Indian fishes. Zoological Survey of India, Kolkata, p 293
- Kalavati C, Sandeep BV, Narasimhamurti CC (1981) Two new species of myxosporidians, *Myxosoma channai* n.sp and *Myxobolus tripathii* n. sp., from fresh water fishes of Andhra Pradesh. Proc Indian Acad Sci (Anim Sci) 90:6–78
- Karamachandani SJ (1970) A new species of *Myxobolus* from the gill cavity of *Labeo bata* (Ham.). J Inland Fish Soc India 2:170–171
- Kaur H (2014) Myxozoan infestation in freshwater fishes in wetlands and aquaculture in Punjab (India). Adv Anim Vet Sci 2(9):488–502
- Kaur H, Singh R (2012) A synopsis of the species of *Myxobolus* Bütschli, 1882 (Myxozoa: Bivalvulida) parasitising Indian fishes and a revised dichotomous key to myxosporean genera. Syst Parasitol 81:17–37
- Kumari J, Sahoo PK (2006) Non-specific immune response of healthy and immunocompromised Asian catfish (*Clarias batrachus*) to several immunostimulants. Aquaculture 255:133–141
- Lalitha KPS (1969) Studies on parasitic protozoa (Myxosporidia) of fresh water fishes of Andhra Pradesh, India. Rivista di Parassitologia 30:153–226
- Ma CL (1998) On the myxosporeans from the fishes of Sichuan Province. J Chongqing Norm Coll (Nat Sci Edn) 15:1–25 (in Chinese)
- Narasimhamurti CC, Kaavati C (1986) A new myxosporidian *Myxobolus bivacuolatus* n. sp. parasitic in the intestinal wall of the fresh water fish *Clarius batrachus*. Archiv für Protistenkunde 131:153–157
- Negm-Eldim NM, Govedich FR, Davies RW (1999) Gill myxosporeans on some Egyptian freshwater fish. Deutsche Tierärztliche Wochenschrift 106:459–465
- Sakiti N, Blanc E, Marques A, Bouix G (1991) Myxosporidies (Myxozoa, Myxosporea) du genre *Myxobolus* Bütschli, 1882 parasites de poissons cichlidae du lac Nokoué au Bénin (Afrique de l'Ouest). J Afr Zool 105:173–186
- Sarkar NK (1985) Some coelozoic myxosporidians (Myxozoa: Myxosporea) from a fresh water teleost fish of river Padma. Acta Protozool 24:47–53
- Sarkar NK (1993) On two new species of *Myxobolus* Bütschli, 1882 (Myxozoa: Myxosporea) from some freshwater fish of West Bengal, India. Proc Zool Soc Calcutta 46:61–66
- Seenappa D, Manohar L (1981) *Myxobolus vanivilasae* n.sp. parasitic in *Cirrhina mrigala* (Hamilton). Proc Indian Acad Sci (Anim Sci) 89(5):485–491
- Srivastava A, Singha A (2015) Biodiversity, ecological status and conservation priority of the fishes of river Gomti, Lucknow (U.P., India). Int J Adv Res 3(9):1471–1480
- Székely C, Cech G, Chaudhary A, Borzák R, Singh HS, Molnár K (2015) Myxozoan infections of the three Indian major carps in fish ponds around Meerut, UP, India, with descriptions of three new species, *Myxobolus basuhaldari* sp. n., *M. kalavatie* sp. n. and *M. meerutensis* sp. n., and the redescription of *M. catlae* and *M. bhadrensis*
- Yokohama H, Ogawa K, Wakabayashi H (1995) *Myxobolus cultus* n. sp. (Myxosporea, Myxobolidae) in the goldfish *Carassius auratus* transformed from the actinosporian stage in the oligochaete *Branchiura sowerbyi*. J Parasitol 81:446–451