Two new species of *Myxobolus* (Myxozoa:Myxosporea: Bivalvulida) from freshwater fishes of Punjab wetlands (India)

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Abstract During the present study two new species were collected from mucous membrane around gill lamellae of *Puntius sophore* (Ham.) vern. chittal and *Cirrhina mrigala* (Ham.) vern. mrigal from Harike Wetland, Punjab respectively. Spore of the first species i.e. *Myxobolus chittalii* are histozoic, pear shaped with characteristic nipple-like anterior end and rounded posterior end. They measure $9.0 \times 6.18 \mu\text{m}$. Polar capsules are two, equal, measuring $4.5 \times 2.4 \mu\text{m}$, pyriform with bluntly pointed anterior end and rounded posterior end. They are placed posteriorly from the tip of the spore and are parallel to each other in the spore body cavity. A prominent, tongue shaped intercapsular process is present. Spores of the second species i.e. *M. mehlhorni* are histozoic, oval to egg in shape having narrow, blunt anterior end and broad rounded posterior end, measure $8.9 \times 6.8 \mu\text{m}$. Shell valves smooth, symmetrically thin, measure $0.5 \mu\text{m}$ in thickness. Parietal folds are absent. Polar capsules two, prominently unequal, placed anteriorly and converge towards the anterior end. Both polar capsules are flask-shaped with anterior end having a prominent neck. The larger polar capsule measure $3.7 \times 2.5 \mu\text{m}$ occupying less than half while the smaller one measure $2.6 \times 1.5 \mu\text{m}$ and occupy less than one-third of the spore body cavity. An intercapsular process is absent.

Keywords Freshwater fish · Harike wetland · Intercapsular process · Polar filament

Introduction

Wetlands of Punjab (included in Ramsar list of Wetlands of International importance) with their vast expanse of water bodies have a rich freshwater fish fauna from the major source of food fish in North India. Harike Wetland harbour 16 species of freshwater fishes (Punjab State Council for Science and Technology Chandigarh, 2002). These fishes are vulnerable to various parasitic infections, out of which Myxozoa is emerging as the major group. Presently, there are more than 2,180 species in 62 genera belonging to the Phylum Myxozoa has been described (Lom and Dykova 2006). Eiras et al. (2005) listed approximately 744 species of *Myxobolus* all over the world. Recently a new genus *Thelohanelloid bengalensis* gen. nov. sp. nov. from gall bladder of *Arius sagor* (a marine fish in Bay of Bengal) has been described by Sarkar (2009). According to Kalavati and Nandi (2007) 104 species of *Myxobolus* spp. are restricted to the Indian sub-continent. During the present investigation 30 fishes belonging to genus *Puntius sophore* (Ham.) (Cypriniformes: Cyprinidae) and *Cirrhina mrigala* (Ham.) (Cypriniformes: Cyprinidae) were examined to ascertain the prevalence of myxozoan parasites in these Wetlands. A variety of other freshwater fishes were also collected and examined which include *Cyprinus carpio*, *Catla catla*, *Amblypharyngodon mola*, *Labeo bata*, *Labeo dero* and *Mystus seenghala*. Two new species *Myxobolus chittalii* and *Myxobolus mehlhorni* are reported from mucous membrane around gill lamellae respectively. The description has been prepared according to the guidelines of Lom and Arthur (1989).

Materials and methods

The fishes pertaining to the present study were collected and examined during December 2009 to February 2010

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from Harike Wetland. Fishes were small sized, young in age and were lightly infected. Infected gills of *P. sophore* and *C. mrigala* were smeared on clean slide in a drop of 0.98% NaCl solution covered with cover slip and were examined for the presence of spores. Some of the smears were immersed in Lugol's Iodine solution to observe iodophilous vacuole and a few others were treated with 8% KOH for filament extrusion. For permanent preparation, smears were fixed in Bouins fixative and stained with Ziehl–Neelsen and iron–haematoxylin. Drawings were made from stained material with the aid of camera lucida. All measurements are in microns (μm) as range values followed by mean $\pm$ SD in parentheses. The abbreviations used in the paper are as follows: LS: length of spore; WS: width of spore; LPC: length of polar capsule; WPC: width of polar capsule; LLPC: length of larger polar capsule; LSPC: length of smaller polar capsule; WLPC: width of larger polar capsule; WSPC: width of smaller polar capsule; ICP: intercapsular process; TS: thickness of spore valves; NC: number of coils of polar filaments; SD: standard deviation.

Results and discussion

Myxobolus chittalii sp. nov. (Figs. 1, 2, 3, 4, 9, Table 1)

Plasmodia

Very small, microscopic, attached on the mucous membrane around gill lamellae. 5–10 spores are present per plasmodium.

Spore description (Measurements based on 7–8 spores in frontal view)

The spores are histozoic, pear shaped in valvular view having characteristic nipple-like anterior end and rounded posterior end. Shell valves are thin, smooth, symmetrical and measure $0.37 \mu\text{m}$ in thickness. Parietal folds are absent. Polar capsules are two, equal, pyriform with bluntly pointed anterior end and rounded posterior end. They are placed posteriorly from the tip of the spore and are parallel to each other in the spore body cavity. Polar filaments form 4–5 coils, ribbon shaped and are arranged perpendicular to the polar capsule axis. A prominent, tongue shaped intercapsular process is present. Two capsulogenic nuclei beneath each polar capsule are present measuring $0.16 \mu\text{m}$ in diameter. Sporoplasm is agranular, homogenous and occupy small part of the spore body cavity posteriorly. Sporoplasm contain a sporoplasmic nucleus and an iodophilous vacuole measuring $1.0 \mu\text{m}$ and $2.6\text{--}3.0$ (2.8 ± 0.28) μm in diameter respectively.

Figs. 1–2 Photomicrographs of the spores of *M. chittalii* sp. nov. stained with Ziehl–Neelsen (unextruded)

Taxonomic summary of M. chittalii sp. nov

Type host	<i>Puntius sophore</i> (Ham.) vern. chittal
Type locality	Harike Wetland, Punjab, India
Type specimen	Paratypes are spores stained in Ziehl–Neelsen and iron–haematoxylin, deposited in the museum of Department of Zoology, Punjabi University, Patiala. Slide no. PS/K/ZN/11/12.10.08 and PS/K/IH/12/12.10.08
Site of infection	Gill lamellae
Prevalence of infection	10% (3/30)
Etymology	The specific epithet <i>chittalii</i> is after the vernacular name of the host fish.

Figs. 3–4 Camera lucida drawings of the spores of *M. chittalii* sp. nov. **3** Mature spore stained in Ziehl-Neelsen (valvular view). **4** Spore stained in iron-haematoxylin (showing capsulogenic and sporoplasmic nuclei)

Discussion

The present species was compared with spores of other *Myxobolus* spp. i.e. *M. obesus* Gurley, 1983 from gills of *Alburnus alburnus*; *M. phylloides* Shulman, 1962 from abdominal serosa of *Hypophthalmichthys molitrix*; *M. potaili* Lalitha Kumari, 1969 from liver, intestine of *Labeo potaili*; *M. undulatum* Lom, 1969 from gills of *Phoxinus phoxinus*; *M. splendidum* Kashkovski in Kashkovskii et al. 1974 from muscles of *Gobio gobio*; *M. curmucae* Seenappa and Manohar, 1980 from scales of *Puntius curmucae*; *M. mathuri* Jayasri et al. 1981 from gills of *P. saranae*; *M. venkateshi* Seenappa and Manohar, 1981 from gills of *Cirrhina mrigala*; *M. sophorae* Jayasri, 1982 from gills, kidneys of *P. sophore*; *M. rohita* Haldar et al. 1983 from scales of *P. saranae*; *M. bhadurius* (Sarkar, 1985) Gupta and Khera, 1988 from gall bladder of *Wallago attu*; *M. hyderabadense* (Lalitha Kumari, 1969) Gupta and Khera, 1988 from gill filaments of *P. filamentosa*; *M. saranae* Gupta and Khera, 1990 from gills of *P. saranae*; *M. acutum* (Fujita,

Figs. 5–6 Photomicrographs of the spores of *M. mehlhorni* sp. nov. stained with Ziehl-Neelsen (unextruded) and iron-haematoxylin (extruded polar filaments)

Table 1 Measurements (in μm) and ratio of *M. chittalii* sp. nov

Characters	Range	Mean values	SD
LS	8.8–9.2	9.0	0.28
WS	5.88–6.48	6.18	0.42
LPC	4.0–5.0	4.5	0.70
WPC	2.0–2.8	2.4	0.56
Ratio: LS/WS		1.4	
ICP		Prominent, tongue shaped	
NC		4–5	
Parietal folds		Absent	

1912) Landsberg and Lom, 1991 from gills of *Carassius auratus gibelio*; *M. lobatus* (Nemeczeck, 1911) Landsberg and Lom, 1991 from gills of *Leuciscus leuciscus* and *Apilus rapax*; *M. filamentosus* (Haldar et al. 1981) Landsberg and Lom, 1991 from cartilage, brain of *P. filamentosa*; *M. zillii* Sakiti et al. 1991 from gills of *Tilapia zillii*; *M. mola* Sarkar, 1993 from kidney of *Amblyphayrnodon mola*; *M. hungaricus* (Jacso 1940) Molnar and Baska, 1999 from gills of *Abramis brama* and *M. ampullicapsulatus* Zhao et al. 2008 from gills of *Carassius auratus auratus* but differed from all

Figs. 7–8 Camera lucida drawings of the spores of *M. mehlhorni* sp. nov. **7** Spore with extruded polar filaments stained in iron-haematoxylin. **8** Valvular view of spore stained in Ziehl-Neelsen

of the above mentioned species in morphometric characteristics (Table 3).

The spores in the present species are pear shaped with characteristic nipple-like anterior end and rounded posterior end. In this respect, it can be compared morphologically with the spores of *M. phylloides*, *M. splendidum*, *M. undulatum*, *M. obesus*, *M. lobatus*, *M. hungaricus*, *M. ampullicapsulatus*, *M. mola* and *M. potaili*. Polar capsules in the present species are pyriform in shape with bluntly pointed anterior end and rounded posterior end. They are placed posteriorly from the tip, running parallel to each other in contrast to anteriorly placed polar capsules in *M. phylloides*, *M. undulatum*, *M. potaili*, *M. obesus*, *M. splendidum*, *M. lobatus* and *M. hungaricus*. Furthermore, in *M. hungaricus* the surface of the spore valves have a distinct emerging ridge running parallel to the sutural line. The presence of converging polar capsules having a very long distinct neck in *M. mola*, ampullaceous in *M. ampullicapsulatus*, with prominent duct in *M. potaili* and unequal polar capsule of *M. splendidum* differentiate them from the present species. The intercapsular process is of smaller type in the spores of *M. potaili* and also the presence of sutural marking on the posterior margin differentiate it from the present species. Furthermore, an intercapsular is absent in *M. undulatum*.

Figs. 9–10 Fresh spores. **9** *M. chittalii* sp. nov. **10** *M. mehlhorni* sp. nov

Table 2 Measurements (in μm) and ratio of *M. mehlhorni* sp. nov

Characters	Range	Mean values	SD
LS	8.8–9.0	8.9	0.14
WS	6.3–7.3	6.8	0.7
LLPC	3.2–4.2	3.7	0.7
WLPC	2.0–3.0	2.5	0.7
LSPC	2.1–3.1	2.6	0.7
WSPC	1.0–2.0	1.5	0.7
Ratio: LS/WS		1.3	
ICP		Absent	
NC		4–6	
Parietal folds		Absent	

Table 3 Comparative description of the *M. chittalii* sp. nov. with morphologically similar species (measurements are in micrometer)

Species	Host	Site of infection	Locality	Spore	Polar capsule
<i>M. chittalii</i> sp. nov. (present study)	<i>Puntius sophore</i>	Gill lamellae (mucous membrane)	Harike Wetland, Punjab (India)	9.0×6.18	4.5×2.4
<i>M. obesus</i> Gurley, 1893	<i>Alburnus alburnus</i>	Gills	France	$8.7\text{--}12.5 \times 7.4\text{--}11.2$	$4.5\text{--}6.0 \times 2.5\text{--}3.7$
<i>M. phyllodes</i> Shulman, 1962	<i>Hypophthalmichthys molitrix</i>	Abdominal-serosa	Amur basin	$9.0\text{--}10.0 \times 7.0\text{--}7.5$	$5.7\text{--}6.5 \times 2.8\text{--}3.5$
<i>M. potaili</i> Lalitha Kumari, 1969	<i>Labeo potail</i>	Liver and intestine	India	7.2×5.4	3.3×2.0
<i>M. undulatum</i> Lom, 1969	<i>Phoxinus phoxinus</i>	Gills	Czech Rep.	$9.0\text{--}10.5 \times 7.0\text{--}8.5$	5.5×2.2
<i>M. splendidum</i> Kashkovskii in Kashkovskii, 1974	<i>Gobio gobio</i>	Muscles	Russia	$8.4\text{--}10.1 \times 7.8\text{--}9$	$5.4\text{--}6.0 \times 3.0\text{--}3.2$
<i>M. curmucae</i> Seenappa and Manohar, 1981	<i>Puntius curmucae</i>	Below scales	India	9.8×7.6	4.9×2.5 and 3.9×2.4
<i>M. mathuri</i> Jayasri et al. 1981	<i>P. saranae</i>	Gills	India	$8.7 \times 23.5 \times 5.7\text{--}10.1$	$2.7\text{--}11.9 \times 1.8\text{--}4.6$ and $2.7\text{--}7.8 \times 1.8\text{--}4.6$
<i>M. rohita</i> Haldar et al. 1983	<i>P. saranae</i>	Scales	India	10.6×9.0	6.6×3.3
<i>M. venkateshi</i> Seenappa and Manohar, 1981	<i>Cirrhhina mrigala</i>	Gills	India	9.7×7.1	5.2×2.0
<i>M. sophorae</i> Jayasri, 1982	<i>P. sophore</i>	Gills, kidney	India	14.9×7.7	–
<i>M. bhadurius</i> (Sarkar, 1985) Gupta and Khera, 1988	<i>Wallago attu</i>	Gall bladder	India	10.59×6.28	5.31×2.78
<i>M. hyderabadense</i> (Lalitha Kumari, 1969) Gupta and Khera, 1988	<i>P. filamentosa</i>	Gill filaments	India	10.1×5.9	5.8×2.2
<i>M. saranae</i> Gupta and Khera, 1990	<i>P. saranae</i>	Gills	India	7.72×6.2	4.24×3.04 and 1.98×1.3
<i>M. filamentosus</i> (Haldar et al. 1981) Landsberg and Lom, 1991	<i>P. filamentosa</i>	Cartilage, brain	India	13.7×9.5	3.6×3.1
<i>M. lobatus</i> (Nemeczek, 1911) Landsberg and Lom, 1991	<i>Leuciscus leuciscus</i> , <i>Aspius rapax</i>	Gills	Germany	12.6×8.2	4.2
<i>M. acutum</i> (Fujita, 1912) Landsberg and Lom, 1991	<i>Carassius auratus gibelio</i>	Gills	Japan	$8.0\text{--}10.0 \times 7.0\text{--}8.0$	5.0×4.0
<i>M. zillii</i> Sakiti et al. 1991	<i>Tilapia zillii</i>	Gills	Benin	9.8×7.5	5.1×2.5
<i>M. mola</i> Sarkar, 1993	<i>Amblypharyngodon mola</i>	Kidney	India	9.0×7.4	6.0×1.5
<i>M. hungaricus</i> (Jaczo, 1940) Molnar and Baska, 1999	<i>Abramis brama</i>	Gills	Hungary	8.1×6.6	3.6
<i>M. ampullicapsulatus</i> Zhao et al. 2008	<i>Carassius auratus auratus</i>	Gills	China	$16.5\text{--}19.5 \times 8.5\text{--}10.0$	$7.0\text{--}10.0 \times 2.5\text{--}4.0$

In view of the above differences, present species under study is proposed as new species to the science and named as *M. chittalii* sp. nov. through this communication.

Myxobolus mehlhorni sp. nov. (Figs. 5, 6, 7, 8, 10, Table 2)

Plasmodia

Very small, microscopic, attached on the mucous membrane around gill lamellae. 8–10 spores are present per plasmodium.

Spore description (Measurements based on 10–11 spores in frontal view)

The spores are histozoic, oval to egg shape in valvular view having narrow, rounded anterior end and broad rounded posterior end. Two shell valves are thick, smooth, symmetrical and measure $0.5 \mu\text{m}$ in thickness. Parietal folds are absent. Polar capsules two, prominently unequal, placed anteriorly and converge towards the anterior end. Both polar capsules are flask-shaped with anterior end having a prominent neck. The larger polar capsule occupy less than half while the smaller one occupy less than one-third of the

Table 4 Comparative description of *M. mehlhorni* Kaur and Singh, 2011 with morphologically similar species (measurements are in micrometer)

Species	Host	Site of infection	Locality	Spore	Polar capsule
<i>M. mehlhorni</i> sp. nov. (present study)	<i>Cirrhina mrigala</i>	Gill lamellae (mucous membrane)	Harike wetland, Punjab (India)	8.9 × 6.8	3.7 × 2.5 and 2.6 × 1.5
<i>M. calbasui</i> Chakravarty, 1939	<i>C. mrigala</i>	Gall bladder	India	12.4–15.0 × 8.2–10.0	6.18 × 4.12 and 4.12 × 3.09
<i>M. mrigalae</i> Chakravarty, 1939	<i>C. mrigala</i>	Scales	India	7.2–8.2	5.15 × 3.09 and 3.09 × 2.06
<i>M. catlae</i> Chakravarty, 1943	<i>C. mrigala</i>	Gills	India	14.5–16.5 × 6.18	10.3–12.36 × 2.06–3.01
<i>M. indicum</i> Tripathi, 1952	<i>C. mrigala</i>	Muscles, liver, intestinal wall	India	9.5–10.8 × 7.5–8.2	2.7–3.6 and 1.8
<i>M. anurensis</i> Akhmerov, 1960	<i>Cyprinus carpio haematopterus</i>	Fin, gut	Amur basin	9.0–13.5 × 9.0–12.5	7.0–8.0 × 5.6–6.5
<i>M. anisocapsularis</i> Shulman, 1962	<i>Hemibarbus labeo</i>	Gills	Amur basin	10.5–15.5 × 7.7–8.4	6.0–8.5 × 4.0
<i>M. chondrostomi</i> Donec, 1962	<i>Chondrostoma nasus</i>	Muscles	Ukraine	13.5–17.0 × 10.0–11.7	7.0–9.0 × 4.0–4.5
<i>M. sphaerocapsularis</i> Shulman, 1962	<i>Acheilognathus chankaensis</i>	Muscles	China	17.0–18.0 × 11.0–12.0	7.0–8.0 × 5.6–6.5
<i>M. koli</i> Lalitha Kumari, 1969	<i>Barbus kolus, Puntius filamentosa</i>	Dorsal and ventral fin	India	8.4 × 6.0	4.3 × 2.8 and 2.0 × 1.2
<i>M. rewensis</i> Srivastava, 1979	<i>C. mrigala</i>	Scales	India	9.66 × 8.05	4.8 × 3.2
<i>M. carnaticus</i> Seenappa and Manohar, 1980	<i>C. mrigala</i>	Gills	India	8.6 × 6.8	3.8 × 2.0 and 2.1 × 1.5
<i>M. vanivilasae</i> Seenappa and Manohar, 1980	<i>C. mrigala</i>	Beneath muscles, scales integument	India	8.0–10.0 × 7.0–9.0	3.57 × 2.57
<i>M. bhadransis</i> Seenappa and Manohar, 1981	<i>Labeo rohita</i>	Muscles	India	9.5 × 7.14	3.5 × 2.2 and 2.5 × 1.75
<i>M. hosadurgensis</i> Seenappa and Manohar, 1981	<i>C. mrigala</i>	Gills, muscles	India	10.5 × 6.25	5.37 × 2.3 and 3.3 × 1.43
<i>M. shetti</i> Seenappa and Manohar, 1981	<i>C. mrigala</i>	Gills	India	8.8 × 7.4	3.4 × 2.3
<i>M. vedavatiensis</i> Seenappa and Manohar, 1981	<i>C. mrigala</i>	Gills	India	13.8 × 9.2	6.2 × 3.4 and 3.9 × 2.6
<i>M. venkateshi</i> Seenappa and Manohar, 1981	<i>C. mrigala</i>	Gills	India	9.75 × 7.15	5.25 × 2.0
<i>M. sophorae</i> Jayasri, 1982	<i>P. sophore</i>	Gills, kidney	India	14.9 × 7.7	–
<i>M. indirae</i> (Kundu, 1985) Gupta and Khera, 1988	<i>C. mrigala</i>	Scales of tail fin	India	12.6 × 9.6	4.7 × 2.2
<i>M. haldari</i> Gupta and Khera, 1989	<i>C. mrigala</i>	Fins, gills	India	9.31 × 7.95	4.31 × 2.97 and 2.95 × 1.98
<i>M. saranae</i> Gupta and Khera, 1990	<i>P. saranae</i> , <i>L. calbasu</i>	Gills	India	7.72 × 6.2	4.24 × 3.04 and 1.98 × 1.3
<i>M. saranae</i> (Tripathi, 1952) Landsberg and Lom, 1991	<i>Barbus saranae</i>	Gills	India	6.4–7.0 × 4.5–5.0	3.5 × 1.5 and 1.5 × 1.0
<i>M. yogindrai</i> (Tripathi, 1952) Landsberg and Lom, 1991	<i>C. mrigala</i>	Inner side of scales	India	9.0–9.5 × 7.2	2.8 × 3.6

Table 4 continued

Species	Host	Site of infection	Locality	Spore	Polar capsule
<i>M. orissae</i> Haldar et al. 1997	<i>C. mrigala</i>	Gills	India	15.71 × 6.8	8.8 × 1.78 and 7.58 × 2.57
<i>M. ophthalmosculata</i> Basu and Haldar, 2002	<i>C. mrigala</i>	Eye muscle	India	13.13 × 8.04	5.47 × 3.06 and 3.03 × 1.99
<i>M. goensis</i> Eiras and D'souza, 2004	<i>Mugil cephalus</i>	Gill rakers	India	9.7 × 6.6	5.3 × 2.4 and 2.4 × 1.8
<i>M. labeoi</i> Boungou et al. 2006	<i>L. coulbe</i>	Among the rays of the fin	West Africa	16.43 × 10.73	8.37 × 6.53 and 1.57 × 0.35
<i>M. naini</i> Kaur and Singh, 2008	<i>C. mrigala</i>	Gill lamellae (mucous membrane)	India	12.9 × 8.2	4.9 × 3.1 and 3.33 × 1.63
<i>M. analfinus</i> Basu et al. 2009	<i>Heteropneustes fossilis</i>	Anal fin	India	12.3 × 8.6	4.1 × 2.2 and 2.5 × 1.8
<i>M. csabai</i> Szekely et al. 2009	<i>Osteochilus hasselti</i>	Renal interstitium	Malaysia	12.9 × 8.6	6.1 × 3.8 and 3.6 × 2.3
<i>M. eirasi</i> Kaur and Singh, 2009a	<i>C. mrigala</i>	Caudal fins	India	8.6 × 6.7	3.2 × 1.57
<i>M. slendrii</i> Kaur and Singh, 2009b	<i>C. mrigala</i>	Gill lamellae (mucous membrane)	India	14.87 × 3.4	5.74 × 1.48

spore body cavity. Polar filaments form 4–6 coils and arranged perpendicular to the polar capsule axis. Polar filaments are thin, thread-like and unequal when extruded and measure 26.6 and 20 µm in length respectively. An inter-capsular process is absent. Capsulogenic nuclei are two, present beneath the polar capsules measuring 1.5 µm in diameter. Sporoplasm is agranular and homogenous occupying whole of the extracapsular space behind the polar capsules. Sporoplasmic nuclei are two, measuring 1.67 µm in diameter. An iodophilous vacuole is present measuring 3.0 µm in diameter.

Taxonomic summary of *M. mehlhorni* sp. nov

Type host	<i>Cirrhina mrigala</i> (Ham.) vern. mrigal
Type locality	Harike Wetland, Punjab, India
Type specimen	Paratypes are spores stained in Ziehl–Neelsen and iron–haematoxylin, deposited in the museum of Department of Zoology, Punjab University, Patiala. Slide no. CH/ZN/14.04.2010 and CH/IH/14.04.2010
Site of infection	Gill lamellae
Prevalence of infection	20% (3/15)
Etymology	The specific epithet <i>mehlhorni</i> has been after Dr. H. Mehlhorn, an eminent worker in the field of Parasitology at Dusseldorf, Germany.

Discussion

The present species was compared with spores of *M. calbasui* Chakravarty, 1939 from gall bladder of *Cirrhina mrigala*; *M. mrigalae* Chakravarty, 1939 from scales of *C. mrigala*; *M. catlae* Chakravarty, 1943 from gills of *C. mrigala*; *M. indicum* Tripathi, 1952 from muscles, liver, intestinal wall of *C. mrigala*; *M. amurensis* Akhmerov, 1960 from fin, gut of *Cyprinus carpio haematopterus*; *M. anisocapsularis* Shulman, 1962 from gills of *Hemibarbus labeo*; *M. chondrostomi* Donec, 1962 from muscles of *Chondrostoma nasus*; *M. koli* Lalitha Kumari, 1969 from dorsal and ventral fins of *Barbus kolus* and *Puntius filamentosa*; *M. sphaerocapsularis* Shulman, 1962 from muscles of *Acheilognathus chankaensis*; *M. rewensis* Srivastava, 1979 from scales of *C. mrigala*; *M. carnaticus* Seenappa and Manohar, 1980 from gills of *C. mrigala*; *M. vanivilasae* Seenappa and Manohar, 1980 from muscles, scales and integument of *C. mrigala*; *M. bhadrensis* Seenappa

and Manohar, 1981 from muscles of *Labeo rohita*; *M. hosadurgensis* Seenappa and Manohar, 1981 from gills, muscles of *C. mrigala*; *M. shetti* Seenappa and Manohar, 1981 from gills of *C. mrigala*; *M. vedavatiensis* Seenappa and Manohar, 1981 from gills of *C. mrigala*; *M. venkateshi* Seenappa and Manohar, 1981 from gills of *C. mrigala*; *M. sophorae* Jayasri, 1982 from gills, kidney of *Puntius sophore*; *M. indirae* (Kundu, 1985) Gupta and Khera, 1988 from scales of tail fin, cartilage of head of *C. mrigala*; *M. haldari* Gupta and Khera, 1989 from fins, gills of *C. mrigala*; *M. saranae* Gupta and Khera, 1990 from gills of *P. sarana*, *L. calbasu*; *M. saranai* (Tripathi, 1952) Landsberg and Lom, 1991 from gills of *Barbus sarana*; *M. yogindrai* (Tripathi, 1952) Landsberg and Lom, 1991 from inner sides of the scales of *C. mrigala*; *M. orissae* Haldar et al. 1997 from gills of *C. mrigala*; *M. ophthalmusculata* Basu and Haldar, 2002 from eye muscle of *C. mrigala*; *M. goensis* Eiras and D'souza, 2004 from gill rakers of *Mugil cephalus*; *M. labeoi* Bounou et al. 2006 among the rays of *Labeo coubie*; *M. naini* Kaur and Singh, 2008 from mucous membrane around gill lamellae of *C. mrigala*; *M. analfinus* Basu et al. 2009 from anal fin of *Heteropneustes fossilis*; *M. csabai* Szekely et al. 2009 from renal interstitium of *Osteochilus hasselti*; *M. eirasi* Kaur and Singh, 2009a from caudal fin of *C. mrigala* and *M. splendii* Kaur and Singh, 2009b from mucous membrane around gill lamellae of *C. mrigala* but differ from all of the above in morphometric characteristics (Table 4).

The spores in the present species are oval to egg in shape with narrow rounded anterior and broad rounded posterior end. Parietal folds are absent. In this respect, it is more or less similar to *M. calbasui*; *M. haldari*; *M. hosadurgensis*; *M. indirae*; *M. mrigalae*; *M. shetti*; *M. orissae*; *M. vanivilasae*; *M. yogindrai*; *M. venkateshi*; *M. carnaticus*; *M. indicum*, *M. saranae*, *M. bhadrensis*, *M. labeoi*, *M. koli*, *M. goensis*, *M. saranai*, *M. vedavatiensis* and *M. analfinus*. In the present species, both the polar capsules are flask-shaped with a prominent neck at the anterior end but the larger polar capsule is pyriform and smaller one is more or less spherical in *M. indicum*; both polar capsules are pyriform in *M. calbasui*; *M. indirae*; *M. saranae* and *M. bhadrensis*; oval in *M. sophorae* and *M. saranai*; the larger polar capsule is oval with a knob-like structure at the anterior most part and the smaller polar capsule is oval or pyriform with a short neck in *M. analfinus*. In *M. labeoi*, spores have polar capsules without neck and differ in size from the species under study. Presence of six parietal folds in *M. goensis*; 6–8 in *M. koli* and several parietal folds in *M. mrigalae* differentiates them from the species under study. An intercapsular process is absent in the present species unlike in *M. bhadrensis* and *M. analfinus* in which it is present in the form of a thickening and an intercapsular notch respectively. An intercapsular process is also present in *M. carnaticus*; *M. haldari*;

M. hosadurgensis; *M. naini*; *M. orissae*; *M. shetti*; *M. vanivilasae*; *M. vedavatiensis* *M. venkateshi* and *M. yogindrai*.

In view of the above differences, present species under study is proposed as new species to the science and named as *M. mehlhorni* sp. nov. through this communication.

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