A report on two new myxozoan parasites infecting gills of fingerlings of Indian major carps cultured in nursery ponds in Punjab (India)

Harpreet Kaur¹ · Ishtiyak Ahmad²

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Abstract This paper presents the morphological characteristics of two new species belonging to the genus *Myxobolus* viz *M. knobii* n. sp. and *M. majraiensis* n. sp., parasites infecting gill lamellae and gill filaments of fingerlings of *Cirrhinus mrigala* (Ham.) and *Catla catla* (Ham.) respectively collected from nursery ponds located in the village Fagan Majra, District Fatehgarh Sahib, Punjab (India). A total of 90 fingerlings were examined (40 *Catla catla* and 50 *Cirrhinus mrigala*). Out of which, 32 *C. mrigala* and 19 *C. catla* fishes were found infected. The total prevalence rate was recorded as 56.66%. The age of the fish was recorded as 2–3 months and length of the fish ranged 4–4.5 cm. The plasmodia of *M. knobii* n. sp. were round to irregular, 0.6–1.0 mm in diameter. Myxospores oval to spherical, pot-shaped in frontal view with a prominent knob at anterior end, measured $5.83 \times 4.29 \mu\text{m}$ in size. Polar capsules were equal, broadly pyriform, $1.95 \times 1.70 \mu\text{m}$ in size having 3–4 polar filament coils. The plasmodia of *M. majraiensis* n. sp. were round to oval, 0.8–1.5 μm in diameter. Myxospores egg-shaped in frontal view also having prominent knob at the anterior end, measured $8.58 \times 5.2 \mu\text{m}$ in size. Polar capsules were equal, pyriform, $3.47 \times 1.80 \mu\text{m}$ in size having 5–6 polar filament coils. Gill plasmodium index showed heavy infection in both of the species. This is the first report of myxobolid infection in the fingerlings of Indian major carps in nursery ponds in Punjab (India).

Keywords Fingerlings · *Myxobolus* · Gills · Nursery ponds · Indian major carps

Introduction

Myxozoans are an economically important group of microscopic metazoan parasites of fish harvested for food. These occur in the form of minute plasmodia within or between tissues of the vertebrate host. New myxosporean pathogens are continually emerging and threatening the development of pisciculture all over the world. Myxozoan parasites are widely dispersed in native and pond-reared fish populations. Most infections in fish create minimal problems, but heavy infestations can become serious especially in fingerlings (Kaur and Ahmad 2016; Ahmad and Kaur 2017). Myxosporeans are known to infect most of the tissue and organs of fish host and usually show considerable degree of tissue and organ specificity (Csaba 1976; Mitchell 1977; Lom and Dyková 1992). Myxozoans are also found in amphibians, reptiles, annelids, platyhelminthes and have been even detected in the fecal samples of humans (Boreham et al. 1998; Moncade et al. 2001). Developmental stages have also been found in waterfowl, but no myxozoan has been known to be hazardous to human health (Lom and Dyková 2006). The landmark synopses on myxobolid species are by Eiras et al. (2005 and 2014) giving all important morphological attributes. Kaur and Singh (2012) gave a synopsis of 131 nominal species of the genus *Myxobolus* parasitizing Indian fishes.

Punjab is emerging as the major carp farming state of India with several farmers diversifying from wheat and paddy cultivation into aquaculture (Debnath et al. 2007). According to the data by Punjab Fisheries Department, there are approximately 7523 fish farms in the state with an area of 10856.6 ha under fish culture. The study site, Fagan Majra

✉ Harpreet Kaur
harpreetbimbura@gmail.com

¹ Department of Zoology, Panjab University, Chandigarh 160014, India

² Department of Zoology and Environmental Sciences, Punjabi University, Patiala 147002, India

fish farm is located in the district of Fatehgarh Sahib managed by Fisheries Department, Government of Punjab consists of a total of 59 culture ponds. Out of which 14 are hatchery/nursery ponds in which Indian major carps such as catla, rohu, mrigal, common carp, grass carp and silver carp are cultured in a semi-intensive polyculture system for supply to fish farmers all over the Punjab and adjoining states.

A large number of myxozoan species have been described infecting freshwater fishes in wetlands and aquaculture in Punjab (Singh and Kaur 2012a, b, c, d; Singh and Kaur 2014; Kaur 2014; Kaur et al. 2014a, b; Kaur and Katoch 2014, 2015; Kaur and Gupta 2015, 2016; Dar et al. 2017). In the present study, two new species belonging to the genus *Myxobolus* Butschli infecting gill lamellae and gill filaments of *Cirrhinus mrigala* (Ham.) and *Catla catla* (Ham.) have been described on the basis of morphology as per the guidelines of Lom and Arthur (1989).

Material and methods

During the present study, live fingerlings of Indian major carps were collected from nursery ponds located in the village Fagan Majra, District Fatehgarh Sahib, Punjab. The fish species examined include native carps such as *Catla catla* Hamilton vern. thail and *Cirrhinus mrigala* Hamilton vern. mrigal. A total of 90 fingerlings were examined (40 *C. catla* and 50 *C. mrigala*). Out of which, 51 fishes were found infected. The prevalence rate was recorded as 56.66%. Various organs such as gills, kidney, scales, intestine and air bladder were examined under stereozoom binocular microscope for the presence of plasmodia. Each plasmodium was carefully picked with fine forceps under stereozoom binocular microscope and teased on a clean slide, and observed under the compound microscope for the presence of myxospores. Permanent slides were made by fixing in Bouin's fixative and stained with Ziehl–Neelsen and Iron haematoxylin. The fresh myxospores were photographed under phase contrast microscope (Magnus MLX-TR) and stained preparations under Leica photographic unit at Sophisticated Instrumentation Center, Punjabi University (Patiala). Line drawings were made from stained material with the aid of camera lucida. Myxospores were measured with the help of calibrated ocular micrometer according to the guidelines given by Lom and Arthur (1989).

For calculations of prevalence, the following formula was applied.

$$\text{Prevalence (\%)} = \frac{\text{Number of infected fish}}{\text{Total number of fish examined}} \times 100$$

The gill plasmodium index (GPI) (Kaur and Attri 2015) was calculated on the basis of number of plasmodia present per gill (one side) visible under the stereozoom binocular

microscope. 0–0 (no infection-0); 1–5 (light infection-1); 5–10 (moderate infection-2); 10–20 (heavy infection-3); 20–50 (severe infection-4).

The location of myxosporean plasmodia in various tissues of the gills was determined with the help of histological sections stained with Luna's method and were categorized into types according to the guidelines of Molnar (2002).

1. *Intralamellar-epithelial type* ($LE-LE_1$, LE_2) Small plasmodia (LE_1) and large plasmodium deforming several gill lamellae (LE_2).
2. *Intralamellar-vascular type* ($LV-LV_1$, LV_2 , LV_3)
 LV_1 Plasmodium located centrally in the gill lamella
 LV_2 Plasmodium protruding from one side of the gill lamella
 LV_3 Large plasmodium deforming several gill lamellae
3. *Intrafilamental-vascular type* ($FV-FV_1$, FV_2) Small round or elongated plasmodia in the afferent artery (FV_1) and large plasmodia formed by the fusion of several plasmodia near the end of the gill filament (FV_2).
4. *Plasmodium located in the gill arch* (AC , AV , AE) Plasmodia developing in the cartilaginous structure of the gill arch (AC). In AV plasmodia develops in the blood vessels of the gill arch and in AE type plasmodia developing in the epithelial or connective tissue elements of the gill arch.

Type of Plasmodia according to size Type of Plasmodia were categorized into three types

- *Type A* Plasmodia visible under binocular microscope (size range = 40–200 μm)
- *Type B* Plasmodia visible under stereo zoom microscope (size range = 0.4–0.9 mm)
- *Type C* Plasmodia visible with naked eye (size range = 0.9–3.0 mm)

Results and discussion

Myxobolus knobii n. sp. (Figs. 1a, b, 2a, b 3a–c; Table 1)

Plasmodia

Minute, visible under stereo zoom binocular microscope, round to irregular, white, 0.4 mm in diameter, attached to gill lamellae, histozoic, 10–16 in number per gill, 800–1500 myxospores present per plasmodium. Mucous laden gills.

Myxospore description

(Measurements based on 10–12 myxospores in frontal view)

Myxospores measure $5.83 \times 4.29 \mu\text{m}$, oval to spherical, pot-shaped in frontal view having anterior end with a prominent knob and broadly rounded posterior end, sometimes a mucous envelope present at the posterior end. Sutural line curved. Both shell valves thin, smooth, symmetrical, $0.3 \mu\text{m}$ in thickness. Parietal folds absent. Polar capsules two, equal, broadly pyriform, measure $1.95 \times 1.70 \mu\text{m}$, with a distinct and narrow neck, convergent, occupying more than half of the myxospore body cavity. Polar filament coils 3–4 in number, arranged obliquely to the polar capsule axis. Intercapsular process (ICP) absent. Sporoplasm agranular, homogenous occupying rest of the myxospore body cavity. Sporoplasmic nuclei two, $0.4\text{--}0.5 \mu\text{m}$ in diameter. Iodinophilous vacuole present, $0.3 \mu\text{m}$ in diameter.

Taxonomic summary of *M. knobii* n.sp.

Family	Myxobolidae
Type host	<i>Cirrhinus mrigala</i> Hamilton vern. mrigal
Family	Cyprinidae
Age of the fish host	2–3 months
Length of the fish	4.5 cm
Type locality	Nursery Pond, Fagan Majra, District Fatehgarh Sahib, Punjab (India)
Type specimen	Paratypes are myxospores stained in Ziehl Neelsen and Iron-haematoxylin, deposited in the Parasitology Laboratory, Department of Zoology and Environmental Sciences, Punjabi University, Patiala, India
	Slide no. CM/ZN/04.01.2015 and CM/IH/04.01.2015
Site of infection	Gill lamellae (Intralamellar vascular type LV ₁)
Type of Plasmodia	Type A (visible under binocular microscope)
Prevalence of infection (%)	64% (32/50)
Gill plasmodial index (GPI)	3 (10–16 plasmodia per gill) indicating heavy infection
Clinical symptomatology	Mucous laden gills
Etymology	The species epithet ' <i>knobii</i> ' is based on the presence of a knob-like structure at the anterior end of the myxospore

Discussion

The present species is compared with morphologically similar myxospores of the species i.e. *M. bankimi* Sarkar (1999) infecting inner wall of gall bladder of *Sicamugil cascasia* Hamilton; *M. batae* Karamchandani (1970)

Fig. 1 **a** Gills of *Cirrhinus mrigala* showing plasmodia of *M. knobii* n. sp., **b** Myxospores of *M. knobii* n. sp. in fresh preparation (Phase Contrast) in frontal view (Scale bar 20 μm)

infecting gill filaments of *Labeo rohita* Hamilton; *M. calcariferum* Basu and Haldar (2003) infecting gill filaments of *Lates calcarifer*; *M. carnaticus* Seenappa and Manohar (1980) infecting gills of *Cirrhinus mrigala*; *M. cartilaginis* Hoffman et al. (1965) infecting gills and base of fin rays of *Lepomis macrochirus* and *Micropterus salmoides*; *M. clarii* Chakravarty (1943) infecting gall bladder, liver, testis, ovary and fat bodies of *Clarias batrachus* Hamilton; *M. curmucae* Seenappa and Manohar (1980) infecting scales of *Puntius curmuca*; *M. edellae* Sarkar (1999) infecting kidney of *Ctenopharyngodon idella* Hamilton; *M. indirae* Kundu (1985) infecting cartilage of head and scales of *C. mrigala* Hamilton; *M. lalithae* Gupta and Khera (1988) infecting gills of *Labeo calbasu* Hamilton; *M. macrolepi* Padma and Kalavati (Padma Dorothy and Kalavati 1992) infecting intestine of *Lizamacrolepis*; *M. mola* Sarkar (1993) infecting kidney of *Amblypharyngodon mola*; *M. narasii* Narasimhamurti (1970) infecting intestine of *Mugil waigensis*; *M. nodularis* Southwell and Prashad (1918) infecting fins, muscles, pancreas, intestine and gall

Fig. 2 **a** Myxospores of *M. knobii* n. sp. stained in Ziehl–Neelsen, **b** Myxospores of *M. knobii* n. sp. stained in Iron haematoxylin (Scale bar 20 µm)

bladder of *Rasbora daniconius* Hamilton; *M. parsi* Das (1996) infecting gills of *Liza parsia*; *M. potaili* Lalitha Kumari infecting liver and intestine of *Labeo potaili*; *M. potularis* Madhavan et al. (2013) infecting gill filaments of *Labeo bata* Hamilton, *L. calbasu* Hamilton, *L. gonius* and *Cirrhinus reba*; *M. rigida* Sarkar (1999) infecting kidney of *Amblypharyngodon mola* Hamilton; *M. serrata* Pagarkar and Das (1996) infecting gill arch of *Cyprinus carpio*; *M. seshadri* Lalitha Kumari (1969) infecting gills of *L. fimbriatus* and *M. shantipuri* Basu and Haldar (2002) infecting gill lamellae of Catla–Rohu hybrid. The present species, *M. knobii* n. sp. is compared with all the above mentioned species and is found different in myxospore morphology and morphometrics (Table 2).

The myxospores of the present species differ from *M. batae*, *M. carnaticus*, *M. cartilaginis*, *M. curmucae*, *M. lalithae*, *M. rigida* and *M. seshadri* in having a prominent intercapsular process (ICP). Furthermore *M. batae*, *M. cartilaginis*, *M. macrolepi*, *M. parsi*, *M. serrata* and *M. seshadri* differ in having parietal folds along the posterior

Fig. 3 **a** Line drawing of fresh mature myxospore of *M. knobii* n. sp. stained in Ziehl–Neelsen (Frontal view), **b** Line drawing of fresh mature myxospore of *M. knobii* n. sp. infecting gills of *C. mrigala* (Sutural view), **c** Line drawing of fresh mature myxospore of *M. knobii* n. sp. stained in Iron haematoxylin (Scale bar 5 µm)

Table 1 Measurements (µm) and ratio of *M. knobii* n. sp

Characters	Range	Mean values	SD
LS	4.83–6.83	5.83	0.42
WS	3.25–5.33	4.29	0.31
LPC	1.25–2.65	1.95	0.28
WPC	1.18–2.22	1.70	0.22
Ratio: LS/WS		1.35	
ICP		Absent	
NC		3–4	
Parietal folds		Absent	

margin of the shell valves. In addition to this, *M. carnaticus*, *M. curmucae*, *M. lalithae*, *M. mathuri*, *M. seshadri* and *M. shantipuri* differ from the present species in having unequal polar capsules.

The present species is characterized in having pot-shaped myxospore body with a prominent knob-like structure at the anterior end, pyriform polar capsules with narrow neck. In this respect, it is comparable to *M. bankimi*, *M. calcafirm*, *M. clarii*, *M. edella*, *M. indiriae*, *M. narasii*, *M. nodularis* and *M. potaili*, however the knob-like structure is absent in the above mentioned species, in contrast to a prominent one in the present species. Furthermore, the present species resemble *M. mola* (knob-like structure seen in the line drawings but not mentioned

Table 2 Comparative description of *M. knobii* n. sp. with morphologically similar species (measurements in micrometer)

Species	Host	Site of infection	Locality	Myxospore	Polar capsule
<i>M. knobii</i> n. sp. (Present study)	<i>Cirrhinus mrigala</i>	Gill lamellae	Nursery Pond, Fagan Majra, Punjab (India)	5.83 × 4.29	1.95 × 1.70
<i>M. molae</i> Sarkar (1993)	<i>Amblypharyngodon mola</i>	Kidney	West Bengal (India)	9.00 × 7.4	6.00 × 1.55
<i>M. potularis</i> Madhavan et al. (2013)	<i>Labeo calbasu</i> , <i>L. bata</i> , <i>L. gonius</i> , <i>Cirrhinus reba</i>	Gill filament	West Bengal (India)	9.0 × 6.0	5.4 × 2.2
<i>M. nodularis</i> Southwell and Prashad (1918)	<i>Rasbora daniconius</i>	Fins, Muscles, Intestine	Kerala (India)	9.00 × 7.2	3.4 × 1.87
<i>M. clarii</i> Chakravarty (1943)	<i>Clarias batrachus</i>	Gall bladder, Liver	West Bengal (India)	11.85 × 10.3	6.1 × 3.0
<i>M. carilaginis</i> Hoffman et al. 1965	<i>Lepomis macrochirus</i> , <i>Micropterus salmoides</i>	Gills, Base of fin rays	Haryana (India)	10.8 × 9.5	5.3 × 3.1
<i>M. potaili</i> Lalitha Kumari (1969)	<i>Labio potail</i>	Liver and Intestine	Andhra Pradesh (India)	7.2 × 5.4	3.3 × 2.0
<i>M. seshadri</i> Lalitha Kumari (1969)	<i>Labeo fimbriatus</i>	Gills	Andhra Pradesh (India)	12.21 × 9.04	5.7 × 3.66(L) 4.9 × 2.99(S)
<i>M. batae</i> Karamchandani 1970	<i>Labeo bata</i>	Gill filament	Orissa (India)	10.4 × 8.0	4.4 × 1.6
<i>M. narasii</i> Narasimhamurti (1970)	<i>Mugil waeigensis</i>	Intestine	Andhra Pradesh (India)	12.8 × 9.0	3.2 × 1.7
<i>M. carnaticus</i> Seenappa and Manohar, (1980)	<i>C. mrigala</i>	Gills	Karnataka (India)	8.6 × 6.8	3.8 × 2.0(L) 2.1 × 1.5(S)
<i>M. indirae</i> Kundu (1985)	<i>C. mrigala</i>	Scales, Cartilage of head	West Bengal (India)	12.6 × 9.6	4.7 × 2.2
<i>M. lalithae</i> Gupta and Khera (1988)	<i>L. calbasu</i>	Gills	Punjab (India)	10.0 × 8.4	5.8 × 4.8(L) 3.05 × 2.85(S)
<i>M. macrolepi</i> Padma Dorothy and Kalavati (1992)	<i>Liza macrolepis</i>	Intestine	Andhra Pradesh (India)	6.28 × 5.26	2.78 × 2.0
<i>M. serrata</i> Pagarkar and Das (1993)	<i>Cyprinus carpio</i>	Gill arch	West Bengal (India))	9.07 × 8.5	4.47 × 2.6
<i>M. parsi</i> Das (1996)	<i>Liza parsi</i>	Gills	West Bengal (India)	9.1 × 8.1	4.4 × 2.8

in the original description) and *M. potularis* in having similar myxospore shape and knob-like structure at the anterior end. *M. molae* differ in having a short intercapsular process (ICP) and *M. potularis* differ in having much larger myxospore size (9.0×6.0 vs. 5.8×4.2 μm), more slender myxospore (as indicated by LS/WS ratio 1.5 vs. 1.35 μm) and polar capsules occupying more than half of the myxospore body cavity (less than half in the present species).

In view of the above differences the present species has been proposed as new to science and named as *M. knobii* n. sp.

***Myxobolus majraiensis* n. sp. (Figs. 4a, b, 5a, b, 6a–c; Table 3)**

Plasmodia

Round to oval, small, visible under stereozoom binocular, creamish, 0.4 mm in diameter, attached to the gill lamellae,

Fig. 4 **a** Gills of *Catla catla* showing plasmodia of *M. majraiensis* n. sp., **b** Myxospores of *M. majraiensis* n. sp. in fresh preparation (Phase Contrast) in frontal view (Scale bar 20 μm)

histozoic, 15–20 in number per gill, 1000–1200 myxospores present per plasmodium. Mucous laden gills.

Myxospore description

(Measurements based on 10–12 myxospores in frontal view)

Myxospores measure 8.58×5.2 μm , egg-shaped in frontal view, ellipsoidal in sutural view, having both ends rounded with a prominent knob at the anterior end. Sutural line slightly curved. Both shell valves smooth, symmetrical, 0.4 μm in thickness. Parietal folds absent. Polar capsules two, equal, pyriform, measure 3.47×1.80 μm with bluntly pointed anterior end and broad rounded posterior end. Both converge anteriorly and placed at a distance posteriorly, occupying less than half of myxospore body cavity. Polar filament form 5–6 coils arranged perpendicular to the polar capsule axis. Intercapsular process (ICP) absent. Sporoplasm agranular, homogenous, with two nuclei, 0.3–0.5 μm in diameter. Iodinophilous vacuole absent.

Taxonomic summary of *M. majraiensis* n. sp.

Family	Myxobolidae
Type host	<i>Catla catla</i> Hamilton vern. thail
Family	Cyprinidae
Age of the fish host	2–3 months
Length of the fish	4 cm
Type locality	Nursery Pond, Fagan Majra, District Fatehgarh Sahib, Punjab (India)
Type specimen	Paratypes are myxospores stained in Ziehl–Neelsen and Iron-haematoxylin, deposited in the Parasitology Laboratory, Department of Zoology Environmental Sciences, Punjabi University, Patiala, India
	Slide no. CC/ZN/12.03.2015 and CC/IH/12.03.2015
Site of Infection	Gill lamellae (Intralamellar vascular type LV1)
Type of Plasmodia	Type A (visible under binocular microscope)
Prevalence of Infection (%)	47.5% (19/40)
Gill plasmodial index (GPI)	3 (15–20 plasmodia per gill) indicating heavy infection
Clinical symptomatology	Mucous laden gills
Etymology	The specific epithet ' <i>majraiensis</i> ' has been given on the basis of its locality Fagan Majra, District Fatehgarh Sahib, Punjab (India)

Discussion

The present species is compared with morphologically similar myxospores of the species i.e. *M. batae* Karamchandni (Karamchandani 1970) infecting gill filaments of

Fig. 5 **a** Myxospore of *M. majraiensis* n. sp. stained in Ziehl–Neelsen, **b** Myxospore of *M. majraiensis* n. sp. stained in Iron haematoxylin (Scale bar 20 µm)

Labeo bata Hamilton; *M. bhadrensis* Seenappa and Manohar (Seenappa and Manohar 1981) infecting muscle of *Labeo rohita* Hamilton; *M. carnaticus* Seenappa and Manohar (1980) infecting gills of *Cirrhinus mrigala*; *M. cartilaginis* Hoffman et al. (1965) infecting gills and cartilage of the branchial arches of *Lepomis macrochirus* and *Micropterus salmoides*; *M. curmucae* Seenappa and Manohar (Seenappa and Manohar 1980) infecting scales of *Puntius curmuca*; *M. dermatis* Haldar et al. (1981) infecting scales of *L. rohita* Hamilton; *M. eeli* Mandal and Nair (1975) infecting inner wall of intestine of *Mastacembelus armatus*; *M. episquammalis* Egusa et al. (Egusa et al. 1990) infecting gills and intestine of *Mugil cephalus* and *Liza macrolepis*; *M. lalithae* Gupta and Khera (1988) infecting gills of *L. calbasu* Hamilton; *M. macrolepi* Padma and Kalavati (Padma Dorothy and Kalavati 1992) infecting intestine of *Liza macrolepis*; *M. molae* Sarkar (1993) infecting kidney of *Amblypharyngodon mola*; *M. parvus* Schulman (Shulman 1962) infecting gill rakers of

Fig. 6 **a** Line drawing of fresh mature myxospore of *M. majraiensis* n. sp. stained in Ziehl–Neelsen (Frontal view), **b** Line drawing of fresh mature myxospore of *M. majraiensis* n. sp. infecting gills of *C. catla* (Sutureal view), **c** Line drawing of fresh mature myxospore of *M. majraiensis* n. sp. stained in Iron haematoxylin (Scale bar 5 µm)

Table 3 Measurements (µm) and ratio of *M. majraiensis* n. sp

Characters	Range	Mean values	SD
LS	7.60–9.56	8.58	0.64
WS	4.27–6.27	5.27	0.42
LPC	2.65–4.29	3.47	0.21
WPC	1.10–2.50	1.80	0.28
Ratio: LS/WS		1.62	
ICP		Absent	
NC		5–6	
Parietal folds		Absent	

Mugil cephalus; *M. serrate* Pagarkar and Das (1993) infecting gill arch of *Cyprinus carpio*; *M. seshadri* Lalitha Kumari (1969) infecting gills of *L. fimbriatus*; *M. shantipuri* Basu and Haldar (2002) infecting gill lamellae of Catla–Rohu hybrid; *M. shetti* Seenappa and Manohar (1981) infecting gills of *Cirrhinus mrigala* Hamilton; and *M. vedavatiensis* Seenappa and Manohar (1981) infecting gills of *C. mrigala* Hamilton. All of the above species are different from the present species in morphological and morphometric characteristics (Table 4).

Table 4 Comparison of *M. majraiensis* n. sp. with morphologically similar species (measurements in micrometer)

Species	Host	Site of infection	Locality	Myxospore	Polar capsule
<i>M. majraiensis</i> n. sp. (Present study)	<i>Catla catla</i>	Gill filament	Nursery Pond, Fagan Majra, Punjab, (India)	8.58 × 5.27	3.47 × 1.80
<i>M. potularis</i> Madhavan et al. (2013)	<i>Labeo calbasu</i> , <i>L. bata</i> , <i>L. gonius</i> , <i>Cirrhinus reba</i>	Gill filament	West Bengal (India)	9.0 × 6.0	5.4 × 2.2
<i>M. potaili</i> Lalitha Kumari (1969)	<i>Labeo potail</i>	Liver and Intestine	Andhra Pradesh (India)	7.2 × 5.4	3.3 × 2.0
<i>M. seshadri</i> Lalitha Kumari (1969)	<i>Labeo fimbriatus</i>	Gills	Andhra Pradesh (India)	12.21 × 9.04	5.7 × 3.66(L) 4.9 × 2.99(S)
<i>M. batae</i> Karamchandani (1970)	<i>L. bata</i>	Gill filament	Orissa (India)	10.4 × 8.0	4.4 × 1.6
<i>M. carnaticus</i> Seenappa and Manohar (1980)	<i>Cirrhinus mrigala</i>	Gills	Karnataka (India)	8.6 × 6.8	3.8 × 2.0(L) 2.1 × 1.5(S)
<i>M. shetti</i> Seenappa and Manohar (1981)	<i>C. mrigala</i>	Gills	Karnataka (India)	8.8 × 7.4	3.4 × 2.3
<i>M. vedavatiensis</i> Seenappa and Manohar (1981)	<i>C. mrigala</i>	Gills	Karnataka (India)	13.8 × 9.2	6.2 × 3.4(L) 3.9 × 2.6(S)
<i>M. lalithae</i> Gupta and Khera (1988)	<i>L. calbasu</i>	Gills	Punjab (India)	10.0 × 8.4	5.8 × 4.8(L) 3.05 × 2.85(S)
<i>M. mola</i> Sarkar (1993)	<i>Amblypharyngodon mola</i>	Kidney	West Bengal (India)	9.00 × 7.4	6.00 × 1.55
<i>M. shantipuri</i> Basu and Halder (2002)	Catla–Rohu hybrid	Gill lamellae	West Bengal (India)	7.3 × 5.8	4.0 × 2.4

The present species is closely compared with morphologically similar myxospores of the species reported from the gills of cyprinid fishes from Indian subcontinent, these include *M. batae*, *M. carnaticus*, *M. lalithae*, *M. mola*, *M. potaili*, *M. shantipuri*, *M. seshadri*, *M. shetti* and *M. vedavatiensis*. All these species differ from the present species in having prominent intercapsular process (ICP). Furthermore, *M. carnaticus*, *M. lalithae*, *M. seshadri* and *M. vedavatiensis* differ in having unequal polar capsules.

The present species is characterized in having egg-shaped/sub-spherical myxospores with a prominent knob at the anterior end. In this respect, the present species is compared with *M. potaili* and *M. potularis* in which a knob-like structure is present. *M. potaili* differ in having intercapsular process (ICP) and *M. potularis* differ from the present species in having a peculiar shape of the myxospore i.e. pot-like, in contrast to egg-shaped myxospores in the present species.

In view of the above differences the present species has been considered as new to science and named as *M. majraiensis* n. sp.

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Compliance with ethical standards

Conflict of interest There is no conflict of interest to disclose.

Ethical approval Not required as per the guidelines of Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA).

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