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Biodiversity of myxozoan parasites infecting freshwater fishes of three main wetlands of Punjab, India

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Summary

Material pertaining to the present investigation was collected from three main wetlands of Punjab (included in Ramsar list of International importance), i.e. Harike, Kanjali and Ropar wetlands. Extensive collection tours were made to these wetlands during the period from May, 2006 to April, 2010. A large number of important commercial fishes of these wetlands are vulnerable to various infections, out of which myxozoans are emerging as the major group. Various organs such as gills, fins, scales, skin, eye, stomach, intestine etc. were found to be infected with plasmodia of as many as 45 species of myxozoans representing 4 genera, namely, *Myxobolus* (26 species), *Thelohanellus* (16 species), *Neothelohanellus* (1 species) and *Triangula* (2 species) were recorded. Two species belonging to the genus *Myxobolus*, i.e. *M. moli* Fomena and co-authors (1985) and *M. stomum* Ali and co-authors (2003) were recorded from gills and scales of *Amblypharyngodon mola* and *Labeo rohita* respectively for the first time in India.

Key words: freshwater fishes, Myxozoa, *Plasmodium*, wetlands of Punjab

Introduction

Myxozoans are one of the economically important groups of microscopic metazoan parasites as they infect fish harvested for food. New myxosporean pathogens are continually emerging and threatening the development of pisciculture all over the world. They cause production losses and some fish have to be discarded because they are unsightly and not considered to be fit for human consumption. Myxozoans undergo a complex, multicellular development, culminating in the formation of a multicellular spore that is resistant to the external environment. Markiw and Wolf (1983) and Wolf and Markiw (1984) made a landmark discovery on the life cycle of *Myxobolus cerebralis* involving alteration with an actinosporean form in *Tubifex tubifex*. Subsequently, involvement of annelid worms in the life cycle of some 30 other freshwater myxozoan have been documented (El-Matbouli and Hoffman, 1989, 1993; Kent et al., 1993a, 1993b; El-Mansy and Molnar, 1997; Eszterbauer et al., 2000; Kallert et al., 2005). Similar life cycle has also been described for other genera which include *Henneguya, Sphaerospora, Ceratomyxa, Myxidium, Zschokkela, Thelohanellus, Hoferellus* and *Tetracapsula*. New aquaculture practice such as intensive and polyculture systems have been widely introduced. Growing more fish on a limited area often resulted in increased disease outbreaks (Hoffman and Bauer, 1971).

Although myxozoans are best known for the infection they cause in teleost (bony fish), a small number of species have also been found parasitizing bryozoans, platyhelminths, annelids, marine fishes, amphibians, reptiles and birds. So far 19 species have been described from amphibians and reptiles belonging to the genera *Myxobolus, Myxidium, Hoferellus, Chloromyxum, Caudomyxum* and *Sphaerospora* (Eiras, 2005). Developmental stages were also found in waterfowl, in nervous system of mammals and were even detected in human faeces (Moncada et al., 2001) but no myxozoan has been known to be hazardous to human health.

Probably the most frequently cited example of myxozoan parasitism is the whirling disease, caused by *M. cerebralis* (Hedrick et al., 1998). In this case, the parasite infects the cartilages of the host's head and spine, causing deformities that result in the characteristic whirling behavior. Others that are associated with host mortalities are *Tetracapsuloides bryosalmonae*, the cause of proliferative kidney disease in Pacific salmon (Kent et al., 2001), *Enteromyxon leei*, an intestinal parasite of Mediterranean sea bream (Diamant, 1992) and *Henneguya ictaluri* in pond-reared catfish (Pote et al., 2000). Recently, Hemananda and co-authors (2008) reported *Henneguya manipurensis* as the main cause of ulcerative disease syndrome in freshwater fish *Anabas testudinus* of Manipur (India).

These are just a few examples of myxozoans that play a role in causing diseases of commercially important fish. Most species of *Kudoa* are recognized for their impacts on marketability of commercially important fish host, rather than causing host mortalities. Egusa (1986) and Moran and co-authors (1999) observed that *Kudoa thyrsites* not only form muscle cysts, but are also responsible for post-mortem degradation in their hosts. Similar observations were also made by Kudo and co-authors (1987) and Yokoyama and co-authors (2004) that some species of *Kudoa* dwell in the myofiber by forming pseudocysts and cause post-mortem myoliquification known as post harvest of flesh or jelly meat. Szczepaniak and co-authors (2010) discussed that cutaneous myxosporidiasis is common in fishes and is usually caused by species belonging to genera *Myxobolus* (*M. squamae, M. ellipsoids, M. sandrae* and *M. cotlani*), *Sphaerospora* (*S. carassii* and *S. molnari*), *Thelohanellus* (*T. dogieli*) and *Henneguya* (*H. wolinensis*).

Dykova and co-authors (1986), Bauer and co-authors (1991) and Kovac-Geyer and Molnar (1983) observed that in farmed carp, *Myxobolus* spp caused locomotory disturbances coupled with emaciation and sunken eyes in the cases of brain infection, anaemia, haemorrhagic dropsy and mortality in the cases of heavy cardiac infection and circulatory dysfunction in infection at the base of the gill lamellae respectively. Martins and co-authors (1997, 1999b), Adriano and co-authors (2005a, 2005b) and Feist and Longshaw (2006) recorded significant tissue damage and occasionally death in gill infections by myxosporea. Earlier, Rukyani (1990) reported congestion caused by hypertrophy and inflammation due to rupture of cysts in cases of heavy infections with *M. koi* in gills of carp. Damage to the gills resulted in respiratory problems and fish were swimming near the surface with distended opercula. Dykova and Lom (1982) demonstrated that *Sphaerospora renicola* proliferating in the renal tubules damaged the renal tubuli epithelium and the released spores congested excretory passages in carp and gold fish. Paperna and Overstreet (1981) and Kalavati and Narashimhamurti (1985) reported that rupture of cysts that caused intense haemorrhage sometimes resulting in considerable loss of blood and facilitated invasion of secondary opportunistic pathogens.

In Punjab, there are 12 natural, 10 man-made wetlands covering the area of 15,500 ha. and only 3 main wetlands are included in Ramsar list of International importance, i.e. Harike, Kanjali and Ropar wetlands (Fig. 1). State has 2 other wetlands of national importance and 5 of state importance (ENVIS Centre, PSCST, Punjab; The Tribune, Feb 04, 2008). These wetlands have extremely rich biodiversity as they support a variety of plant and animal life. Out of 3 wetlands, the Harike wetland is located at the confluence of two major rivers of Punjab namely Sutlej and Beas. It falls in three districts of Amritsar, Ferozepur and Kapurthala and is the largest freshwater wetland in northern India occupying 4,100 ha. It is ecologically important having an extremely rich biodiversity with as many as 26 species of fishes. Kanjali wetland with an area of 183 ha. supports diversity of resident and migratory birds, nurture large number of fish fauna with as many as 17 species of fishes. Ropar wetland is a unique wetland being located in the lap of Shivalik foothills, is an important habitat of many species and has tremendous ecological value, spread over 1,365 ha.; this wetland supports as many as 35 species of fishes. A large variety of fishes in these wetlands are vulnerable to various parasitic infections, out of which Myxozoa is emerging as the major group.

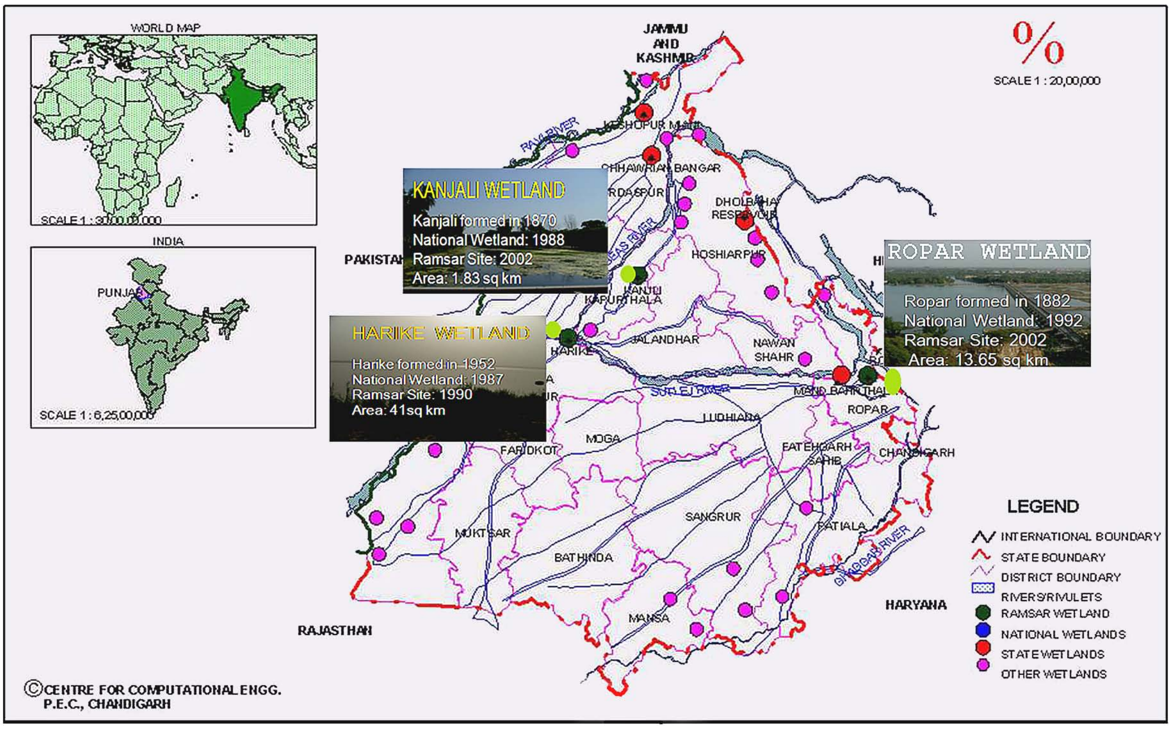

Fig. 1. Location map of wetlands in Punjab.

Material and methods

Fishes collected from Harike, Kanjali and Ropar wetlands were brought to the laboratory and examined for the myxozoan infection. Plasmodia when found were removed and teased on slide and covered with cover slip to examine the myxospores. Fresh spores were treated with 8% KOH solution for the extrusion of polar filaments. For permanent preparation, air-dried smears were stained with Ziehl-Neelsen and Iron-haematoxylin. Spores were measured with the help of a calibrated ocular micrometer. All measurements are in microns (μm). For calculations of prevalence, mean intensity and abundance, the following formulae were applied.

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

(b) **Mean Intensity** $= \dfrac{\text{Number of collected parasites}}{\text{Number of infected fish}}$

(c) **Abundance** $= \dfrac{\text{Number of collected parasites}}{\text{Number of fish examined}}$

Results and discussion

During the present study on three wetlands of Punjab, a total of 1,397 fishes belonging to 7 families and 15 genera were examined for the presence of myxozoan parasites (Table 1). Different organs such as gills, fins, scale, skin, eye ball and duodenum were found infected in 780 fishes with the 55.8% of infection. As many as 45 species of myxozoans representing 4 genera, namely, *Myxobolus* (26 species), *Thelohanellus* (16 species), *Neothelohanellus* (1 species) and *Triangula* (2 species) were recorded.

Prevalence rate was found to be the highest in *Labeo rohita* (72.7%) and *L. bata* (72.7%) followed by *Labeo dero* (33.3%) in Ropar wetland. In Kanjali wetland, the prevalence rate was highest in *C. mrigala* (85.4%) followed by *Labeo calbasu* (83.3%) and *Labeo rohita* (75%). In Harike wetland, the prevalence rate was highest in *Wallago attu* (84.6%) followed by *Catla catla* (83.3%) and *Amblypharyngodon mola* (66.6%) (Tables 2, 3 and 4). Fishes of Kanjali wetland were found to be more infected (71.1%) in comparison to Harike wetland (60.8%) followed by Ropar wetland (28.7%).

Two species belonging to the genus *Myxobolus*, i.e. *M. moli* (Fomena et al., 1985) and *M. stomum* (Ali et al., 2003) were recorded from gills and scales of *A. mola* and *L. rohita* respectively for the first time in India.

In the three wetlands of Punjab, 13 species of carps, 2 species of catfishes (*Wallago attu, Mystus seenghala*), 2 species of murrels (*Ophiocephalus punctatus, O. marulius*) and 1 species each of gourami (*Colisa lalia*), batchwas (*Eutropiichthys murius*)

Table 1. Fish hosts and their parasites.*

S. No.	Host examined	Number examined	Number infected	Myxozoan parasites recorded
1	*Amblypharyngodon mola* vern. mola carplet, molelia (common name: makhani)	30	10	*Myxobolus moli* Fomena et al., 1985 (revised diagnosis and new nomenclature *Myxobolus* sp. 4 Fomena et al.,1985)
2	*Carassius carassius* vern. crucian carp (common name: carp)	80	Nil	—
3	*Catla catla* vern. thail (common name: thail)	172	71	*Myxoblus catli* Kaur and Singh (2011c); *M. magauddi* (Bajpai et al., 1981) Gupta and Khera, 1988; *M. parsi* Das (1996); *M. sclerii* Kaur and Singh (2010a); *Thelohanellus boggoti* Qadri (1962); *T. kanjalensis* sp. nov. Singh (2011); *T. mrigalae* Tripathi (1952); *T. mucousalis* sp. nov. Singh (2011); *T. thaili* sp. nov. Singh (2011)
4	*Cirrhina reba* vern. mori, kursa (common name: mori, sunni)	50	35	*Myxobolus kalmani* Kaur and Singh (2011c); *Triangula ludhianae* (syn. *Myxobolus ludhianae* Gupta and Khera, 1991) Kaur and Singh, 2012; *Thelohanellus kalavatae* sp. nov. Singh (2011); *T. haldari* Singh (2011); *T. globulosa* Singh (2011); *Triangula cirrhini* Kaur and Singh (2012)
5	*Cirrhina mrigala* vern. mrigal (common name: naraini, marakh)	364	185	*Myxobolus bhadurius* (Sarkar 1985) Gupta and Khera, 1988; *M. eirasi* Kaur and Singh (2009); *M. kanjali* Kaur and Singh (2011d); *M. mehl-horni* Kaur and Singh (2011b); *M.. naini* Kaur and Singh (2008); *M. punjabensis* Gupta and Khera (1989); *M. ropari* Kaur and Singh (2011d); *M. slendrii* Kaur and Singh (2010b); *M. venkateshi* Seenappa and Manohar (1981); *M. harikensis* Kaur and Singh (2011e)
6	*Colisa lalia* vern. gurami (common name: dwarf gurami)	20	Nil	—
7	*Ctenopharngodon idella* vern. grass carp (common name: grass carp)	70	Nil	—
8	*Cyprinus carpio* vern. mirror carp (common name: mirror carp)	30	Nil	—
9	*Eutropiichthys murius* vern. dhungi, piassi (common name: not known)	70	Nil	—
10	*Hypophthalmichthys molitrix* vern. silver carp, brigade (common name: silver carp)	30	Nil	—
11	*Labeo bata* vern. bata (common name: bata)	37	8	*Thelohanellus avijiti* Basu and Haldar (2003)
12	*Labeo calbasu* vern. kalbans (common name: kalbasu)	60	25	*Myxobolus filamentosus* (Haldar et al., 1981) Gupta and Khera, 1988; *Thelohanellus caudatus* Pagarkar and Das (1993); *T. gangeticus* Tripathi (1952); *T. kalbensi* sp. nov. Singh (2011); *Neothelohanellus indicus* (Gupta and Khera, 1988) Lom and Dykova, 1992
13	*Labeo dero* vern. gid (common name: gid)	30	10	*Thelohanellus deri* sp. nov. Singh (2011)
14	*Labeo rohita* vern. rohu (common name: rohu)	135	58	*Myxobolus patialensis* Kaur and Singh (2011a); *M. punjabii* Kaur and Singh (2010/2011); *M. saugati* Kaur and Singh (2011f); *M. saranae* Gupta and Khera (1990); *M. stomum* Ali et al., (2003); *M. sushmii* Kaur and Singh (2010/2011); *Thelohanellus rohi* sp. nov. Singh (2011)
15	*Mystus seenghala* vern. seenghala (common name: seenghala)	30	Nil	—
16	*Notopterus notopterus* vern. parri (common name: grey featherback)	25	Nil	—
17	*Ophiocephalus marulius* vern. Sol (common name: giant snake head)	15	Nil	—
18	*Ophiocephalus punctatus* vern. damra (common name: spotted snakehead)	10	Nil	—
19	*Puntius sophore* vern. chital, ticker barb (common name: spot fin swamp barb)	25	20	*Myxobolus chittalii* Kaur and Singh (2011b)
20	*Wallago attu* vern. mulle (common name: boal, freshwater shark)	114	40	*Myxobolus duodenalis* Kaur and Singh (2011a); *M. szekeli* Kaur and Singh (2011f); *Thelohanellus batae* Lalitha Kumari (1969); *T. wallagoi* Sarkar (1985)

* Total number of fishes examined = 1.397, total number of fishes infected = 78, total prevalence= 55.8%.

Table 2. Biodiversity of myxozoan parasites in Ropar wetland.*

S. No.	Host examined	Number examined	Number infected	Organs examined	Organs infected	Infection in percentage (%)	Myxozoan parasites recorded
1	*Carassius carassius*	50	Nil	gills, fin, scales, skin, air bladder, gall bladder, body- cavity, eye, stomach, intestine	Nil	—	—
2	*Catla catla*	35	23	-do-	gills, scales	65.7%	*Myxobolus catli*
3	*Cirrhina mrigala*	35	25	-do-	gills, fin	71.4%	*Myxobolus eirasi; M. ropari; M. slendrii; M. venkateshi*
4	*Colisa lalia*	20	Nil	-do-	Nil	—	—
5	*Ctenopharyngodon idella*	70	Nil	-do-	Nil	—	—
6	*Cyprinus carpio*	20	Nil	-do-	Nil	—	—
7	*Eutropiichthys murius*	40	Nil	-do-	Nil	—	—
8	*Hypophthalmichths molitrix*	20	Nil		Nil	—	—
9	*Labeo bata*	22	16	-do-	gills, fin	72.7%	*Thelohanellus avijiti*
10	*Labeo dero*	30	10	-do-	gills, fin	33.3%	*Thelohanellus deri*
11	*Labeo rohita*	55	40	-do-	fin, scales	72.7%	*Myxobolus patialensis; M. stomum; Thelohanellus rohi*

* Total number of fishes examined = 397, total number of fishes infected=114, total prevalence= 28.7%.

and grey feather back (*Notopterus notopterus*) were examined. A total of 1,158 carps were examined which comprised mola carplet, crucian carp, thail, reba carp, mrigal, grass carp, mirror carp, silver carp, bata, kalbans, gid, rohu, and blackspot barb. Among them 402 carps (9 species) were infected (34.71%) with as many as 40 species of myxosporeans belonging to genera *Myxobolus, Thelohanellus, Neothelohanellus* and *Triangula*. In addition to this, a total of 144 catfishes naming seenghala and mulle were examined, 40 were found infected (27.7%) with 4 species of myxozoans (*Myxobolus duodenalis, M. szekeli, Thelohanellus batae* and *T. wallagoi*). No infection was found in murrels, gourami, batchwas and grey feather back fishes. The present study indicated that the maximum mean intensity of the parasite species was shown by *Myxobolus duodenalis* followed by *Triangula cirrhini* and maximum abundance again by *M. duodenalis* followed by *M. szekeli* (Table 5).

Four major carps examined were *C. mrigala, L. rohita, Catla catla* and *L. calbasu*. Among these *Catla catla* was most susceptible to myxozoans (9 species) followed by *C. mrigala* (8 species), *C. reba* (8 species), *L. rohita* (7 species) and *L. calbasu* (5 species). Kalavati and Nandi (2007) also discussed that out of three major carps in India, the most susceptible was *L. rohita*, followed by *C. mrigala* and *Catla catla*. Furthermore, they reported that the parasite virulence was greater in *Catla catla* with mortality up to 80-90%.

The present study indicated that gills (45.6%), caudal fin (29.4%), duodenum (5.12%), scales (16.1%), pectoral fin (1.92%), pelvic fin (1.67%), eyeball (1.4%), skin of snout (0.38%) and stomach (0.12%) were infected. However, no infection could be detected in air bladder, gall bladder, coelomic cavities, buccal cavity and muscles beneath skin. Longshaw and co-authors (2005) also made similar findings and reported that majority of infections with *Myxobolus* sp. were found in the gills in cyprinids. Earlier, to this Martins and co-authors (1999a) also reported 79.2% of infection in the gills of Pacu (*Piaractus mesopotamicus*) with *M. colossomatus* and *Henneguya piaractus*. Kalavati and Nandi (2007) discussed that gill myxoboliosis was the most widely distributed disease infecting various species of carps in many states in India and also reported heavy mortality in Andhra Pradesh during November and December, 2000.

Table 3. Biodiversity of myxozoan parasites in Kanjali wetland.*

S. No.	Host examined	Number examined	Number infected	Organs examined	Organs infected	Infection in percentage (%)	Myxozoan parasites recorded
1	*Carassius carassius*	10	Nil	gills, fin, scales, skin, air bladder, gall bladder, body-cavity, eye, stomach, intestine	Nil	—	—
2	*Catla catla*	77	60	-do-	gills, fin, scales, eye-ball, skin	77.9 %	*Myxobolus magauddi;M. sclerii; Thelohanellus kanjalensis; T. mrigalae; T. thaili*
3	*Cirrhina mrigala*	302	258	-do-	gills, fin	85.4%	*Myxobolus eirasi; M. kanjali; M. naini; M. punjabensis; M. venkateshi*
4	*Cyprinus carpio*	10	Nil	-do-	Nil	—	—
5	*Eutropiichthys murius*	10	Nil	-do-	Nil	—	—
6	*Hypophthalmichthys molitrix*	10	Nil	-do-	Nil	—	—
7	*Labeo calbasu*	60	50	-do-	scales, fin, gills	83.3%	*Thelohanellus caudatus; T. gangeticus; T. kalbensi; Myxobolus filamentosus; M. venkateshi; Neothelohanellus indicus*
8	*Labeo rohita*	40	30	-do-	fin, scales	75%	*Myxoblus punjabii; M. saranae; M. saugati*
9	*Mystus seenghala*	10	Nil	-do-	Nil	—	—
10	*Notopterus notopterus*	10	Nil	-do-	Nil	—	—
11	*Ophiocephalus punctatus*	10	Nil	-do-	Nil	—	—
12	*Wallago attu*	10	Nil	-do-	Nil	—	—

* Total number of fishes examined = 559, total number of fishes infected = 398, total prevalence= 71.1%.

During the present study, 4-6 plasmodia were found to be present per scale and 5-7 plasmodia were recorded per fin. Molnar (1997) also reported up to 7 plasmodia of *M. squamaphilus* per scale in sea bream, *Abramis brama*.

The present study exhibited 36% infection in carps. Wang and co-authors (2003) and Wu and Wang (1997) reported more than 60% infection in carp fishes in China while Bauer and co-authors (1991) and Yokoyama and co-authors (1996) reported more than 10% infection rate in carp fishes in Russia and Japan (Tokyo), respectively. In the present study, no infection was found in *Cyprinus carpio* as also observed by Martin and co-authors (1999a) from Brazilian fishes.

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Table 4. Biodiversity of myxozoan parasites in Harike wetland.*

S. No.	Host examined	Number examined	Number infected	Organs examined	Organs infected	Infection in percentage (%)	Myxozoan parasites recorded
1	*Amblypharyngodon mola*	30	20	gills, fin, scales, skin, air bladder, gall bladder, body-cavity, eye, stomach, intestine	gills, caudal fin	66.6%	*Myxobolus moli*
2	*Catla catla*	60	50	-do-	scales, gills	83.3%	*Myxobolus parsi; Thelohanellus mucousalis; T. boggoti*
3	*Cirrhina reba*	50	40	-do-	gills, caudal fin, scales	80%	*Myxobolus kalmani; Triangula cirrhini; T. ludhianae; Thelohanellus globulosa; T. haldari; T. kalavatae*
4	*Cirrhina mrigala*	27	20	-do-	gills, caudal fin	74.0%	*Myxobolus bhadurius; M. mehlhorni; M. harikensis*
5	*Carassius carassius*	20	Nil	-do-	—	—	—
6	*Eutropiichthys murius*	20	Nil	-do-	—	—	—
7	*Labeo bata*	15	Nil	-do-	—	—	—
8	*Labeo rohita*	40	30	-do-	eye-ball, gills, fin, scales	75%	*Myxobolus sushmii*
9	*Notopterus notopterus*	15	Nil	-do-	—	—	—
10	*Ophiocephalus marulius*	15	Nil	-do-	Nil	—	—
11	*Mystus seenghala*	20	Nil	-do-	—	—	—
12	*Puntius sophore*	25	20	-do-	gills	80%	*Myxobolus chittalii*
13	*Wallago attu*	104	88	-do-	fin, wall of duodenum	84.6%	*Myxobolus duodenalis; M. szekeli; Thelohanellus batae; T. wallagoi*

* Total number of fishes examined = 441, total number of fishes infected = 268, total prevalence= 60.8%.

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Table 5. Prevalence of myxozoan parasites in the fishes collected from wetlands of Punjab.*

S. No.	Genus	Site of infection	No. of examined fish	No. of infected fish	No. of collected parasite	Prevalence (%)	Mean intensity	Abundance (%)
1	*Myxobolus bhadurius*	Gill lamellae	35	13	117	37.14%	9	3.3
2	*Myxobolus catli*	Gill lamellae	40	13	117	32.5%	9	2.9
3	*Myxobolus chittalii*	Gill lamellae	40	13	247	32.5%	19	6.1
4	*Myxobolus duodenalis*	Inner wall of the duodenum	40	25	5925	62.5%	237	148.1
5	*Myxobolus eirasi*	Caudal fin	30	25	2800	83%	112	93.3
6	*Myxobolus filamentosus*	Scales	10	2	88	20%	44	8.8
7	*Myxobolus harikensis*	Caudal fin (in between fin rays)	45	15	285	33.333%	19	6.3
8	*Myxobolus kalmani*	Gill lamellae	33	25	425	75.758%	17	12.8
9	*Myxobolus kanjali*	Scales	40	32	2240	80%	70	56
10	*Myxobolus magauddi*	Gill lamellae	15	10	560	66.667%	56	37.3
11	*Myxobolus mehlhorni*	Gill lamellae	25	13	286	52%	22	11.4
12	*Myxobolus moli*	Gill lamellae	20	1	31	5%	31	1.5
13	*Myxobolus naini*	Gill lamellae	50	32	224	64%	7	4.4
14	*Myxobolus parsi*	Scales	35	25	1225	71.4%	49	35
15	*Myxobolus patialensis*	Caudal fin	110	77	11473	63%	149	104.3
16	*Myxobolus punjabensis*	Caudal fin	50	38	3838	76%	101	76.7
17	*Myxobolus punjabii*	Caudal fin	15	5	730	33.3%	146	48.7
18	*Myxobolus roparae*	Gill lamellae	55	30	510	54.5%	17	9.2
19	*Myxobolus saranae*	Caudal fin	15	2	54	13.333%	27	9
20	*Myxobolus saugati*	Scales	62	35	6335	56.4%	181	102.1
21	*Myxobolus sclerii*	Eye-ball (sclera)	10	3	138	30%	46	13.8
22	*Myxobolus slendrii*	Gill lamellae	52	12	324	23%	27	6.23
23	*Myxobolus stomum*	Scales	40	32	2336	80%	73	58.4
24	*Myxobolus sushmii*	Eye- ball	28	8	1248	28.5%	156	44.5
25	*Myxobolus szekeli*	Inner wall of the stomach	25	1	8	4%	8	0.3
26	*Myxobolus venkateshi*	Gill lamellae	25	22	3938	88%	179	157.5
27	*Thelohanellus avjiti*	Pelvic fin	25	13	286	52%	22	11.4
28	*Thelohanellus batae*	Wall of duodenum, pectoral fin	20	15	465	75%	31	23.2
29	*Thelohanellus boggoti*	Gill lamellae	14	3	57	21%	19	4.0
30	*Thelohanellus caudatus*	Caudal fin	22	13	481	59.091%	37	21.8
31	*Thelohanellus deri*	Caudal fin	10	2	66	20%	33	6.6
32	*Thelohanellus gangeticus*	Gill lamellae	20	12	132	60%	11	6.6
33	*Thelohanellus globulosa*	Caudal fin	15	7	182	46.667%	26	12.1
34	*Thelohanellus haldari*	Caudal fin	12	3	198	25%	66	16.5
35	*Thelohanellus kalavatae*	Caudal fin	12	3	78	25%	26	6.5
36	*Thelohanellus kalbensi*	Gill lamellae	10	2	34	20%	17	3.4
37	*Thelohanellus kanjalensis*	Skin of snout	10	3	192	30%	64	19.2
38	*Thelohanellus mrigalae*	Caudal fin	15	7	217	46.6%	31	14.4
39	*Thelohanellus mucousalis*	Gill lamellae	40	31	465	77.5%	15	11.6
40	*Thelohanellus rohi*	Caudal fin	42	33	1815	78.571%	55	43.2
41	*Thelohanellus thaili*	Gill lamellae	50	40	520	80%	13	10.4
42	*Thelohanellus wallagoi*	Gill lamellae	45	34	442	75.5%	13	9.8
43	*Neothelohanellus indicus*	Gill lamellae	20	10	70	50%	7	3.5
44	*Triangula cirrhini*	Gill lamellae	40	17	68	42.5%	4	1.7
45	*Triangula ludhianae*	Gill lamellae	30	23	207	76.7%	9	6.9

* Total number of fishes examined = 1,397, total number of fishes infected = 780.

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