

## **A CHECKLIST ON THE PROTOZOAN PARASITES OF FRESHWATER FISHES OF BANGLADESH**

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**Abstract:** The current work has been proposed to accumulate baseline information regarding prevalence, diversity and distribution of the protozoan parasites found in the freshwater fishes of Bangladesh from its inception to 2019. This is an attempt to compile a baseline data on protozoan parasites of freshwater fishes in Bangladesh. A total of thirty four articles were reviewed whereas sixteen articles reported systematic, taxonomic and morphometric analysis of protozoan parasites, five articles described seasonal parasitic infestation in carp fishes including protozoan parasites, seven articles reported overall parasitic infestation along with protozoan infection, three articles described protozoan infection in consort with the histo-pathological analysis, one article revealed the occurrence of one protozoan parasite named *Trypanosoma* sp. and one study described monthly fluctuation of overall parasitic infection together with protozoan infestation. A number of thirty four freshwater fish species under nine orders in Bangladesh were retrieved on the mentioned articles and found 48 species of protozoan parasites under 19 genera. Noticeably, parasites under genus *Trichodina* was frequently found in the freshwater fish species. Most of the parasites were found from the gills (micro-habited) of the host fish. To sum up, from this compilation a primary database of protozoan parasites of freshwater fish species might be expected to establish that will be supportive for further extensive study.

**Key words:** Protozoan parasite, Fish disease, Freshwater fish, Bangladesh

### **INTRODUCTION**

Fish pathogens are one of the leading impediments of freshwater fish production in Bangladesh. Generally fishes are conspicuous carrier for various parasites as they are majorly serve as an intermediary host of the parasites, being a chief source of animal protein (Luangphai *et al.* 2004). There is a vast range of diseases occurred on freshwater fishes in Bangladesh, of them most noticeable are- Bacterial disease (tail and fin rot, gill disease, hemorrhagic septicemia and dropsy), Fungal diseases, Protozoan diseases, Nutritional diseases and Parasitic diseases (white spot disease, trichodiniasis and myxosporidiasis) which play a subversive role in retardation of fish production. Various metazoan parasites like monogeneans, digeneans, larval cestodes and ectoparasitic crustaceans are regularly reported in freshwater fishes; however inferences on protozoan fish parasites are rarely reported.

In spite of being negligibly reported, both ecto and endo-parasitic protozoa serve as one of the menacing extortions to fish health and are the contributory agents of various diseases in freshwater fishes (Reda 2011). Usually protozoans infect the skin and gill epithelium of host fish causing a massive destruction of fish stock resulting growth

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retardation, weight loss, suppression of reproductive activity and to severe extant mortality (Deshpande and Verma 2015).

Owing to its inherent difficulty paralleled to other larger parasites, there is a scanty of researches regarding protozoan parasites in Bangladesh. However a few studies have been conducted on the distribution, intensity, histopathology, taxonomy and systematics of this group (Protozoan) of parasite. Several studies reported evidences of *Chilodonella* sp., *Ichthyophthirius* sp. and *Trichodina* sp. in Bangladesh (Hossain and Barua 1991, Hossain and Khan 1992 and Banu et al. 1999). A study conducted by Sanaullah and Ahmed (1980) reported myxobolid protozoans from Indian major carps. Likewise, Chandra et al. (1996) defined myxosporean (a group of protozoa) parasites from adolescent carps in both governmental and non-governmental nurseries at Mymensingh, Bangladesh. One more study conducted by Sanaullah (1996) reported the occurrence of *Trypanosoma* sp. in *Channa punctatus* and *Anabas testudineus* at beels in Mahmoodpur, Faridpur. Henceforth Asmat et al. (1997) made the first taxonomic report on trichodinid ciliates; since then occasional evidences have become available on this particular group of parasites in this region. However, the most recent attempt has brought a pronounced change in trichodinid ciliate investigation by establishing four genera of trichodinid ciliate parasites, from various species of freshwater and estuarine fishes (Asmat et al. 1997, 2003a, b, c, 2005a, b, 2006, 2017, Bhouyain 1999, Habib and Asmat 2008, Habib et al. 2010a, b, Kibria et al. 2009, 2010, 2011a, b, Kibria and Asmat 2014 and Haque et al. 2018a, b, c).

The present study is an attempt to compile data through an extensive review of published articles in the above-mentioned area. This review will focus on the diversity and distribution of protozoan fauna infecting the freshwater fishes in different seasons of Bangladesh along with the specification of the locality of host fishes. In fact, it may be of a great use as national baseline data to design further researches on this important content.

## **MATERIAL AND METHODS**

The present work has been completed based on articles available for protozoan parasites of freshwater fishes in Bangladesh. An extensive search was made on literature published from the inception to the present (2020) on protozoan parasites of freshwater fishes in Bangladesh. Pertinent articles were searched using Web of Science, Research gate and Fish base database by means of a combination of Key words such as- Protozoa, Parasite, Fish Disease, Freshwater and Bangladesh. Some Analogue articles were searched and collected from Seminar library of the Department of Zoology and Science library, University of Dhaka.

Inclusion criteria: Full text English language articles, Abstracts, Checklists reported on any degree of protozoan infestation of freshwater fishes in Bangladesh.

Exclusion criteria: Letter to editor, Project reports and any articles written in any other language except English were excluded from this review. And irretrievable articles were not included.

## RESULTS AND DISCUSSION

A total of thirty four articles were found and collected of which seventeen articles reported protozoan parasites under the phylum Ciliophora, one study reported parasites under the phylum Myxozoa and Microsporea, one study reported parasites under the phylum Mastigophora and Sarcodina along with Ciliophora, eight studies reported parasites under the phylum both Ciliophora and Myxozoa, four studied reported parasites under the phylum Myxozoa, one study reported the parasites under the phylum Mastigophora, one study reported the parasites under the phylum Ciliophora and Mastigophora and one study reported the parasites under the phylum Myxozoa, Ciliophora accompanied by Mastigophora. Brief findings regarding the prevalence and distribution of the protozoan parasites are as follows (records are arranged in accordance with the 'Taxonomical Order' of host fishes)-

**Table 1. Records of work accomplished on protozoan parasites of Cypriniformes fishes in Bangladesh**

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Hossain <i>et al.</i> 1978	<i>Thelohanellus dogieli</i> (Myxozoa)	<i>Labeo rohita</i>	Epidermis at base of fins	Dhaka	
Sanaullah and Ahmed 1980	<i>Myxobolus</i> sp. (Myxozoa)	<i>Gibelion catla</i>	Gills	Chandpur	82.88
		<i>Gibelion catla</i>	Gills	Mymensingh	72.92
		<i>Labeo rohita</i>	Gills	Chandpur	45.83
		<i>Cirrhinus cirrhosus</i> ,	Gills	Mymensingh	41.51
			Gills	Chandpur	29.17
Gills	Mymensingh	3.85			
Ahmed 1982	<i>Myxobolus</i> sp. (Myxozoa)	<i>Labeo rohita</i>	Gills, skin	—	
Banu <i>et al.</i> 1993	<i>Ichthyophthirius multifiliis</i> (Ciliophora) <i>Chilodonella</i> sp. (Ciliophora) <i>Trichodina</i> sp. (Ciliophora)	<i>Labeo rohita</i> ,	Skin	Dhaka	
		<i>Gibelion catla</i>			
		<i>Cyprinus carpio</i> ,	Gills, Skin	Dhaka	
		<i>Gibelion catla</i> ,	Gills, Skin	Dhaka	
		<i>Cirrhinus cirrhosus</i> ,			
		<i>Ctenopharyngodon idella</i> ,			
		<i>Cyprinus carpio</i> ,			
		<i>Hypophthalmichthys molitrix</i> ,			
		<i>Labeo rohita</i>			
	<i>Myxobolus</i> sp. (Myxozoa)	<i>Gibelion catla</i> ,	Gills, Skin	Dhaka	
		<i>Cirrhinus cirrhosus</i> ,			
		<i>Ctenopharyngodon idella</i> ,			
		<i>Labeo rohita</i>			

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Hossain and Khan 1992	<i>Chilodonella</i> sp. (Ciliophora)	<i>Gibelion catla</i>	Gills, Skin		
	<i>Ichthyophthirius multifiliis</i> (Ciliophora)	<i>Cirrhinus cirrhosus</i>	Skin		
	<i>Trichodina</i> sp. (Ciliophora)	<i>Ctenopharyngodon idella</i>	Gills, Skin		
	<i>Myxobolus</i> sp. (Myxozoa)	<i>Cirrhinus cirrhosus</i>	Gills, Skin		
Awal et al. 2001	<i>Myxobolus</i> sp. (Myxozoa)	<i>Labeo rohita</i>	Gills, Skin	Mymensingh	
		<i>Cirrhinus cirrhosus</i>	Gills, Skin	Mymensingh	
Hossain et al. 2007	<i>Trichodina domerguei</i> (Ciliophora)	<i>Hypophthalmichthys molitrix</i>	Gills, Skin and fins	Mymensingh Bogura	64.77
		<i>Ctenopharyngodon idella</i>	Gills, Skin and fins	Mymensingh Bogura	56.76
		<i>Cirrhinus cirrhosus</i>	Gills, Skin and fins	Mymensingh Bogura	85.00
		<i>Barbodes gonionotus</i>	Gills, Skin and fins	Mymensingh Bogura	93.75
		<i>Gibelion catla</i>	Gills, Skin and fins	Mymensingh Bogura	34.88
		<i>Labeo rohita</i>	Gills, Skin and fins	Mymensingh Bogura	83.33
		<i>Labeo rohita</i>	Gills, Skin and fins	Mymensingh Bogura	62.76
	<i>Trichodina reticulata</i> (Ciliophora)	<i>Cyprinus carpio</i>	Gills, skin	Mymensingh	75.00
		<i>Ctenopharyngodon idella</i>	Gills, skin	Mymensingh	64.58
		<i>Barbodes gonionotus</i>	Gills, skin	Mymensingh	77.14
	<i>Chilodonella cyprini</i> (Ciliophora)	<i>Cyprinus carpio</i>	Gills, skin	Mymensingh	56.25
		<i>Ctenopharyngodon idella</i>	Gills, skin	Mymensingh	1.35
		<i>Barbodes gonionotus</i>	Gills, skin	Mymensingh	9.30
		<i>Cyprinus carpio</i>	Gills, skin	Mymensingh	68.75
Hossain et al. 2007	<i>Myxobolus koi</i> (Myxozoa)	<i>Cyprinus carpio</i>	Gills, skin	Bogura	53.85
		<i>Ctenopharyngodon idella</i>	Gills, skin	Mymensingh	10.81
		<i>Barbodes gonionotus</i>	Gills, skin	Bogura	10.00
		<i>Gibelion catla</i>	Gills, skin	Mymensingh	4.65
		<i>Labeo rohita</i>	Gills, skin	Mymensingh	2.13
		<i>Labeo rohita</i>	Gills, skin	Mymensingh	2.08
Hossain et al. 2007	<i>Myxobolus koi</i> (Myxozoa)	<i>Hypophthalmichthys molitrix</i>	Gills, skin	Mymensingh	5.6
		<i>Ctenopharyngodon idella</i>	Gills, skin	Bogura	29.63
		<i>Cyprinus carpio</i>	Gills, skin	Mymensingh	17.57
		<i>Cyprinus carpio</i>	Gills, skin	Bogura	20.00
		<i>Cyprinus carpio</i>	Gills, skin	Mymensingh	22.92
		<i>Cyprinus carpio</i>	Gills, skin	Bogura	15.38
		<i>Gibelion catla</i>	Gills, skin	Mymensingh	4.25
		<i>Labeo rohita</i>	Gills, skin	Bogura	8.33
Hossain et al. 2007	<i>Myxobolus koi</i> (Myxozoa)	<i>Labeo rohita</i>	Gills, skin	Mymensingh	4.17
		<i>Barbodes gonionotus</i>	Gills, skin	Bogura	5.17
		<i>Barbodes gonionotus</i>	Gills, skin	Mymensingh	50.00
		<i>Cirrhinus cirrhosus</i>	Gills, skin	Bogura	29.63
Bhuiyan et al. 2007	<i>Trichodina</i> sp. (Ciliophora)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
	<i>Chilodonella</i> sp. (Ciliophora)	<i>Labeo rohita</i>	Gills	Rajshahi	
	<i>Myxobolus</i> sp. (Myxozoa)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
Bhuiyan and Musa 2008	<i>Trichodina domerguei</i> (Ciliophora)	<i>Hypophthalmichthys molitrix</i>		Mymensingh Bogura	
	<i>Trichodina reticulata</i> (Ciliophora)	<i>Ctenopharyngodon idella</i>		Mymensingh Bogura	

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Bhuiyan and Musa 2008	<i>Chilodonella cyprini</i> (Ciliophora)	<i>Cyprinus carpio</i> <i>Barbodes gonionotus</i>		Mymensingh Bogura	
	<i>Myxobolus koi</i> (Myxozoa)	<i>Gibelion catla</i> <i>Labeo rohita</i> <i>Cirrhinus cirrhosus</i>		Mymensingh Bogura	
Hossain et al. 2008	<i>Trichodina domerguei</i> (Ciliophora)	<i>Hypophthalmichthys molitrix</i>	Gills, Skin and fins	Santaher, Bogura	80.67
	<i>Trichodina reticulata</i> (Ciliophora)	<i>Ctenopharyngodon idella</i>	Gills, Skin and fins	Santaher, Bogura	45.67
	<i>Chilodonella cyprini</i> (Ciliophora)	<i>Cyprinus carpio</i> <i>Barbodes gonionotus</i>	Gills, Skin and fins	Santaher, Bogura	31.33
	<i>Myxobolus koi</i> (Myxozoa)	<i>Gibelion catla</i> <i>Labeo rohita</i> <i>Cirrhinus cirrhosus</i>	Gills, Skin and fins	Santaher, Bogura	37.33
Habib and Asmat 2008	<i>Trichodinella epizootica</i> (Ciliophora)	<i>Labeo rohita</i>	Gills	Tanguar Haor, Sunamganj	12.00
Delwer et al. 2010	<i>Trichodina pediculatus</i> (Ciliophora)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
	<i>Chilodonella cyprini</i> (Ciliophora)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
	<i>Myxobolus rohita</i> (Myxozoa)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
Delwer et al. 2010	<i>Ichthyophthirius multifiliis</i> (Ciliophora)	<i>Labeo rohita</i>	Skin, Fin	Rajshahi	
	<i>Chilodonella cyprini</i> (Ciliophora)	<i>Labeo rohita</i>	Skin, Fin	Rajshahi	
	<i>Apiosoma sp.</i> (Ciliophora)	<i>Gibelion catla</i>	Skin, Gills	Rajshahi	
	<i>Ichthyobodo necatrix</i> (Mastigophora)	<i>Gibelion catla</i>	Skin, Gills	Rajshahi	
	<i>Ichthyophthirius multifiliis</i> (Ciliophora)	<i>Gibelion catla</i>	Gills, Fin	Rajshahi	
	<i>Trichodina pediculatus</i> (Ciliophora)	<i>Gibelion catla</i>	Gills	Rajshahi	
	<i>Apiosoma sp.</i> (Ciliophora)	<i>Cirrhinus cirrhosus</i>	Skin, Fin	Rajshahi	
	<i>Chilodonella cyprini</i> (Ciliophora)	<i>Cirrhinus cirrhosus</i>	Skin, Fin	Rajshahi	
	<i>Ichthyophthirius multifiliis</i> (Ciliophora)	<i>Cirrhinus cirrhosus</i>	Fin	Rajshahi	
<i>Trichodina pediculatus</i> (Ciliophora)	<i>Cirrhinus cirrhosus</i>	Gills	Rajshahi		
Farhaduz-zaman et al. 2010	<i>Trichodina pediculatus</i> (Ciliophora)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
	<i>Chilodonella cyprinid</i> (Ciliophora)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
	<i>Myxobolus rohita</i> (Myxozoa)	<i>Labeo rohita</i>	Gills, skin	Rajshahi	
	<i>Ichthyophthirius multifiliis</i> (Ciliophora)	<i>Labeo rohita</i>	Skin, Fin	Rajshahi	
Kibria et al. 2011a	<i>Trichodina molae</i> (Ciliophora)	<i>Amblypharyngodon mola</i>	Gills	Shitalakshya River, Kapasia, Gazipur	7.1

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Mofassh-alin et al. 2012	<i>Chilodonella</i> sp. (Ciliophora)	<i>Labeo bata</i>	Skin	Rajshahi	10.00
		<i>Labeo gonius</i>	Skin	Rajshahi	18.33
		<i>Cirrhinus reba</i>	Skin	Rajshahi	9.44
	<i>Trichodina</i> sp. (Ciliophora)	<i>Labeo bata</i>	Gills	Rajshahi	12.22
		<i>Cirrhinus reba</i>		Rajshahi	9.44
<i>Ichthyophthirius</i> sp. (Ciliophora)	<i>Labeo bata</i>	Skin	Rajshahi	7.78	
Mofassh-alin et al. 2012	<i>Apiosoma</i> sp. (Ciliophora)	<i>Cirrhinus reba</i>	Skin	Rajshahi	8.33
Monir et al. 2015	<i>Chilodonella</i> sp. (Ciliophora)	<i>Labeo rohita</i>	Gills, skin	Mymensingh, Sylhet and Rajshahi	
		<i>Cirrhinus cirrhosus</i>	Skin, Fin	Mymensingh, Sylhet and Rajshahi	
	<i>Trichodina</i> sp. (Ciliophora)	<i>Gibelion catla</i>	Gills	Mymensingh, Sylhet and Rajshahi	
		<i>Cirrhinus cirrhosus</i>	Gills	Mymensingh, Sylhet and Rajshahi	
	<i>Ichthyobodo</i> sp. (Mastigophora)	<i>Labeo rohita</i> , <i>Cirrhinus cirrhosus</i>	Skin, Fins	Mymensingh, Sylhet and Rajshahi	
<i>Ichthyophthirius</i> sp. (Ciliophora)	<i>Labeo rohita</i> , <i>Cirrhinus cirrhosus</i>	Skin	Mymensingh, Sylhet and Rajshahi		
Haque et al. 2018a	<i>Trichodina hafizuddini</i> (Ciliophora)	<i>Amblypharyngodon mola</i>	Gills	Moulavibazar, Sylhet	40.00
Haque et al. 2018a	<i>Trichodina amblypharyngodoni</i> (Ciliophora)	<i>Amblypharyngodon mola</i>	Gills	Moulavibazar, Sylhet	61.53

**Table 2. Records of work accomplished on protozoan parasites of Perciformes fishes in Bangladesh**

Authors	Parasite recorded	Host fish species	Site of Infection (Micro habitat)	Locality (Macro habitat)	Prevalence (%)
Banu et al. 1993	<i>Chilodonella</i> sp. (Ciliophora)	<i>Oreochromis niloticus</i>	Gills, Skin	Dhaka	
Anon 1993	<i>Tripartiella</i> sp. (Ciliophora)	<i>Anabas testudineus</i>		Chattogram	
Sanaullah 1996	<i>Trypanosoma</i> sp. (Mastigophora)	<i>Anabas testudineus</i>	Blood	Faridpur	14
Asmat et al. 2003a	<i>Trichodina anabasi</i> sp. n. (Ciliophora)	<i>Anabas testudineus</i>	Gills	Chattogram	19.6
Asmat et al. 2003b	<i>Trichodina sylhetensis</i> sp. n. (Ciliophora)	<i>Nandus nandus</i>	Gills	Tanguar Haor, Sylhet	75.00
Asmat et al. 2005a	<i>Trichodina kaptaiensis</i> sp. n. (Ciliophora)	<i>Chanda nama</i>	Gills	Rangamati Hill District	20.0
Kibria et al. 2009	<i>Trichodina modesta</i> (Ciliophora)	<i>Oreochromis</i>	Gills	Ponds of Chattogram	25

Authors	Parasite recorded	Host fish species	Site of Infection (Micro habitat)	Locality (Macro habitat)	Prevalence (%)
Kibria <i>et al.</i> 2009	<i>Paratrichodina africana</i> (Ciliophora)	<i>mossambicus</i>		and Cox's Bazar	60
Habib <i>et al.</i> 2010b	<i>Tripartiella bursiformis</i> (Ciliophora)	<i>Chanda baculis</i>	Gills	Tanguar Haor, Sylhet	33.3
Kibria <i>et al.</i> 2010	<i>Trichodina shitalakshyae</i> sp. n. (Ciliophora)	<i>Glossogobius giuris</i>	Gills	Kapasia, Gazipur	60
Kibria <i>et al.</i> 2011a	<i>Trichodina domerguei</i> (Ciliophora)	<i>Johnius coitor</i>			9.7
	<i>Trichodina sylhetensis</i> (Ciliophora)	<i>Nandus nandus</i>	Gills	Shitalakshya River, Kapasia, Gazipur	17.1
	<i>Trichodina centrostrigeata</i> (Ciliophora)	<i>Oreochromis mossambicus</i>			42.8
	<i>Trichodina mossambicus</i> (Ciliophora)				7.1
	<i>Trichodina anabasi</i> (Ciliophora)	<i>Anabas testudineus</i>			40.0
Kibria <i>et al.</i> 2011b	<i>Trichodina johniusi</i> sp. n. (Ciliophora)	<i>Johnius coitor</i>	Gills	Kapasia, Gazipur	9.7
Haque <i>et al.</i> 2018c	<i>Trichodina cottidarum</i> (Ciliophora)	<i>Nandus nandus</i>	Gills	Moulvibazar, Sylhet	56.00

**Table 3. Records of work accomplished on protozoan parasites of Siluriformes fishes in Bangladesh**

Authors	Parasite recorded	Host species	fish	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Banu <i>et al.</i> 1993	<i>Trichodina</i> sp. (Ciliophora)	<i>Clarias batrachus</i> , <i>Clarias gariepinus</i>		Gills, Skin	Dhaka	
	<i>Myxobolus</i> sp. (Myxozoa)	<i>Clarias batrachus</i>				
Asmat <i>et al.</i> 2005a	<i>Trichodina siddiquae</i> sp. n. (Ciliophora)	<i>Heteropneustes fossilis</i>		Gills	Rangamati Hill District	10.0
Habib <i>et al.</i> 2010a	<i>Trichodina japonica</i> (Ciliophora)	<i>Rita rita</i>		Gills	Tanguar Haor, Sylhet	20.8
	<i>Trichodina ngoma</i> (Ciliophora)	<i>Mystus tengara</i>				16.7
Kibria <i>et al.</i> 2010	<i>Trichodina acuta</i> (Ciliophora)	<i>Mystus bleekeri</i>		Gills	Kapasia, Gazipur	46.3
Kibria <i>et al.</i> 2011a	<i>Trichodina microspina</i> (Ciliophora)	<i>Rita rita</i>		Gills	Shitalakshya River, Kapasia,	18.7

Authors	Parasite recorded	Host species	fish	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Kibria et al. 2011a	<i>Trichodina modesta</i> (Ciliophora)	<i>Clupisoma garua</i>			Gazipur	2.8
Asmat et al. 2017	<i>Tripartiella orthodens</i> (Ciliophora)	<i>Rita rita</i>		Gills	Chattogram	15.0
Haque et al. 2018a	<i>Trichodina pseudoheterodentata</i> (Ciliophora)	<i>Mystus bleekeri</i>		Gills	Moulvibazar, Sylhet	76
Haque et al. 2018b	<i>Trichodina hoffmani</i> (Ciliophora)	<i>Mystus tengara</i>		Gills	Moulvibazar, Sylhet	26.66

**Table 4. Records of work accomplished on protozoan parasites of Channiformes fishes in Bangladesh**

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Sanaullah 1996	<i>Trypanosoma</i> sp. (Mastigophora)	<i>Channa punctatus</i>	Blood	Faridpur	66.6
Miah et al. 2013	<i>Trichodina</i> sp. (Ciliophora)		Gills, skin		32.50
	<i>Chilodonella</i> sp. (Ciliophora)		Skin		5.00
	<i>Chilodonella</i> sp. (cysts) (Ciliophora)	<i>Channa punctatus</i>		Sylhet	2.50
	<i>Ichthyobodo</i> sp. (Mastigophora)		Gills, skin		15.00
	<i>Actinophrys</i> sp. (Sarcodina)		Gills		2.50
	Unidentified Protozoa		Gills		2.50
Deb et al. 2015	<i>Trichodina cyprinocola</i> (Ciliophora)				33.33
	<i>Trichodina pediculus</i> (Ciliophora)	<i>Channa punctatus</i>	Gills	Sylhet	3.33
Asmat et al. 2017	<i>Trichodina cobitis</i> (Ciliophora)	<i>Channa striata</i>	Gills	Peerbari Pond, Chattogram	15.7
Akhter et al. 2018	<i>Trichodina pediculus</i> (Ciliophora)	<i>Channa punctatus</i>	Skin, gills	Rajshahi	—
	<i>Myxobolus</i> sp. (Myxozoa)				—
	<i>Ichthyophthirius multifiliis</i> (Ciliophora)		Skin		—



**Table 5. Records of work accomplished on protozoan parasites of Clupeiformes fishes in Bangladesh**

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Bhuiyan and Momen 2012	<i>Glugea</i> sp. (Microsporea)	<i>Tenualosa ilisha</i>	Skin/ gills	Aricha Ghat, Dhaka	43.30
	<i>Jirovecia piscicola</i> (Microsporea)		Skin		53.33
	<i>Zschokkella ilishae</i> (Myxozoa)		Gall bladder		36.67
	<i>Coccomyxa baleswarensis</i> (Myxozoa)		Gall bladder		26.67
	<i>Ceratomyxa hilsae</i> (Myxozoa)		Gall bladder		50.00
	<i>Sphaeromyxadi ghae</i> (Myxozoa)		Gall bladder		46.67
	<i>Myxobolus</i> sp. (Myxozoa)		Gall bladder		51.33
	<i>Kudoa</i> sp. (Myxozoa)		Gills		28.24

**Table 6. Records of work accomplished on protozoan parasites of Beloniformes fishes in Bangladesh**

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Habib <i>et al.</i> 2010b	<i>Tripartiella bulbosa</i> (Ciliophora)	<i>Xenentodon cancila</i>	Gills	Tanguar Haor, Sylhet	20.0
Kibria <i>et al.</i> 2011a	<i>Trichodina cancelae</i> (Ciliophora)	<i>Xenentodon cancila</i>	Gills	Kapasias, Gazipur	37.5

**Table 7. Records of work accomplished on protozoan parasites of Cyprinodontiformes fishes in Bangladesh**

Authors	Parasite recorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Asmat <i>et al.</i> 2005a	<i>Trichodina aplocheilosis</i> p. n. (Ciliophora)	<i>Aplocheilus panchax</i>	Gills	Rangamati Hill District	20.0

**Table 8. Records of work accomplished on protozoan parasites of Osteoglossiformes fishes in Bangladesh**

Authors	Parasiterecorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Kibria et al. 2011a	<i>Trichodina nigra</i> (Ciliophora)	<i>Notopterus notopterus</i>	Gills	Shitalakshya River,	27.0
	<i>Trichodina siliuri</i> (Ciliophora)			Kapasasia, Gazipur	18.9

**Table 9. Records of work accomplished on protozoan parasites of Tetraodontiformes fishes in Bangladesh**

Authors	Parasiterecorded	Host fish species	Site of Infection (Micro-habitat)	Locality (Macro-habitat)	Prevalence (%)
Haque et al. 2018c	<i>Trichodina cutcutiae</i> sp. n. (Ciliophora)	<i>Leiodon cutcutia</i>	Gills	Moulvibazar, Sylhet	83.33

A total of thirty four articles were reviewed where sixteen studies reported systematic, taxonomic and morphometric analysis of protozoan parasites based on dry silver impregnated specimens (Asmat et al. 2003a, Asmat et al. 2003b, Asmat et al. 2005, Habib and Asmat 2008, Kibria et al. 2009, Habib et al. 2010a, Habib et al. 2010b, Kibria et al. 2010, Kibria et al. 2011a, Kibria et al. 2011b, Bhuiyan and Momen 2012, Deb et al. 2015, Asmat et al. 2017, Haque et al. 2018a, Haque et al. 2018b and Haque et al. 2018c), three studies described protozoan infection along with histo-pathological study (Sanaullah and Ahmed 1980, Ahmed 1982 and Awal et al. 2001) and only Sanaullah (1996) showed the occurrence of *Trypanosoma* sp. in freshwater fish of Bangladesh. On the other hand seven studies showed overall parasitic infestation including protozoan parasites in freshwater fish (Hossain et al. 1978, Hossain and Khan 1992, Banu et al. 1993, Hossain et al. 2007, Delwer et al. 2010, Miah et al. 2013 and Akhter et al. 2018) and four studies reported seasonal parasitic infestation along with protozoan parasites in Carps fish (Bhuiyan et al. 2007, Hossain et al. 2008, Bhuiyan and Musa 2008, Mofasshalin et al. 2012 and Monir et al. 2015). Additionally, Farhaduzzaman et al. (2010) showed the prevalence and monthly fluctuation of parasitic infection including protozoan parasites in Carp fish (*Labeo rohita*) for comprehending the affiliation and mean density with the fish size of the 265 (Rahman 2005) freshwater fish species in Bangladesh, 34 species under 9 orders were studied by different researchers. A total of 48 species under 19 genera of protozoan parasite have been recorded in various studies. Of them 37 species were under 7 genera of phylum Ciliophora, 7 species were under 7 genera of phylum Myxozoa, 2 species were under 2 genera of phylum Microsporea, 1 species was under 2 genera of phylum mastigophora and 1 species was under 1 genera of phylum sarcodina, the range of prevalence was found from 1.35% to 93.75%. Hossain et al. (2007) found both the highest prevalence rate of *Tricodina domerguei* (93.75%) in host

*Cirrhinus cirrhosus* in ponds of Santaher, Bogura (macrohabitat) and the lowest prevalence rate of *Tricodina reticulata* was 1.35% in host *Ctenopharyngodon idella* in Shambhuganj, Mymensingh. On those studies, *Trichodina* genus was the most common protozoan parasite of freshwater fishes followed by *Chilodonella*, *Myxobolus*, *Ichthyophthirius* and *Ichthyobodo* sp., rest of the genus from these findings were host specific.

The most common microhabitats of freshwater fishes were found to be gills, fins, skin, gall bladder and blood to be infected by protozoan parasites. However, gill was found to be the most common infected site and fin to be the least vulnerable. And only one study reported protozoan parasitic infection in blood of freshwater fish. Following orders of host fishes were reported to be infested with protozoan parasites- Beloniformes, Channiformes, Clupeiformes, Cypriniformes, Cyprinodontiformes, Osteoglossiformes, Perciformes, Siluriformes and Tetraodontiformes. Among them most of the researches were conducted on order- Cypriniformes followed by order- Siluriformes, Perciformes and Channiformes.

According to the macro-habitat specification, most of the studies were found to be performed in Sylhet division particularly at Sunamganj, Sylhet and Moulvibazar district which were followed by Rajshahi division predominantly at Rajshahi and Bogura district, Dhaka division mostly at Gazipur and Dhaka district, Chattogram division particularly at Chattogram and Rangamati district, Mymensingh district (5) and only one study recorded in each Chandpur and Faridpur district respectively.

In the above mentioned studies, most of the protozoan parasites were recorded for the very first time in Bangladesh. Among them eight species were completely new to science to be explored, they were- *Trichodina anabasi* sp. n., *Trichodina sylhetensis* sp. n., *Trichodina kaptaiensis* sp. n., *Trichodina aplocheilusi* sp. n. *Trichodina siddiquae* sp. n., *Trichodina shitalakshyae* sp. n., *Trichodina johniusi* sp. n. and *Trichodina cutcutiae* sp. n. reported by Asmat *et al.* 2003a, 2003b, 2005, Kibria *et al.* 2010, 2011b and Haque *et al.* 2018a, respectively.

The articles consulted for the present checklist are mostly on the taxonomy of the parasites. Altogether forty-eight (48) species of parasites have been recorded which seemed to be insufficient and should be subjected to increase for further extensive study. Moreover, most of the host species are still to be studied for protozoan parasites. This compilation of work will aid us to determine the area of work to be selected and explored to conduct any prospective study.

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