A CHECKLIST ON THE PROTOZOA 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 et al. 1978| Thelohanellus dogielii (Myxozoa) | Labeo rohita      | Epidermis at base of fins         | Dhaka                    |                |
| Sanaullah and Ahmed 1980 | Myxobolus sp. (Myxozoa) | Gibelion catla, Labeo rohita | Gills, Gills | Chandpur, Mymensingh | 82.88, 72.92 |
| Ahmed 1982         | Myxobolus sp. (Myxozoa)    | Labeo cirrhosus, | Gills, Gills | Chandpur, Mymensingh | 45.83, 41.51 |
|                    |                            | Labeo rohita      | Gills, Gills | Chandpur, Mymensingh | 29.17, 3.85  |
| Banu et al. 1993   | Ichthyophthirius multifilis (Ciliophora) | Labeo rohita, Gibelion catla, Cyprinus carpio, | Skin, Gills, Skin | Dhaka, Dhaka |                |
| Chilodonella sp. (Ciliophora) | Gibelion catla, Cyprinus carpio, | | | | |
| Trichodina sp. (Ciliophora) | Gibelion catla, Cyprinus carpio, | | | | |
| Myxobolus sp. (Myxozoa) | Gibelion catla, Cyprinus carpio, | | | | |
|                  |                            | Labeo rohita      | Gills, Skin | Dhaka | |
|                  |                            | Labeo rohita      | Gills, Skin | Dhaka | |
|                  |                            | Labeo rohita      | Gills, Skin | Dhaka | |
| Authors          | Parasite recorded               | Host fish species | Site of Infection (Macro-habitat) | Locality (Macro-habitat) | Prevalence (%) |
|------------------|---------------------------------|-------------------|-----------------------------------|--------------------------|----------------|
| Hossain and Khan  | Chilodonella sp. (Ciliophora)   | Gibelion catla    | Gills, Skin                       | Mymensingh               |                |
| 1992             | Ichthyophthirius multifilis     | Cirrhinus cirrhosus| Skin                              | Mymensingh               |                |
|                  | (Ciliophora)                    |                   |                                   |                          |                |
|                  | Trichodina sp. (Ciliophora)     | Ctenopharyngodon idella | Gills, Skin                       | Mymensingh               |                |
|                  | Myxobolus sp. (Myxozoa)         | Cirrhinus cirrhosus| Gills, Skin                       | Mymensingh               |                |
| Awal et al. 2001 | Myxobolus sp. (Myxozoa)         | Labeo rohita      | Gills, Skin                       | Mymensingh               |                |
|                  |                                 | Cirrhinus cirrhosus| Gills, Skin                       | Mymensingh               |                |
| Hossain et al. 2007 | Trichodina domerguei (Ciliophora) | Hypophthalmichthys molitrix | Gills, Skin and fins              | Bogura                   | 64.77          |
|                  |                                 | Ctenopharyngodon idella | Gills, Skin and fins              | Bogura                   | 56.76          |
|                  |                                 | Cirrhinus cirrhosus| Gills, Skin                       | Mymensingh               | 75.92          |
|                  |                                 | Barbodes gonionotus| Gills, Skin                       | Bogura                   | 34.88          |
|                  |                                 | Gibelion catla    | Gills, Skin                       | Mymensingh               | 62.76          |
|                  |                                 | Labeo rohita      | Gills, Skin                       | Mymensingh               | 75.00          |
|                  |                                 | Cyprinus carpio   | Gills, skin                       | Mymensingh               | 64.58          |
|                  |                                 | Ctenopharyngodon idella | Gills, Skin and fins              | Bogura                   | 77.14          |
|                  |                                 | Barbodes gonionotus| Gills, skin                       | Mymensingh               | 56.25          |
|                  |                                 | Cyprinus carpio   | Gills, skin                       | Mymensingh               | 1.35           |
|                  | Trichodina reticulata (Ciliophora) | Ctenopharyngodon idella | Gills, skin                       | Mymensingh               | 9.30           |
|                  |                                 | Barbodes gonionotus| Gills, skin                       | Mymensingh               | 68.75          |
|                  |                                 | Cyprinus carpio   | Gills, skin                       | Mymensingh               | 53.85          |
|                  | Chilodonella cyprini (Ciliophora) | Ctenopharyngodon idella | Gills, skin                       | Mymensingh               | 10.81          |
|                  |                                 |                   |                                   |                          | 10.00          |
| Hossain et al. 2007 | Barbodes gonionotus            | Gills, skin       | Mymensingh                        |                          | 4.65           |
|                  |                                 | Gibelion catla    | Gills, skin                       |                          | 2.13           |
|                  |                                 | Labeo rohita      | Gills, skin                       |                          | 2.08           |
|                  | Myxobolus koi (Myxozoa)         | Hypophthalmichthys molitrix | Gills, skin                       |                          | 5.6            |
|                  |                                 |                   |                                   |                          | 29.63          |
| Hossain et al. 2007 | Ctenopharyngodon idella       | Gills, skin       | Mymensingh                        | Bogura                   | 17.57          |
|                  |                                 | Cyprinus carpio   | Gills, skin                       | Mymensingh               | 22.92          |
|                  |                                 | Gibelion catla    | Gills, skin                       | Mymensingh               | 15.38          |
|                  |                                 | Labeo rohita      | Gills, skin                       | Mymensingh               | 4.25           |
|                  |                                 | Barbodes gonionotus| Gills, skin                       | Mymensingh               | 8.33           |
|                  |                                 | Cyprinus carpio   | Gills, skin                       | Mymensingh               | 5.17           |
|                  |                                 |                   |                                   |                          | 50.00          |
|                  |                                 |                   |                                   |                          | 29.63          |
| Bhuiyan et al. 2007 | Trichodina domerguei (Ciliophora) | Hypophthalmichthys molitrix | Gills, skin                       | Mymensingh               |                |
|                  |                                 |                   |                                   |                          |                |
|                  |                                 |                   |                                   |                          |                |
| Bhuiyan and Musa 2008 | Trichodina reticulata (Ciliophora) | Ctenopharyngodon idella | Gills, skin                       | Mymensingh               |                |
|                  |                                 |                   |                                   |                          |                |
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| Authors               | Parasite recorded          | Host fish species          | Site of Infection (Micro-habitat) | Locality (Macro-habitat) | Prevalence (%) |
|-----------------------|---------------------------|----------------------------|-----------------------------------|--------------------------|----------------|
| Bhuiyan and Musa 2008 | Chilodonella cyprini (Ciliophora) | Cyprinus carpio            | Mymensingh                        | Mymensingh               | 25             |
|                       | Myxobolus koi (Myxozoa)   | Gibelion catla             | Bogura                            | Bogura                   | 25             |
| Hossain et al. 2008   | Trichodina domerguei (Ciliophora) | Hypophthalmichthys motilrix | Jhelum                            | Santaher, Bogura         | 80.67          |
|                       | Trichodina reticulata (Ciliophora) | Ctenopharyngodon idella    | Santaher, Bogura                  | Santaher, Bogura         | 45.67          |
|                       | Chilodonella cyprini (Ciliophora) | Cyprinus carpio            | Santaher, Bogura                  | Santaher, Bogura         | 37.33          |
|                       | Myxobolus koi (Myxozoa)   | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 31.33          |
| Habib and Asmat 2008  | Trichodinella epizootica (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
| Delwer et al. 2010    | Trichodina pediculatus (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Chilodonella cyprini (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Myxobolus rohitae (Myxozoa) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
| Delwer et al. 2010    | Ichthyophthirius multifilis (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Chilodonella cyprini (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Apiosoma sp. (Ciliophora)  | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Ichthyophthirius multifilis (Ciliophora) | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Trichodina pediculatus (Ciliophora) | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Apiosoma sp. (Ciliophora)  | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Chilodonella cyprini (Ciliophora) | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Ichthyophthirius multifilis (Ciliophora) | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Trichodina pediculatus (Ciliophora) | Gibelion catla             | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
| Farhaduzzaman et al. 2010 | Trichodina pediculatus (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Chilodonella cyprini (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Myxobolus rohitae (Myxozoa) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
|                       | Ichthyophthirius multifilis (Ciliophora) | Labeo rohita              | Santaher, Bogura                  | Santaher, Bogura         | 12.00          |
| Kibria et al. 2011a   | Trichodina molae (Ciliophora) | Amblypahrynogdria mola     | Shitalakshya River, Kapasia, Gazipur | 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 | Chilodonella sp. (Ciliophora) | Labeo bata, Labeo gonias, Cirrhinus reba | Skin | Rajshahi | 10.00 |
| | Trichodina sp. (Ciliophora) | Labeo bata, Cirrhinus reba | Gills | Rajshahi | 12.22 |
| | Ichthyophthirius sp. (Ciliophora) | Labeo bata | Skin | Rajshahi | 9.44 |
| Mofassh-alin et al. 2012 | Apiosoma sp. (Ciliophora) | Cirrhinus reba | Skin | Rajshahi | 8.33 |
| Monir et al. 2015 | Chilodonella sp. (Ciliophora) | Labeo rohita | Gills, Skin | Mymensingh, Sylhet and Rajshahi | 14.4 |
| | Apiosoma sp. (Ciliophora) | Cirrhinus cirrhosus | Skin, Fin | Mymensingh, Sylhet and Rajshahi | 14.4 |
| | Trichodina sp. (Ciliophora) | Gibelion catla, Cirrhinus cirrhosus | Gills | Rajshahi | 14.4 |
| | Ichthyobodo sp. (Mastigophora) | Labeo rohita, Cirrhinus cirrhosus | Skin, Fins | Mymensingh, Sylhet and Rajshahi | 14.4 |
| | Ichthyophthirius sp. (Ciliophora) | Labeo rohita, Cirrhinus cirrhosus | Skin | Mymensingh, Sylhet and Rajshahi | 14.4 |
| Haque et al. 2018a | Trichodina hafizuddini (Ciliophora) | Amblypharyngodon mola | Gills | Moulovibazar, Sylhet | 40.00 |
| Haque et al. 2018a | Trichodina amblypharyngodon (Ciliophora) | Amblypharyngodon mola | Gills | Moulovibazar, 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 | Chilodonella sp. (Ciliophora) | Oreochromis niloticus | Gills, Skin | Dhaka | 25 |
| Anon 1993 | Tripartiella sp. (Ciliophora) | Anabas testudineus | | Chattogram | 14 |
| Sanaullah 1996 | Trypanosoma sp. (Mastigophora) | Anabas testudineus | Blood | Faridpur | 14 |
| Asmat et al. 2003a | Trichodina anabasi sp. n.(Ciliophora) | Anabas testudineus | Gills | Chattogram | 19.6 |
| Asmat et al. 2003b | Trichodina sylhetensis sp. n. (Ciliophora) | Nandus nandus | Gills | Tanguar Haor, Sylhet | 75.00 |
| Asmat et al. 2005a | Trichodina kaptaiensis sp. n.(Ciliophora) | Chanda nama | Gills | Rangamati Hill District | 20.0 |
| Kibria et al. 2009 | Trichodina modesta (Ciliophora) | Oreochromis | Gills | Ponds of Chattogram | 25 |
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 et al. 1993 | Trichodina sp. (Ciliophora) | Clarias batrachus, Clarias gariepinus | Gills, Skin | Dhaka | 10.0 |
|               | Myxobolus sp.     | Clarias batrachus |         |       |       |
|               | (Myxozoa)         |                   |         |       |       |
| Asmat et al. 2005a | Trichodina siddiquae sp. n. (Ciliophora) | Heteropneustes fossilis | Gills | Rangamati Hill District | 10.0 |
| Habib et al. 2010a | Trichodina japonica (Ciliophora) | Rita rita | Gills | Tanguar Haor, Sylhet | 20.8 |
|                 | Trichodina ngoma (Ciliophora) | Mystus tengara | Gills | Kapasia, Gazipur | 16.7 |
| Kibria et al. 2010 | Trichodina acuta (Ciliophora) | Mystus bleekeri | Gills | Kapasia, Gazipur | 46.3 |
| Kibria et al. 2011a | Trichodina microspina (Ciliophora) | Rita rita | Gills | Shitalakshya River, Kapasia | 18.7 |
| Authors          | Parasite recorded                        | Host fish species       | Site of Infection (Micro-habitat) | Locality (Macro-habitat) | Prevalence (%) |
|------------------|------------------------------------------|-------------------------|-----------------------------------|--------------------------|----------------|
| Kibria et al. 2011a | Trichodina modesta (Ciliophora)         | Clupisoma garua        | Gazipur                           |                          | 2.8            |
| Asmat et al. 2017 | Tripartiella orthodox (Ciliophora)      | Rita rita               | Gills                             | Chattogram               | 15.0           |
| Haque et al. 2018a | Trichodina pseudoheterodentata (Ciliophora) | Mystus bleekeri      | Gills                             | Moulvibazar, Sylhet      | 76             |
| Haque et al. 2018b | Trichodina hoffmani (Ciliophora)        | Mystus tengara         | 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   | Trypanosoma sp. (Mastigophora)           | Channa punctatus        | Blood                             | Faridpur                 | 66.6           |
| Miah et al. 2013 | Trichodina sp. (Ciliophora)              | Channa punctatus        | Gills, skin                       |                          | 32.50          |
|                  | Chilodonella sp. (Ciliophora)            |                         | Skin                              |                          | 5.00           |
|                  | Chilodonella sp.(cysts) (Ciliophora)     |                         | Skin                              |                          | 2.50           |
|                  | Ichthyobodo sp. (Mastigophora)           | Channa punctatus        | Gills, skin                       | Sylhet                   | 15.00          |
|                  | Actinophrys sp. (Sarcodina)              |                         | Gills                             |                          | 2.50           |
|                  | Unidentified Protozoa                    |                         | Gills                             |                          | 2.50           |
| Deb et al. 2015  | Trichodina cyprinocola (Ciliophora)      | Channa punctatus        | Gills                             | Sylhet                   | 33.33          |
|                  | Trichodina pediculus (Ciliophora)        |                         |                                   |                          |                |
| Asmat et al. 2017 | Trichodina cobitis (Ciliophora)          | Channa striata          | Gills                             | Peerbari Pond, Chattogram | 15.7           |
| Akhter et al. 2018 | Trichodina pediculus (Ciliophora)        | Channa punctatus        | Rajshahi                          |                          |                |
|                  | Myxobolus sp. (Myxozoa)                  |                         | Skin, gills                       |                          |                |
|                  | Ichthyophthirius multifilis (Ciliophora) |                         |                                   |                          |                |
### 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 (%) |
|------------------|--------------------|------------------|-----------------------------------|--------------------------|----------------|
| Bhuian and Momen 2012 | Glugea sp. (Microsporea) | Tenualosa ilisha | Skin/ gills                       | Aricha Ghat, Dhaka       | 43.30          |
|                   | Jirovecia piscicola (Microsporea) |              | Skin                             |                          | 53.33          |
|                   | Zschokkella ilishae (Myxozoa) |              | Gall bladder                     |                          | 36.67          |
|                   | Coccomyxa baleswarentis (Myxozoa) |              | Gall bladder                     | Aricha Ghat, Dhaka       | 26.67          |
|                   | Ceratomyxa hilsae (Myxozoa) |              | Gall bladder                     |                          | 50.00          |
|                   | Sphaeromyxadi ghae (Myxozoa) |              | Gall bladder                     |                          | 46.67          |
|                   | Myxobolus sp. (Myxozoa) |              | Gall bladder                     |                          | 51.33          |
|                   | Kudoa 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 et al. 2010 | Tripartiella bulbosa (Ciliophora) | Xenentodon cancila | Gill                             | Tanguar Haor, Sylhet      | 20.0           |
| Kibria et al. 2011 | Trichodina cancila (Ciliophora) | Xenentodon cancila | Gill                             | Kapasia, 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 et al. 2005 | Trichodina aplocheilus p. n. (Ciliophora) | Aplocheilus panchax | Gill                             | Rangamati Hill District   | 20.0           |
Table 8. Records of work accomplished on protozoan parasites of Osteoglossiformes fishes in Bangladesh

| Authors          | Parasite recorded | Host fish species | Site of Infection (Micro-habitat) | Locality (Macro-habitat) | Prevalence (%) |
|------------------|-------------------|-------------------|-----------------------------------|--------------------------|----------------|
| Kibria et al. 2011a | *Trichodina nigra* (Ciliophora) | *Notopterus notopterus* | Gills                             | Shitalakshya River, Kapasia, Gazipur | 27.0           |
|                  | *Trichodina siliuri* (Ciliophora) |                      |                                   |                          | 18.9           |

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

| Authors          | Parasite recorded | Host fish species | Site of Infection (Micro-habitat) | Locality (Macro-habitat) | Prevalence (%) |
|------------------|-------------------|-------------------|-----------------------------------|--------------------------|----------------|
| Haque et al. 2018c | *Trichodina cutcutiae* sp. n. (Ciliophora) | *Leiodon cutcutia* | 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, Mofassghalin 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...
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*Cirrhinus cirrhosus* in ponds of Santaher, Bogura (macrohabitat) and the lowest prevalence rate of *Tricodina reticulate* 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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