STUDY OF PARASITIC INFECTION IN *PIARACTUS BRACHYPOMUS* (CUVIER, 1817) IN LAY DAUNG KAN FISH FARM OF YANGON REGION

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Abstract

Freshwater fish culture is a major source of aquaculture production in Myanmar. In 2015-2016, the production of freshwater fish at 2.59 million MT (46% of total freshwater fish production). Examination of parasitic infection in freshwater as well as in marine fishes in Myanmar is still required to improve Myanmar aquaculture system. The present study was carried out to isolate and identify of different parasites and prevalence and mean intensity of infection from *Piaractus brachypomus*. A total of 240 fishes were observed in between August 2017 to July 2018 from Lay Daung Kan fish farm. Skin, gills, eyes, brain, heart, liver, gallbladder, muscles, intestine and kidneys were examined for infection. The isolated parasites were *Myxobolus* sp.1 and *Myxobolus* sp.2 were found in gills and gallbladder, *Trichodina heterodentata* in the gills and skin, *Ichthyophthirius multifiliis* in the skin and *Mymarothecium viatorum* and *Mymarothecium boegeri* in the gills respectively. Highest prevalence of infection was recorded in Monogenea parasites during the study period.

Keywords: *Piaractus brachypomus*, Parasitic, Platyhelminthes, Myxozoa, Cilophora, Prevalence

Introduction

Myanmar is the second largest country in Southeast Asia, with a land area of 676,577 square kilometers (km^2). Abundant natural resources in fresh- and brackish water fisheries contribute significantly to its food security (FAO, 2012). Myanmar had the highest number of fishers and fish farmers in the Southeast Asian region in 2014 (SEFDEC, 2012). Freshwater fish culture is a major source of the total aquaculture production (including mariculture) in Myanmar. Fishery products serve as major source of animal protein for the local population that largely consumes rice and fish in their daily meals. With population of 51.5 million in 2016, the country's average fish consumption was 68 kg/person/year (DoF, 2016).

The Red bellied pacu *Piaractus brachypomus*, also known as pirapitinga, is a native fish from the Amazon and Orinoco rivers and can reach up to 20 kg of weight (Alcantara *et al*., 1990). This species is used for fish farming, especially in Brazil, is valued for its meat and has a fast growth performance (Fresneda *et al*., 2004; MPA, 2013). This species also has economic importance for aquaculture in other countries in South America (Colombia, Peru, and Venezuela) and in Asia (China, Myanmar, Thailand and Vietnam) (Flores Nava, 2007; Honglang, 2007 and Lin *et al*., 2015). The demand of pacu fish significantly increased since 2010 because it is an almost boneless species, which is favoured by human consumers (FAO, 2013).

Currently, fish farmers in Myanmar do not maximize their productivity by enhancing the natural productivity of their ponds. Intensive systems in Myanmar are limited to a small number of specialized marine farms producing finfish and White Leg shrimp (*Penaeus vannamei*), and a few farms produce Striped catfish and Red-bellied pacu intensively (Belton *et al*., 2017b).

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Fish naturally carries a variety of pathogenic bacteria, fungi and parasites. Healthy fish with healthy immune systems should be able to fight off these ever-present disease organisms but unhealthy fish may fall victim. Fish can be affected by a wide range of infectious and non-infectious diseases. Infectious diseases are contagious and caused by parasites, bacteria, viruses or fungi. Non-infectious diseases can be infected environmental, nutritional or genetic (Floyd, 1997).

The production from culture systems is hampered by the infection of various fish parasites. Parasites and diseases are the most serious limiting factors in culture farms (FAO, 2004). Fishes are usually cultured in high density in restricted waterbodies, where pathogens can easily be transmitted between individuals (Woo *et al*., 2011). Besides direct losses caused by mortality, parasites may have considerable impact on growth, behavior of fish and their resistance to other stressing factors (Floyd, 1997). Protozoan and monogenean ectoparasites are common in juvenile carp in nursery ponds. High mortality rates caused by myxosporidian infections in the gills have raised serious concern among fish farmers (Awal *et al*., 2001).

The number of fish parasitologists in fishery and aquaculture sectors of the country is small. Most of the studies were emphasized on wild populations or single fish species from aquaculture farms. Examination of parasitic infections in freshwater as well as in marine fishes in Myanmar is still required to improve production local aquaculture system.

The present study was undertaken to collect, identify and record the occurrence of parasites in *Piaractus brachypomus*. Prevalence and mean intensity of infections were also reported.

Materials and methods

Sample collection and preparation of aquaria

Fish were produced using the induced breeding method and breeders were cultured separately in 1436.67 m^2 pond very extensively. Approximately 240 fishes were collected to examine parasitic infections in between August 2017 to July 2018 from Lay Daung Kan Fish Farm, Yangon Township. (Fig.1). The sampling fishes were transported to the Laboratory of Aquatic Bioscience, Department of Zoology, University of Yangon alive in plastic bags filled with pond water enriched with oxygen. On arrival, they were kept separately in fiber tanks with the supply of aeration. One day prior to the arrival of the fish, aquaria were thoroughly cleaned, filled with water and aerated. Some fish were immediately dissected to examine their parasite load and incidence, and the remainders were kept in aquaria for five days for subsequent studies. All diagnostic symptoms were carefully recorded for each individual fish.

Examination and identification of Monogenea parasites

For the collection of live gill parasites, live fishes were sacrificed after anaesthetization and the gills were removed immediately. Each gill arch was separately cut and placed in a Petri dish containing saline water. Alive monogeneans were dislodged from gill arches by gentle scraping and collected under a dissecting microscope. The alive monogeneans were placed in cavity blocks filled with physiological saline solution (0.9% NaCl) and transferred to a clean glass slide containing one drop of physiological saline solution. The parasite on the slide was then covered with a coverslip. Prepared live specimens were examined under a compound

microscope to study their internal soft organs such as the reproductive and digestive organs. According to Yamaguti (1963) and Brain (2004), identification of the monogeneans was based mainly on the sclerotized hard parts of the haptor, supporting bar, marginal hooks and copulatory organs.

Examination and identification of protozoan parasites

Mucous scrapped from fins, skin and gills removed from the branchial cavity were placed in a Petridish for microscopic examination. The body of the host was then opened and internal organs, viz., eye, brain, gills, heart, swim-bladder, liver, gall-bladder, muscles, fins, mucus, intestine and kidney were removed and transferred into Petridishes. Tissues were placed on a glass slide, physiological saline solution (0.9% NaCl solution) was added, and a cover slip was placed over the specimen prior to subsequent examination by light microscope. In order to prepare permanent slides, tissues were stamped on the slide and left for a few minutes to dry. Air-dried smears were stained with Giemsa after fixing in absolute methanol, they were then cleaned with distilled water, dipped in xylene and mounted permanently with D.P.X mounted. Identification of protozoan parasites was done following the description and figure of Lom and Dykova (2006).

Data analyses for parasites

Parasite infestation was quantified according to Bush, (1990) and Margolis *et al*., (1982).

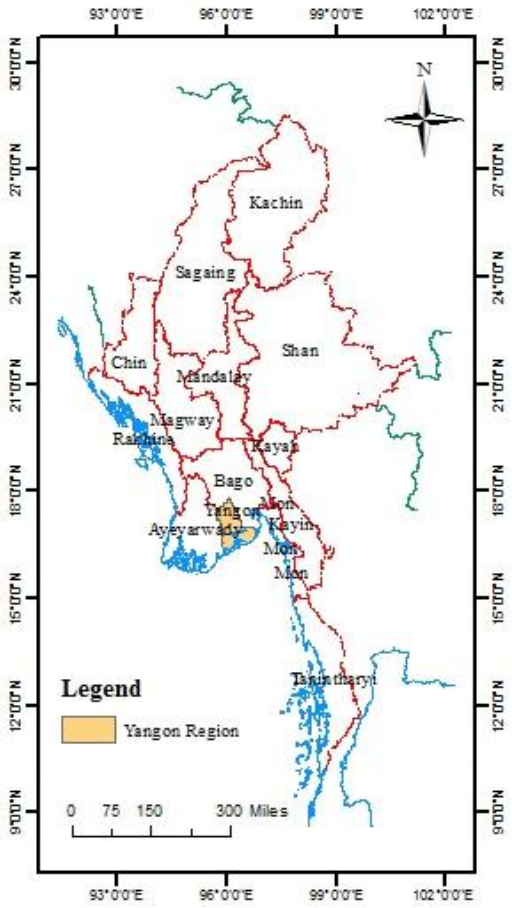
$$\text{Prevalence (\%)} = \frac{\text{Number of infected host} \times 100}{\text{Total number of host examined}}$$

While the Mean Intensity (MI) of monogenean parasites is given by the total number of parasites of a given species divided by the number of fishes infested with that species.

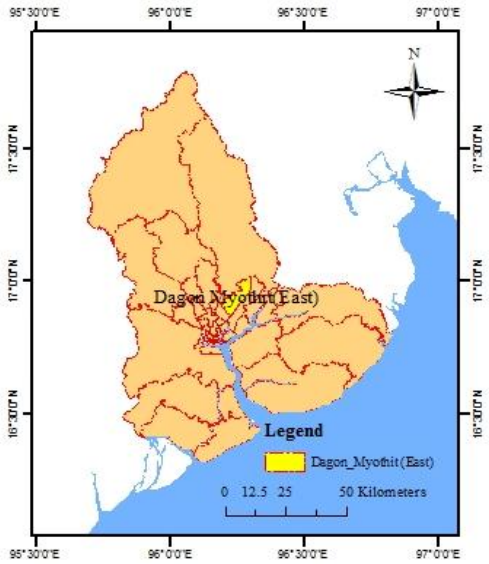
$$\text{Mean intensity} = \frac{\text{Total number of parasites}}{\text{Total number of infected fish}}$$

Intensity of infection was categorized into five stages for protozoan parasites according to Bachere *et al*., (1982) and Culloty *et al*., (1999).

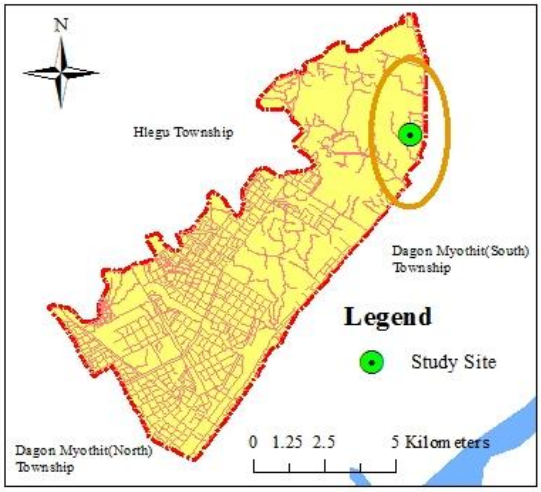
- Stage (I): 1 – 20 parasites observed within 3-min of screening under 40X magnification.
- Stage (II): 21– 40 parasites observed within 3-min of screening under 40X magnification.
- Stage (III): 41– 60 parasites observed within 3-min of screening under 40X magnification.
- Stage (IV): 1 – 10 parasites in all fields of vision observed immediately in screening under 40X magnification.



A. Yangon Division



B. Dagon Myothit (East)



C. Lay Daung Kan Fish Farm

Source: Geography Department, Institute of Education

Figure 1 Map showing location of Lay Daung Kan Fish Farm in Dagon (East) Township, Yangon Region

Results

1.1 Parasitic infection in *Piaractus brachypomus*

During the study period six species of parasites belonging to three phyla were detected in the gills and skin of *Piaractus brachypomus*, namely *Myxobolus* sp.1, *Myxobolus* sp.2, *Trichodina heterodentata*, *Ichthyophthirius multifillis*, *Mymarothecium viatorum* and *Mymarothecium boegeri* (the latter both fungi: Ascomycota) (Table 1).

1.1.1 Taxonomy of the recorded parasite taxa

Systematic positions of the two observed species of the phylum Cnidaria in *Piaractus brachypomus* are:

Phylum - Cnidaria Hatschek, 1888
Class - Myxozoa Grasse, 1970
Order - Bivalvulida Shulman, 1959
Family - Myxobolidae Thelohan, 1892
Genus - *Myxobolus* Butschli, 1882
Species - *Myxobolus* sp.1
Species - *Myxobolus* sp.2

Systematic positions of two observed species of the phylum Cilophora in *Piaractus brachypomus* are:

Phylum - Cilophora Doflein, 1901
Class - Oligohymenophorea de Puytorac *et al*., 1974
Order - Mobilina Kahl, 1933
Family - Trichodinidae Raabe, 1959
Genus - *Trichodina* Ehrenberg, 1838
Species - *Trichodina heterodentata* Duncan, 1977
Class - Oligohymenophorea de Puytorac *et al*., 1974
Order - Hymenostomatida Delage & Hérouard 1896
Family - Ichthyophthiriidae Brown, 1951
Genus - *Ichthyophthirius* Fouquet, 1876
Species - *Ichthyophthirius multifiliis* Fouquet, 1876

Systematic positions of the two observed species of the phylum Platyhelminthes in *Piaractus brachypomus* are:

Phylum - Platyhelminthes Claus, 1887
Class - Monogenea Van Beneden, 1858 and Bychowsky, 1973
Order - Dactylogyridae Bychowsky, 1937
Family - Ancyrocephalidae Bychowsky, 1937
Genus - *Mymarothecium* Kritsky Boeger et Jegu, 1996
Species - *Mymarothecium viatorum* Boeger, 2002
Species - *Mymarothecium boegeri* Boeger, 2002

1.1.2 Morphological description of Cnidaria in *Piaractus brachypomus*

Myobolus sp. 1 (Plate1A)

Host	-	*Piaractus brachypomus* (Cuvier, 1817)
Locality	-	Lay Daung Kan fish farm, Dagon (East),Yangon.
Site of infection	-	Spores were isolated from the gills.

Prevalence of infection (based on the seasonal data): 55% (134/240 investigated host individuals)

Characteristics of the spore:

Immature spores are round to ovoid in shape. Two polar capsules are pear shaped. Sporoplasm has two nuclei. Mature spores are ovoidal to rounded in shape in front view. Both the anterior and posterior ends are blunt. The two polar capsules are equal in shape. The capsules are pear shaped with anterior tip and blunt posterior end. Polar filaments were sometimes extruding outside the polar capsules and spores. The polar filaments were invisible and impossible to count the number of coil. Sporoplasm agranular, homogenous and occupying whole of the extracapsular space behind the polar capsules. The measurement of the spores was as follows;

Length of spore	= 7.5µm ± 0.3µm (n=10)
Width of spore	= 5µm ± 0.5µm (n=10)
Length of polar capsule	= 5µm (n=10)
Width of polar capsule	= 2.5µm ± 0.8µm (n=10)

Myobolus sp. 2 (Plate 1B)

Host	-	*Piaractus brachypomus* (Cuvier, 1817)
Locality	-	Lay Daung Kan fish farm, Dagon (East), Yangon.
Site of infection	-	Spores were found in gills

Prevalence of infection (based on the seasonal data): 35% (83/240 investigated host individuals)

Characteristics of the spore:

The spores were circle-shaped in front view. Shell valves thick, smooth and symmetrical. No parietal folds were present. Polar capsules two, unequal, oval to spherical in shape and placed anteriorly in the spore body cavity. The large polar capsules were pumpkin seed-like in shape and the smaller one was tear-shaped. The polar filaments were invisible and impossible to count the number of coil. The measurements of the spores were as follows;

Length of spore	= 51µm ± 3.2µm (n=10)
Width of spore	= 38µm ± 4.2µm (n=10)
Length of right polar capsule	= 34µm ± 5.2µm (n=10)
Width of right polar capsule	= 24µm ± 5.1µm (n=10)
Length of left polar capsule	= 14µm ± 1.5µm (n=10)
Width of left polar capsule	= 10µm ± 0.2µm (n=10)

1.1.3 Morphological description of Cilophora in *Piaractus brachypomus*

Trichodina heterodentata (Plate 1C)

Host	-	*Piaractus brachypomus* (Cuvier, 1817)
Locality	-	Lay Daung Kan fish farm, Dagon (East), Yangon
Site of infection	-	Parasites were isolated from the skin and gills.

Prevalence of infection (based on the seasonal data): 85% (205/240 investigated host individuals)

Characteristics of the taxon:

Trichodinid of medium size with a disc-shaped. They have a broad sickle-shaped blade that fit into the quadrant delimited. The distal surface of the blade form a shallow curve, parallel to the border membrane. The tangential point is sharp in the majority of the individuals, or slightly rounded in the others; it is located slightly below or at the same level as the distal tip of the distal blade margin. The blade is prominent. The blade shows moderate fit with the central part. The central part is thick and triangular shape. The rays are moderately thick and straight, and their tips are generally sharp. The measurements of the parasites were as follows;

Diameter of adhesive disc (da)	= 45µm ± 4.2µm (n=10)
Diameter of denticulate ring (dd)	= 15.2µm ± 2.5µm (n=10)
Diameter of clear area (dc)	= 12.5µm ± 1.4µm (n=10)
Number of denticles	= 20 ± 1.5 (n=10)

Ichthyophthirius multifiliis (Plate 1D)

Host	-	*Labeo rohita* (Hamilton, 1822) and *Piaractus brachypomus* (Cuvier, 1817)
Locality	-	Lay Daung Kan fish farm, Dagon (East), Yangon
Site of infection	-	White spot were found on the skin, gill filaments and gill arch.

Prevalence of infection (based on the seasonal data): 52% (125/240 investigated host individuals)

Characteristic of the spores:

Ichthophthirius multifiliis shows macronucleus surrounded by a thin rounded, transparent jelly mass changing its shape by a thin rounded. The mature parasites secrete a cyst around themselves which is generally spherical or ovoid in shape although considerable variation in shape has been observed. The whole body of *Ichthyophthirius multifiliis* bears a large number of cilia. It has a tubular mouth, several vacuoles and a large horse-shoe-shaped nucleus.

Length of spore	= 20.5µm ± 4.5µm (n = 10)
Width of spore	= 26.2µm ± 6.5µm (n = 10)

1.1.4 Morphological description of Platyhelminthes in *Piaractus brachypomus*

Mymarothecium viatorum (Plate 2A)

Host	-	*Piaractus brachypomus* (Cuvier, 1817)
Locality	-	Lay Daung Kan fish farm, Dagon (East),Yangon
Site of infection	-	Gills
Number of specimen measured	-	10

Prevalence of infection (based on the seasonal data): 100% (240/240 investigated host individuals)

Characteristics:

Body - Body elongate, 716 µm ± 78.3 µm long, greatest width 96µm ± 7.1µm. Tegument smooth. Cephalic lobes well developed, head organs present. Eyes 4, posterior pair slightly larger than anterior pair; accessory granules few or absent. Pharynx bulbous. Male copulatory organ 12.5µm ± 1.9µm long, a sinuous tube, tapering distally, base skirt like. Accessory piece, 14.3µm ± 0.9µm long. Testis ovate, single prostatic reservoir, seminal vesicle fusiform.

Haptor - Ventral Haptor 30µm ±4.8 µm long, with elongate superficial root, evenly curved shaft, point; 4µm ± 1.8µm wide. Dorsal Haptor 32µm ± 2.1µm long, with coparatively shorter superficial root often bent, articulates to respective extremities of dorsal bar, curved shaft, elongate point; base 11.8µm ± 0.6µm wide. Ventral bar 30µm ± 4.8µm long, broadly Vshaped, with expanded ends, posteromedial process. Dorsal bar 33µm ± 4.1µm long, broadly V-shaped with slightly expanded ends, short posteromedian process. Hooks 14, similar in shape; each with delicate point, protruding thumb. Their total length is 8.7 µm ±2.9 µm.

***Mymarothecium boegeri* (Plate 2B)**

Host	-	*Piaractus brachypomus* (Cuvier, 1817)
Locality	-	Lay Daung Kan fish farm, Dagon (East), Yangon
Site of infection	-	Gills
Number of specimen measured	-	10

Prevalence of infection (based on the seasonal data): 15% (35/240 investigated host individuals)

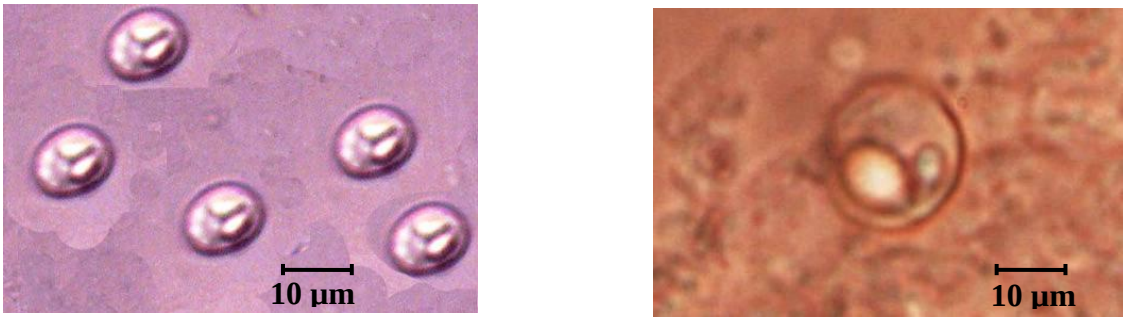
Characteristics:

Body - Body 730µm ± 48.3µm long by 88µm ± 10.3µm wide at level of ovary. Tegument smooth or presenting scaled annulations. Cephalic lobes developed. Two pairs of eyes; posterior pair larger and separated from anterior pair. Pharynx spherical to ovate. Copulatory organ comprising a narrow tube. Accessory piece bifurcated at base, measuring 12µm ±1.7µm, ring-shaped sub-terminal flap and hook-shaped process. Testis subovate, 10µm ± 0.2µm, seminal vesicle elongate; germarium elongate. Vaginal aperture dextroventral. Vitelline follicles in two bilateral fields of trunk, extending from pharynx to level of haptor.

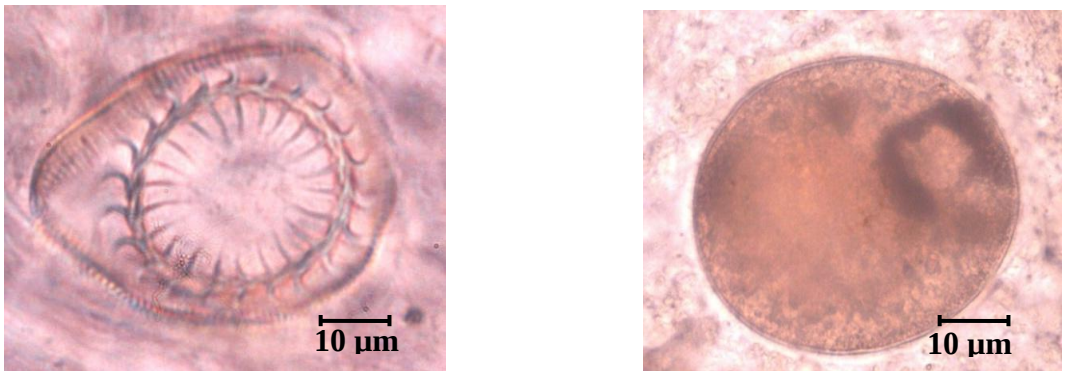
Haptor - Haptors similar; ventral haptor 12µm ± 1.5µm long, dorsal haptor 10.8 µm ±0.2 µm long; each having well-developed superficial root with slight depressions, deep root comparatively smaller, curved shaft, elongate point. Ventral bar V-shaped, 29.2µm ± 7.9µm long, with short posteromedial process. Dorsal bar broadly U-shaped, 21.7µm ± 10.4µm long. Haptor with 7 pairs of marginal hooks. Their total length is 7.5µm ±1.5µm.

Table 1 List of parasites recovered and their site of infection

Parasite		**Host**	**Site of infection**
Cnidaria	*Myxobolus* sp.1	*Piaractus brachypomus*	Gills
	Myxobolus sp.2		Gills
Cilophora	*Trichodina heterodentata*		Gills and skin
	Ichthyophthirius Multifiliis		Skin
Platyhelminthes	*Mymarothecium Viatorum*		Gills
	Mymarothecium Boegeri		



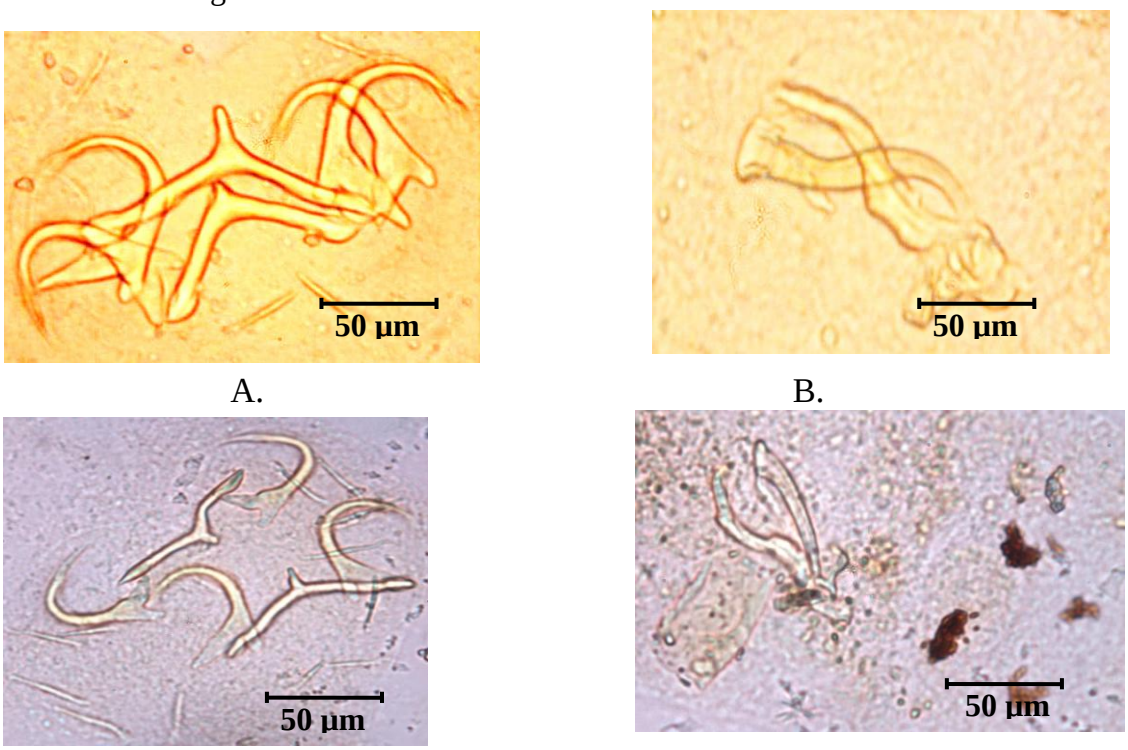
A. B.



C. D.

Plate 1: Recorded protozoan parasite from *Piaractus brachypomus* during the study period.

A. *Myxobolus* sp.1 recorded from the gills, B. *Myxobolus* sp.2 recorded from the gills, C. *Trichodina heterodentata* recorded from the gills and skin and D. *Ichthyophthirius multifiliis* recorded from the gills and skin



A. B.

C. D.

Plate 2: Recorded Monogenea parasite from *Piaractus brachypomus* during the study period.

A. Sclearotised parts of *Mymarothecium viatorum*, B. Copulatory organ of *Mymarothecium viatorum*, C. Sclearotised parts of *Mymarothecium boegeri* and D. Copulatory organ of *Mymarothecium boegeri*

1.2 Prevalence and mean intensity of parasaite infestations of the phylum Cnidaria in *Piaractus brachypomus*

Figure (2) shows two species of Cnidaria recorded in *Piaractus brachypomus.* Infection started when fish were five months old.

Myxobolus sp.1 was found in the whole study period except from August and September, 2017 and July, 2018. Low prevalence of infection was detected during the study period. Prevalence of infestation was ranging from 15% to 55%. The highest prevalence, 55% was recorded in May, 2018 while the lowest one, 15% was found in June, 2018. Low mean intensity of infection ranged from 1.2 to 2. Intensity decreased slightly from October, 2017 to January, 2018 while it was increased in March, 2018.

Prevalence of infection of *Myxobolus* sp.2 from the gills of *Piaractus brachypomus* during study period was 35%. The highest prevalence found in the month of October, 2017 (35%) and lowest in June, 2018 and July, 2018 (10%). No infection was recorded from December, 2017 to April, 2018.

Monthly intensity of infestation was described in Fig. 3. High mean intensity of 1.4 was recorded in October, 2017 and while it was decreased around about 1.2 in November, 2017.

1.3 Prevalence and mean intensity of parasite infestations of the phylum Cilophora in *Piaractus brachypomus*

The highest prevalence of infestation was recorded in *Trichodina heterodentata*. Prevalence of infestation fluctuated monthly ranging from 50% to 85%. The highest prevalence was recorded in October, 2017 and the lowest prevalence was recorded in March, 2018 (Fig. 4). Monthly intensity of *Trichodina heterodentata* infestation was described in (Fig. 5). High mean intensity 2.5 was recorded in April 2018. Mostly, mean intensity of *Trichodina* sp. range was 1.2 during study period.

Ichthyophthirius multifiliis was recorded only three times in December, 2017, January and February, 2018 with the prevalence of infection of 30%, 45% and 20% respectively. The intensity of infection ranged from 1 to 1.5. Except from theses three months, *Ichthyophthirius multifiliis* was not recorded in the studied area.

1.4 Prevalence and mean intensity of parasite infestations of the phylum Platyhelminthes in *Piaractus brachypomus*

Figure (6) shows prevalence of infestation of *Mymarothecium* spp. from gills of *Piaractus brachypomus* during the study period. *Mymarothecium viatorum* was found in gills of *Piaractus brachypomus* in October, 2007 when the fish was five months old. Prevalence of infection of *Mymarothecium viatorum* range from 25% to 85%. Prevalence of infecting did not change very much during study period (until April, 2018). Prevalence of infestation was sharply increased with high prevalence of 85% was recorded in May, 2018 (Fig. 6). Monthly intensity of *Mymarothecium viatorum* infestation was described in (Fig. 7). Mean intensity ranged from 1to 1.5.

Prevalence of infection of *Mymarothecium boegeri* was described in Fig. 6. Prevalence of infection was very low when it was compared with *Mymarothecium bogeri*. It was recorded only four months among study period. The highest prevalence range was 15% in *Mymarothecium boegeri*. Mean intensity of infestation was described in Fig. 7. Mean intensity of infection ranged from 1.5 to 3.2. Intensity slightly increased from November, 2017 to June, 2018. The highest intensity of infection 3.2 was recorded in June, 2018.

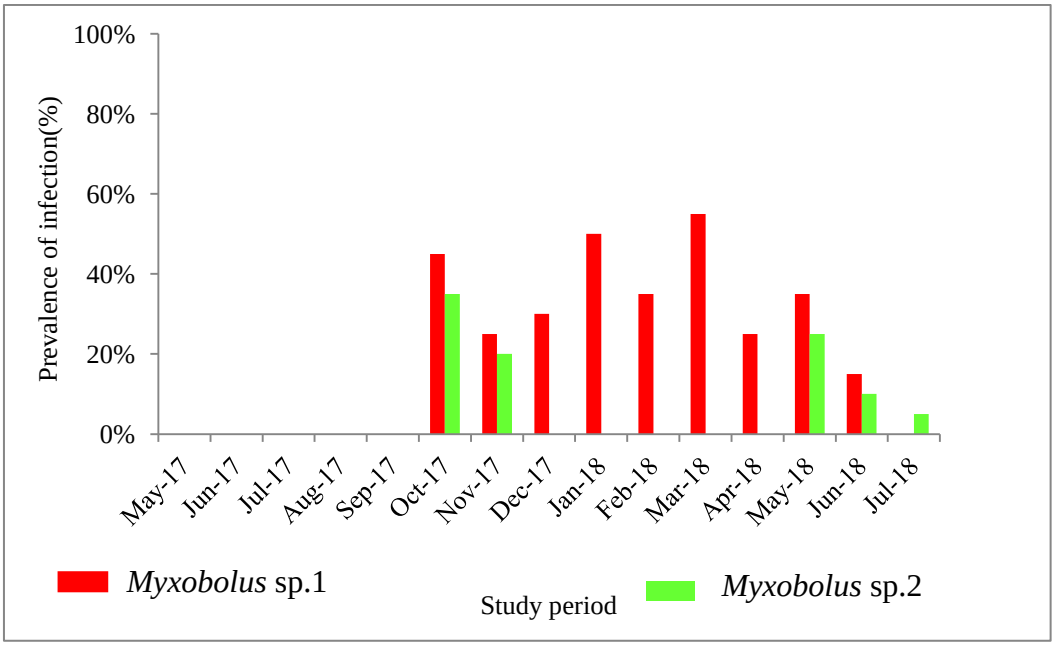


Figure 2 Prevalence of Cnidaria parasites in *Piaractus brachypomus* during the study period

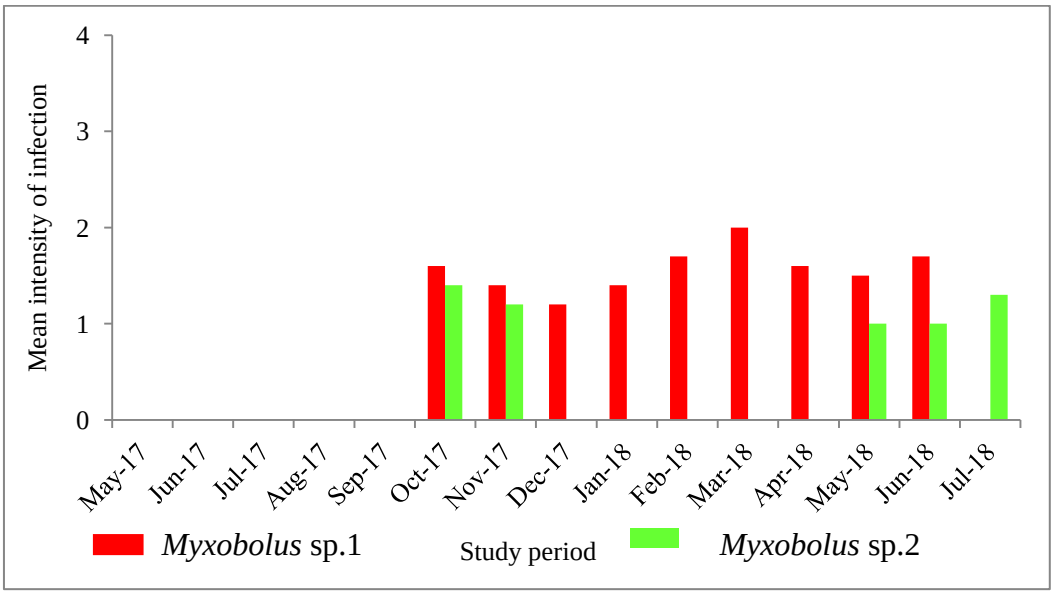


Figure 3 Mean intensity of Cnidaria parasites in *Piaractus brachypomus* during the study period

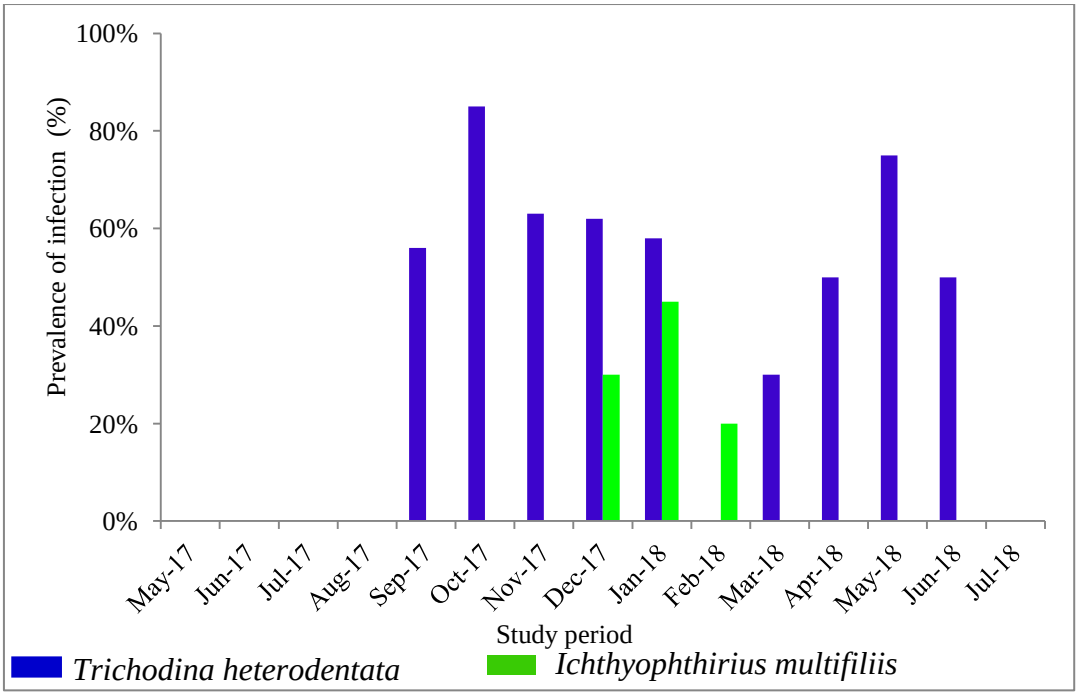


Figure 4 Prevalence of Cilophora parasites in *Piaractus brachypomus* during the study period

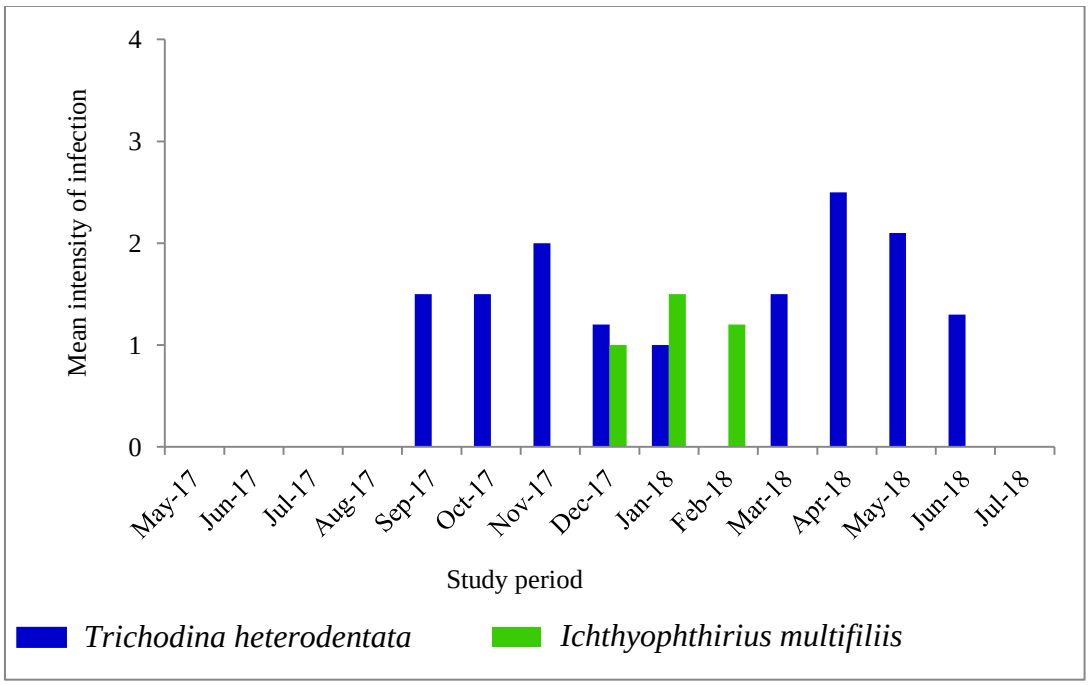


Figure 5 Mean intensity of Cilophora parasites in *Piaractus brachypomus* during the study period

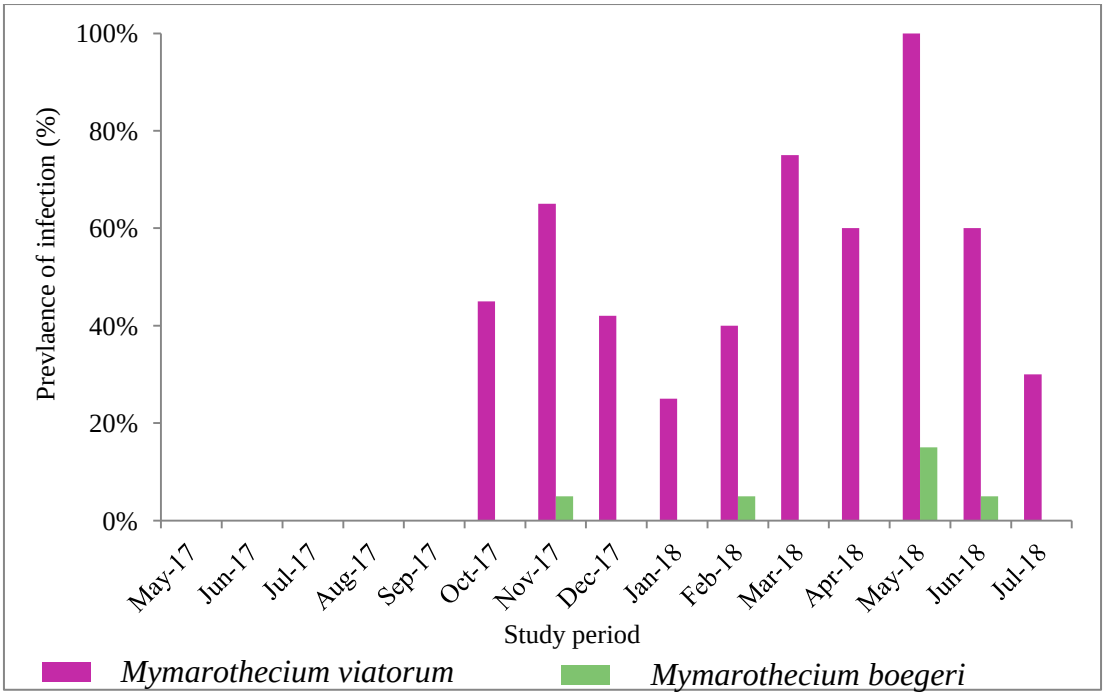


Figure 6 Prevalence of Monogenea parasites in *Piaractus brachypomus* during the study period

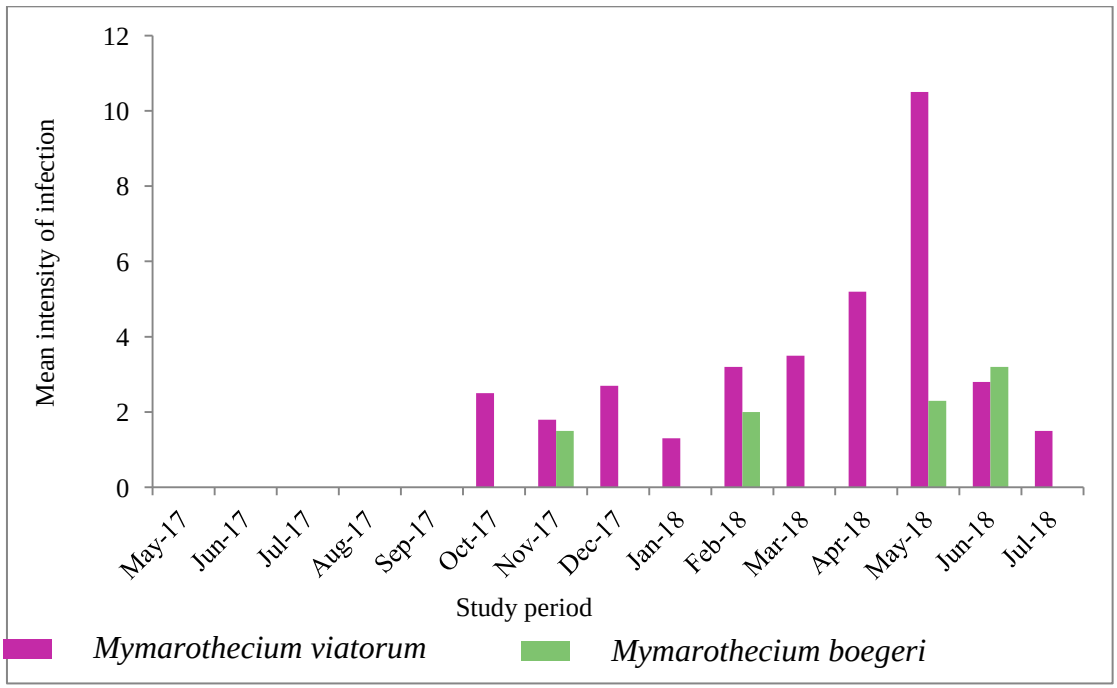


Figure 7 Mean intensity of Monogenea parasites in *Piaractus brachypomus* during the study period

Discussion

The present work was conducted to examine the occurrence of parasitic infection in *Piaractus brachypomus* in Myanmar aquaculture. *Piarctus brachypomus* was infested with six parasite taxa, namely *Myxobolus* sp.1 and 2, *Trichodina heterodentata, Ichthyophthirius multifillis, Mymarothecium viatorum* and *M. boegeri.*

Within the protozoan phyla, the most destructive pathogens causing large scale mortalities in natural and culture conditions are undeniably the myxosporeans of the phylum Myxozoa (Schulmann, 1966). Egusa (1991) observed that the myxosporeans parasitize on the different tissues and organs of the host fishes and hamper the growth as well as cause deformities and bizarre external appearances leading to commercial rejection of the infected fishes.

Myxobolus sp. 1 recorded in the present study is very similar in shape and dimension reported by Moe Kyi Han (2006) and Su Su Mon (2014) from *L. rohita*. The shape of *Myxobolus* sp. 2 was nearly similar to the reported by Basu and Haldar (2003) from Punjab wetlands (India) that infected in the gills of *Labeo bata*, but the spore dimension and the size of the polar capsule were quite different, although the length and width of the spore did not differ from those species.

In Myxozoa, high prevalence of infections were found for the first four months but it decreased after five months of culture period. Myxozoa is a spore formation parasite and they produce spore in the infected tissue and then the tissue will be burst out and fish will be recover from infection (Yokoyama *et al*., 2008, Yanagita *et al*., 2010). Therefore, infection was high in the beginning of sample period and it decreased after five months of culture period. Due to their low intensity of infection, impact of parasite in culture fish is assumed as low. However, secondary infection such as bacteria and fungus from infected skin/ gills should be considered.

Parasitic infestation of cultured fish in tropical and subtropical countries represents a serious problem for aquaculture due to severe economical losses either as directly or indirectly (Roberts, 1978).

Trichodina sp. was isolated from examined fish species within the present study. In Myanmar, *Trichodina* spp were so far recorded in *Carassius auratus*, *Cyprinus carpio, Labeo rohita* and *Pangasianodon hypophthalmus* (Thi Thi Thaw, 2007; Pa Pa Win, 2008; Khin May That, 2009 and Su Su Mon 2014). The genus *Trichodina* is the largest within the family Trichodinidae (Raabe, 1959). *Trichodina* spp. are most famous and best known as ectoparasites of skin, fin and gill of fish hosts (Hoffman, 1998). They are typically reported from aquaculture farms and also from natural water resources (Lom and Dykova, 1992).

Although *Trichodina heterodentata* was recorded within the present study, the intensity of infection was very low (range from 1 -2). The impact of *Trichodina* spp. in the culture fish species is therefore considered to be low. However, since poor water qualities enhance the

reproduction and biomass of *Trichodina* spp., trichodinids become a problem in aquaculture if farmers do not maintain a high water quality. In order to keeping high water qualities, feed residues and cleaning of the pool is mandatory to control *Trichodina* spp. outbreaks (Arthur and Lorn, 1984; Ogut *et al*, 2005). Contrary to Lom (1962), who reported that the parasite occur only on the skin in the fresh water, and on the gills in the marine forms. On the other hand, the present findings confirm those of Snieszko and Axelrod (1971) in which they mentioned that *Trichodina* spp. occur on the gills and skin in numbers that could obscure the normal structure of the epithelium.

Ichthyophthirius multifiliis, causative agent of the famous white spot disease, was isolated from *Piaractus brachypomus* within the present study. In Myanmar, *Ichthyophthirius multifiliis* was recorded in ornamental fish species (Thi Thi Thaw, 2007 and Phyo Ma Ma Lin, 2014). However hitherto it was not reported from aquaculture fish species. *I. multifiliis* is a histophagous ciliate and fatal to its host (Lom and Dykova, 1992). It is known as a causative agent of the so called 'Ich' disease of tropical aquarium fishes and is now causing a serious problem in the ornamental fish culture industry world wide (Ponpornpisit *et al*, 2009).

I. multifiliis can infect all freshwater fish species, especially when the water quality is poor, the weather is cool and dark and the fish are immunologically depressed (Lom and Dykova, 1992 and Gratzek, 1993). It may cause even severe problems in tropical fish farms in Myanmar in the future if an appropriate control method is not applied.

Monogenea species were reported from various authors in Myanmar, e.g. by Thi Thi Thaw, 2007, Khin May Thet, 2009, Myint Myint Win, 2012 and Su Su Mon, 2014. Seven *Dactylogyrus* species from *Channa striatus, Anabas testudinus* and *Clarias batrichus* were reported by Kyaw Thu Win (2014) in Myanmar. 14 *Dactylogyrus* species are recorded from 20 freshwater fishes in Sittaung river (Myint Myint Win, 2012). Ogawa (2006) noted that monogeneans parasites are very common in freshwater fish in culture ponds. It is assumed that Monogenea are dispersal in culture ponds in Myanmar.

High prevalences of monogenean infection are reported within the present study. Monogeneans are naturally found in rivers and streams as well as in lakes but prevalence of infection is naturally not high (Khin Mi Mi Oo, 2009; Myint Myint Win, 2012). Based on the life cycle and reproductive development of monogenean parasites, it is assumed that because they are hermaphrodites, they can cross-fertilize themselves to reproduce easily (Cecchini *et al*., 1998).

It is more easy to find, invade and settle on host fishes in captive conditions than in natural water bodies. Therefore, high prevalences of infection in the sampled fish was recorded in the present study because all fishes were collected from relatively dense culture farms compare to natural environments. *Mymarothecium viatorum and M. boegeri* from *Piaractus brachypomus*

have not been reported yet in Myanmar. These species therefore represent new locality records for Myanmar.

Monogeneans are represented by a great variety of mainly fish parasitic taxa, inhabiting both freshwater and sea water environments (Harris, 1985). Monogenean infection in the gills of carp fry induces severe hyperplasia of the gill filament epithelium (Myint Myint Win, 2012). Extreme proliferation of the respiratory epithelium of the gills interferes with respiratory function. Bashirullah (1973) reported that the degree of parasitism was obviously related to the age of the host fishes. The author also reported that the abundance of Monogenea in old fish pond was higher comparted to new ponds leading to higher prevalence in older fish.

Conclusion

The data obtained from the present study are informative and useful for the expanding fish culture and its management in Myanmar. Six species of parasites were recorded in *Piaractus brachypomus*. Highest prevalence of infection was found in Monogenean parasites while the lowest one is found in Cilophora parasites. Intensity of infections of in all parasite species were low. Impact of parasitic infection in study area is assumed as low, however, secondary infection from the damage of infected skin and gills should be considered. The findings will not only be applicable for locally cultivated freshwater fish, but will also provide a frame work for further basic and applied research in the underrepresented field of fish parasitology in Myanmar.

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