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Article

Ornamental fishes in Khulna City, Bangladesh: culture practices and commercial aspects

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Abstract: An investigation was carried out to provide an initial assessment of aquarium fish trade from December 2018 to May 2019 in Khulna city, Khulna of Bangladesh. A total 12 shops were established in this district where 46 aquarium fish species were found of which 12 species were bred for fry production. In the study area, some ornamental fishes such as Gold fish, Black moor, Comet, Red parrot, Tiger barb, Angel fish, Black molly, Guppy, koi carp, Rosy barb, Silver shark, Rainbow shark, Tiger shark, Sucker mouth catfish, Blue gourami, Pearl gourami, Golden gourami, White molly, Pearl scale gold fish, Silver dollar, LT sucker fish were very common. Besides Glass catfish, Siamese fighting fish, calico, Swordtail, Oscar, Widow tetra, Neon tetra, Balloon molly, Moon tail balloon molly, Alligator gar were common and Tangerrine swordtail, Arowana, Flower horn, Red tail black shark, platy, cardinal tetra, Discuss fish, Rummy nose, Bolivian ram, Balloon ram, Bosemoni rainbow, Red tail catfish, Bichir, Mono angel, Knife fish were the rare fish of the Khulna city. All aquarium fish species were brought from catabon area of Dhaka city that were mainly imported from the international markets like India, Singapore, Thailand, etc. Importers/wholesalers and breeders marketed them to retailers, local breeders, shopkeepers, etc. and finally, the shopkeepers sold them to the aquaria owners. The most profitable large aquarium fishes were Gold fish which made a profit of (100±20 tk/pair), Black moor (150±20 tk/pair), Red parrot (250±50 tk/pair), angelfish (100±10 tk/pair), Pearl gourami (300±50 tk/pair), Guppy (400±50 tk/pair), Siamese Fighting Fish (300±50 tk /piece), Tiger Shark **(**40±10 tk/pair), Sucker mouth catfish **(**50±5 tk/pair) to the retailers. During this survey, it was found that the breeders used cement tank, glass aquaria, plastic tank and even plastic jar as culture tanks. They bred aquarium fish all over the year. In the present study the market is mainly domestic. There is a good domestic market which is increasing day by day. Except winter, average annual income was recorded 13,140,000 Tk from the 12 aquarium shops. However, when temperature dropped during winter, sale became reduced; sometimes no selling was also observed during this time.

Keywords: ornamental fishes; culture; disease; management; Khulna; Bangladesh

1. Introduction

The most valuable fish are the aquarium fish or ornamental fish based on cost per unit, length and weight (Saxena, 2003; Galib and Mohsin, 2010). These are attractive colorful fishes of various characteristics, which are kept as pets in confined space of an aquarium or a garden pool for fun and fancy (Chakravartty *et al*., 2012). Business of ornamental fish is now very popular in many countries of the world and a rapidly growing venture in Bangladesh (Galib and Mohsin, 2010). But this business is limited to large cities of the country. Only

research effort on aquarium fish business is essential to understand present status and its development, but such efforts are scantly in Bangladesh and only a few studies can be cited *viz.* Mohsin *et al*. (2007); Galib and Mohsin (2010). Bangladesh has a richness of natural resources such as suitable climate, natural rivers and traditional experience in the culture of fish so that the Bangladeshi farmer can readily culture aquarium fish. Considering the importance of this newly emerging field, many farmers are involved in aquarium fish trade and Aquarium fish business became very popular in many cities of Bangladesh such as Rajshahi, Khulna, Jashore etc. There are vast opportunities of aquarium sector not only in the local market but also in world market. But, it is still couldn't develop according to the desire of the consumer as well as the provider. Most of the aquarium fish shops are found in the capital (Dhaka) and other major city (such as Rajshahi, Khulna etc.) of Bangladesh. The majority of the shops of aquarium fish are located in Dhaka city. Katabon market, the most common and popular market in Dhaka city for aquariums and other aquarium products like aquarium fishes, aquarium foods, chemicals, toys, plants etc. Galib (2010) found that at least 30 aquarium shops are available in Katabon market of Dhaka city where all kinds of aquarium products can be found. Galib (2010) stated that there are only 2 shops in Rajshahi city, while 12 shops are found in Khulna city. Mostafizur *et al*. (2009) reported that 12 shops and 7 breeders have been found in Khulna district where 29 different aquarium fish species were marketed of which 12 species were bred for fry production. Rahman (2005) recorded at least 25 aquarium fish species in Bangladesh. A total of 78 varieties of exotic ornamental fishes were identified under 45 species, 41 genera (excluding 2 cross-bred), 18 families and 5 orders (Galib, 2010). Majority fishes were introduced from Thailand and no true quarantine measures are used at the time of introduction. Artificial breeding techniques of at least 17 varieties of exotic ornamental fishes have been developed by amateur fish breeders (Galib, 2010). According to Mohsin *et al*. (2007) there are found about 12 exotic and 2 indigenous aquarium fishes in Rajshahi city. There are found about 30 species of aquarium fishes in Khulna district (Mostafizur *et al*., 2009). In Bangladesh the professional culture of aquarium fish was started in 1980. At first aquarium were set in restaurant for aesthetic enjoyment to attract people. Then the rearing of aquarium was practiced in shopping centers. Generally elite people keep aquarium in their house or office for their aesthetic enjoyment. The ornamental fish culture practice was increasing day by day. Due to the increasing demand, aquarium fish culture was oriented in mid-1980, at Kataban in Dhaka (Mostafizur *et al.*, 2009). According to the field survey, the aquarium business in Khulna region was reported to be started in 1988-89 and that time there was only one shop which was the pioneer of this business in this region. Some low-income suburban fisher folk have successfully established aquarium fish farming as a small-scale business. There were only a few numbers of aquarium fish farmers found in this region which is increasing day by day for more profit and easy procedure. There are vast opportunities of aquarium sector not only in the local market but also in world market. But, it is still couldn't develop according to the desire of the consumer as well as the provider. Considering these criteria present study is conducted to enlist the available species of ornamental fish in Khulna district; to know the culture practices of ornamental fishes; to investigate the commercial aspects of ornamental fishes.

2. Materials and Methods

2.1. Study area and periods

The survey was carried out at aquarium fish shops and aquarium fish farm of Khulna city under Khulna district, Bangladesh. Data were collected through questionnaire interview from 12 shops and 7 breeders in Flower market ,Faragipara (Khan Jahan Ali Road), New Market Shangeeta Cinema Hall area, Khalishpur, Boira, Raipara , Main road, house No.17 Purbobania khamer, Poschim tooth para, Toothpara moulabarir mor, Foridmolla barir mor, Azadlondir farm, Sonadangar farm in Khulna district from December 2018 to May 2019 (Figure 1).

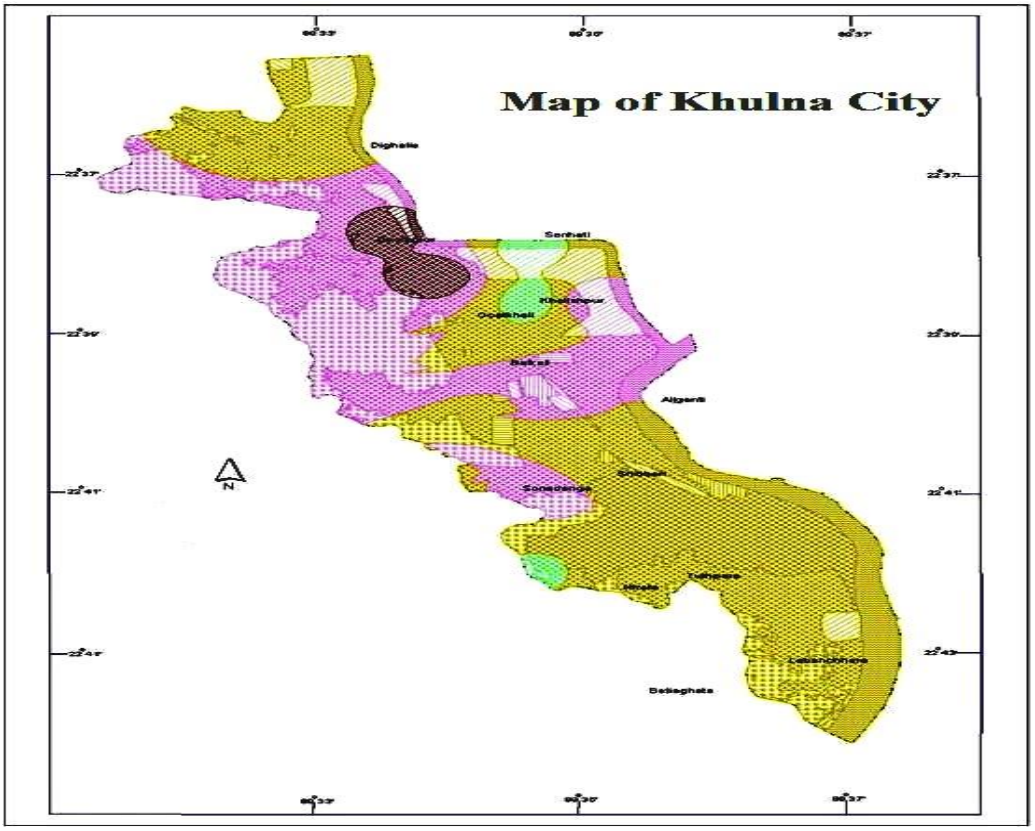

Figure 1. Map showing of Khulna city selected for the study area.

2.2. Sampling technique

In order to meet the objectives of the study, different categories of shopkeepers were purposively selected. A total 12 shops were randomly selected from the Khulna market under Khulna district and concerned shopkeepers were interviewed to collect necessary data and information.

2.3. Data collection

Primary data were mainly collected through market and farm survey. For collection of data a structured questionnaire was prepared. Before formulating the questionnaire, visits were made in the study area. Different information about ornamental fish species were collected during the visit. After finalizing the questionnaire relevant data were collected by interviewing the shopkeepers and breeders directly. The secondary data were collected from Department of Fisheries (DoF), Khulna, Research journals and internet.

2.4. Data processing and analysis

After collection of data from the study area, the data were checked and cross checked for accuracy, consistency and reliability. The filled in interview schedule were scrutinized and the collected data were processed and edited. The collected data were then transferred to master sheets, compiled and summarized to facilitate tabulation. Then the data were entered into computer software 'SPSS' for necessary analysis. A list of table was prepared in accordance with the objectives of the study.

3. Results

3.1. Aquarium shops in Khulna

There were 12 aquarium shops Sagor shomver aquarium (34, khan jahan ali road farajipara, Khulna), Fish and Hobby, Aquarium Gallery, Matshyamela, Khulna aquarium, Sagor aquarium and pet-1 (Flower market, Khulna), Aquarium park (Boira, Khulna), Fish aquarium (New Market Shangeeta Cinema Hall area) were recorded and all were located at the heart of Khulna city.

3.2. Sources of aquarium fish

All the recorded species were exotic fish in Bangladesh and all those fish were brought from Katabon area of Dhaka city that were all imported from the international markets like India, Singapore, Malaysia, Thailand.

3.3. Availability of aquarium fish in Khulna

There were 46 varieties of ornamental fishes were recorded to be sold in the surveyed shops. In the study area, some ornamental fishes such as Gold fish, Black moor, Comet, Red parrot, Tiger barb, Angel fish, Black molly, Guppy, koi carp, Rosy barb, Silver shark, Rainbow shark, Tiger shark, Sucker mouth catfish, Blue gourami, Pearl gourami, Golden gourami, White molly, Pearl scale gold fish, Silver dollar, LT sucker fish were very common. Besides Glass catfish, Siamese fighting fish, calico, Swordtail, Oscar, Widow tetra, Neon tetra, Ballon molly, Moon tail balloon molly, Alligator gar were common and Tangerrine swordtail, Arowana, Flower horn, Red tail black shark, platy, cardinal tetra, Discuss fish, Rummy nose, Bolivian ram, Balloon ram, Bosemoni rainbow, Red tail catfish, Bichir, Mono angel, Knife fish were the rare fish of the Khulna district (Table 1).

Table 1. List of available aquarium fish recorded during the period of study.

Sl No	Common name	Scientific name	Availability	Breeding
01	Goldfish	*Carassius auratus*	Very Common	Y
02	Black moor	*Carassius auratus*	Very Common	Y
03	Comet	*Carassius auratus*	Very Common	Y
04	Red parrot	*Scarus xanthopleura*	Very Common	Y
05	Koi carp	*Cyprinus carpio var koi*	Very Common	Y
06	Tiger barb	*Barbus tetrazona*	Very Common	Y
07	Rosy barb	*Barbus conchonius*	Very Common	Y
08	Silver shark	*Balantiocheilos melanopterus*	Very Common	Y
09	Rainbow shark	*Epalzeorhynchos frenatu*	Very Common	Y
10	Glass catfish	*Kryptopterus bicirrhis*	Common	N
11	Tiger shark	*Galeocerdo cuvier*	Very Common	Y
12	Tangerrine swordtail	*Xiphophorus helleri*	Rare	N
13	Sucker mouth catfishº	*Plecostomus punctatus*	Very Common	N
14	Angel fish	*Pterophyllum scalare*	Very Common	Y
15	Black molly	*Poecilia sphenops*	Very Common	N
16	Blue gourami	*Colisa lalia*	Very Common	Y
17	Golden gourami	*Trichogaster trichopterus*	Very Common	Y
18	Pearl gourami	*Trichogaster teeri*	Very Common	Y
19	Guppy	*Poecilia reticulata*	Very Common	Y
20	Siamese fighting fish	*Betta splendens*	Common	Y
21	White molly	*Poecilia sphenops*	Very Common	N
22	Red tail black shark	*Epalzeorhynchus bicolor*	Rare	N
23	Pearl scale gold fish	*Corassius auratus*	Very Common	Y
24	Calico	*Carassius auratus*	Common	Y
25	Platy	*Xiphophorus maculatus*	Rare	N
26	Cardinal tetra	*Paracheirodon axelrodi*	Rare	Y
27	Discus fish	*Symphysodon aequifasciatus*	Rare	Y
28	Swordtail	*Xiphophorus helleri*	Common	N
29	Oscar	*Astronotus ocetllatus*	Common	Y
30	Arowana	*Scleropages formosus*	rare	Y
31	Flower horn	*Paraneetroplus synspilus*	rare	Y
32	Widow tetra	*Gymnocorymbus ternetzi*	Common	Y
33	Neon tetra	*Parscheirodon innesi*	Common	Y
34	Rummy nose	*Hemigrammus rhodostomus*	Rare	Y
35	Bolivian ram	*Mikrogeophagus altispinosus*	Rare	Y
36	Balloon ram	*Mikrogeophagus ramirezi*	Rare	Y
37	Balloon molly	*Poecilia latipinna*	Common	N
38	Moon tail balloon molly	*Poecilia latipinna*	Common	N
39	Bosemoni rainbow	*Melanotaenia bosemoni*	Rare	Y
40	Retail catfish	*Phractocephalus hemioliopterus*	Rare	Y
41	Bichir	*Polypterus senegalus*	Rare	Y
42	Mono angel	*Monodactylus argenteus*	Rare	Y
43	Silver dollar	*Metynnis argenteus*	Very Common	Y
44	LT sucker	*Hypostomus plecostomus*	Very Common	Y
45	Knife fish	*Apteronotus albiforns*	Rare	Y
46	Alligator gar	*Atractosteus spatula*	Common	Y

Y = Breeding conducted; N = Breeding not conducted

3.4. Availability status of aquarium fish species

In the survey it was observed that 46 varieties of ornamental fishes were found among them 46% were very common aquarium fishes, 26% were common aquarium fishes, and 28% were rare aquarium fishes. It has been clearly seen that the aquarium fish trades are now well established in Khulna district (Figure 2).

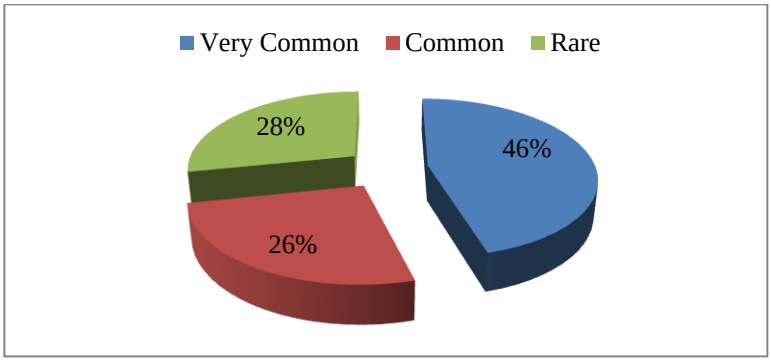

Figure 2. Availability of aquarium fish.

3.5. Aquarium fish species (According to breeding and not breeding conducted)

During the study 12 shops and 7 breeders have been found in Khulna district where 46 different aquarium fish species were marketed of which 12 species (Angel fish, Gold fish, Black moor, Fighter fish, Blue Gourami, Golden Gourami, Pearl Gourami, Calico, Comet, Guppy, Pearl scale gold fish, Tiger shark) were bred for fry production and some of other species (Balloon ram, Bolivian ram, Rummy nose, Discus Fish, Arowana, Flower horn, LT sucker, Knife fish, Alligator gar etc.) also breed but not in the study area they were imported and Glass catfish, Tengerrine swordtail, Sucker mouth catfish, Black molly, White molly, Red tail black shark, platy, Swordtail, Balloon molly, Moon tail balloon molly were not breeding conducted (Table 1 and Figure 3).

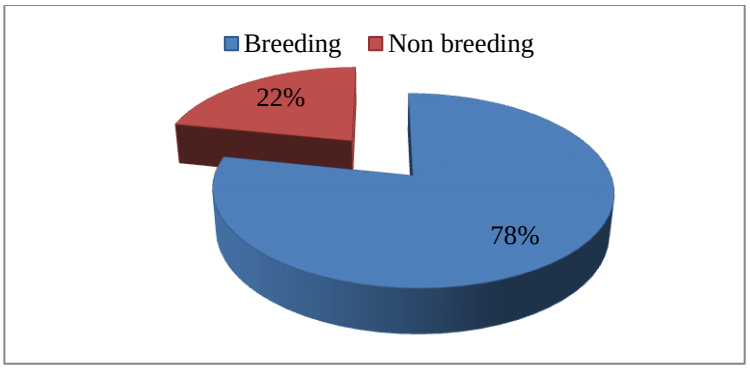

Figure 3. Breeding and not breeding status of aquarium fish.

3.6. Culture practices of ornamental fish farming

3.6.1. Medium

In the present study, most frequent culture facilities utilized for decorative fish are cement tank, glass aquaria, plastic tank, plastic jar earthen tank, earthen pots etc.

3.6.2. Stocking density

Table 2. Stocking density of ornamental fish species.

Species	Species Size (inch)	Species Number	Tank type	Tank size (Sq ft)	Water capacity (liter)	Liter/species
Gold fish	1	200	Cement	4×2.5×2	200	1L/Species
Guppy	2	100	Plastic	3×3×2.3	207	2.07L/Species
All other	3	10	Glass	2×1×1.5	30	3L/Species

3.6.3. Feeding and care required in ornamental fish farming

In the fish farm at the study area young fish are fed mainly with Infusoria, Artemia, Daphnia, Mosquito larvae Tubifex and Blood worms. For rearing, formulated artificial or prepared feed can be used. At present no indigenous prepared feed for aquarium fish is available. The amount and type of food to be given depends on the size of the fry. Feeding is generally done twice in a day or according to requirement. For rearing from fry stage dry/ prepared feed can be used.

3.6.4. Water management of ornamental fish farming

In the present study normally rainwater is the best source of water for ornamental fish culture. If the municipal distribution water is in use, before using, it is aerated for a few days for de-chlorination. The typical temperature of the rearing water in the region is 15 ºC to 28 ºC and the water pH are slightly alkaline. Where large quantities of fish have been stored in smallish distances, the buildup of nitrogenous wastes, most especially ammonia, requires the manufacturer to implement steps to handle it correctly. Standard water exchange together with appropriate aeration overcomes this kind of difficulty in the tanks.

3.6.5. Health management

In the study area appropriate water quality control in ornamental fish breeding and culture is the primary preventive measures since they are very sensitive to temperature as well as pH. The most common diseases of ornamental fishes are reported to be a white spot, mouth disease, tail and fin rot. Some of these easily available and economic chemicals and medicines may be used as preventive measures. The easily available chemicals and medicines for health management are typical salt @15-30 grams/Liter of water used as a bath treatment for 30 min as the disinfectant. Methylene blue @ 2.5 grams/Liter of water inserted in aquarium water for water purification and aluminum sulphate or potassium permanganate @ 0.5-1 gram/ Liter of water used as bath therapy for 1 min as disinfectant.

3.7. Breeding

In the present study the method of breeding is based on the family characteristics of the fish. The success of breeding depends on the compatibility of pairs, the identification of which is a skill born out of experience. Generally the brooders are selected from the standing crop or purchased and reared separately by feeding them with good live food. However, it is always better to buy good brooding stock. Otherwise, the original characteristic of the species keeps on getting diluted because of continuous inbreeding. Brooders especially egg layers should be discarded after few spawning. The basic requirements for successful breeding and rearing of ornamental fish (angel fish, Gold fish, Fighter fish) are adequate space, quality water and sufficient feed. Considering this the following investments are required for starting of ornamental fish farming.

3.7.1. Tanks

The tanks can be of RCC or brick masonry work having flat bottoms with inlet and outlet pipes. Cement tank, glass tank, plastic tanks, plastic jar can be used (figure showed in the above) Rearing of fishes should be done in large tanks. Size of the tanks varies according to the space, the number and type of fish cultured.

3.7.2. Aquariums

Glass tanks of varying size are required for breeding. Small glass bottles of 250 ml are used for keeping individual male fighter fishes. Number and size of the glass tanks depend on the specific breeding / spawning behavior of the species selected.

3.7.3. Over head tank

An overhead tank of suitable size for storing and to enable sedimentation of water is required. It increases the water pressure when needed. At times of low pressure it is used to feed water into the mains water system, and because of the great height, the pressure increase is sufficient to make a difference.

3.7.4. Water supply

Deep tube wells would be the best source of water. Recycling of water through bio-filters or other sort of filtering mechanism can be tried.

3.7.5. Work shed

Work shed should be designed in such a way that the tanks get filtered sunlight. Translucent HDPE sheets can be used. This also protects the culture tanks from falling debris and bird dropping etc.

3.7.6. Aeration equipments

A blower pump with network of tubes for aeration is a must. Continuous power supply should also be ensured through generator set or UPS or inverter.

3.8. Commercial aspects of ornamental fishes

3.8.1. Marketing channels of ornamental fishes

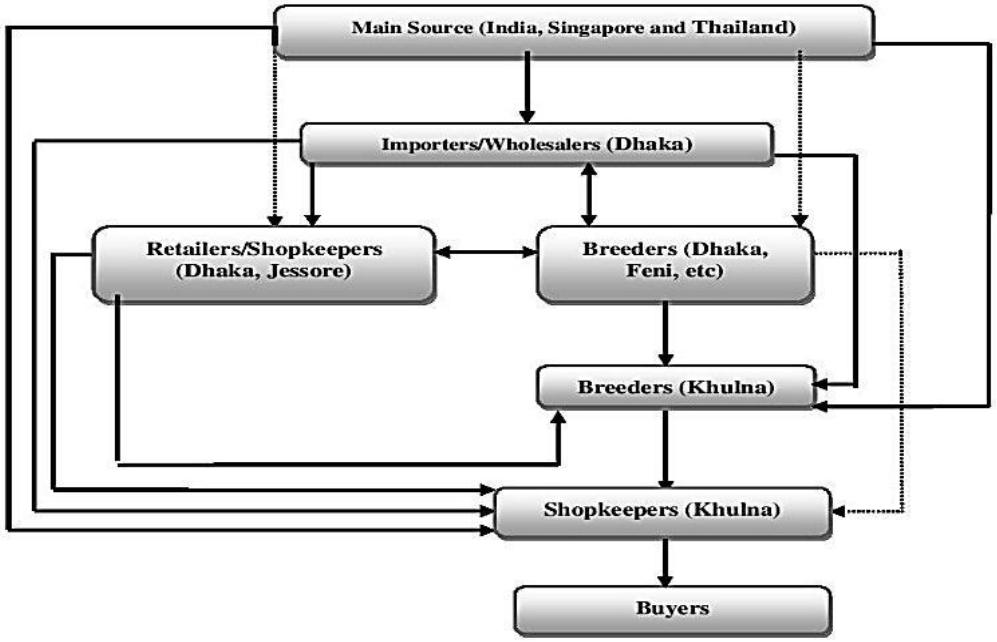

Figure 4. Distribution and marketing channel of aquarium fish in Bangladesh.

→ Always occur ⇢ = Sometimes occur

3.8.2. Pricing and selling status

The most common profitable large aquarium fishes were Gold fish which made a profit of (100±20 tk/pair) Black moor (150±20tk/pair), Red parrot (250±50tk/pair), angel fish (100±10tk/pair) Pearl gourami (300±50tk/pair). Guppy (400±50tk/pair), Siamese fighting fish (300±50tk/piece), Tiger Shark **(**40±10tk/pair) Sucker Mouth Catfish **(**50±5tk/pair) to the retailers (Table 3).

Table 3. Wholesale and retail prices, and profit of aquarium fish.

Fish	**Pair/Single**	**Fish Size**	**Wholesale Price** (BDT)	**Retail Price** (BDT)	**Profit (**BDT**)**
Goldfish	Pair	Small	40±5	50±10	10±5
		Large	300±30	400±50	100±20
Black Moor	Pair	Small	35±5	50±10	15±10
		Large	350±30	400±50	150±20
Comet	Pair	Small	25±5	40±10	15±5
		Large	200±20	250±30	50±10
Red Parrot	Single		750±50	1000±100	250±50
Koi Carp	Pair	Small	35±5	50±10	15±5
		Large	200±20	250±30	50±10
Tiger Barb	Single	1 size	30±5	50±10	20±5
Rosy Barb	Single	1 size	30±5	50±10	20±5
Silver Shark	Pair	Small	50±10	80±20	30±10
		Large	130±30	200±50	70±20

Rainbow Shark	Single	1 size	45±10	80±20	35±10
Glass catfish	Single	1 size	100±10	150±50	50±40
Tiger Shark	Pair	1 size	60±10	100±20	40±10
Tangerrine swordtail	Pair	Small	30±5	50±10	20±5
		Large	100±30	150 ±50	50±20
Sucker Mouth Catfish	Pair	Small	15±5	20±10	5±5
		Large	50±5	100±10	50±5
Angel fish	Pair	Small	30±5	50±10	20±5
		Large	300±40	400±50	100±10
Black Molly	Pair	Small	30±5	50±10	20±5
		Large	100±20	150±30	50±10
Blue Gourami	Pair	Small	25±5	50±10	25±5
		Large	60±20	120±30	60±10
Golden Gourami	Pair	Small	40±5	50±10	10±5
		Large	80±20	120±30	40±10
Pearl Gourami	Pair	Small	500±40	650±50	150±10
		Large	600±50	800±100	300±50
Guppy	Pair	Small	30±5	50±10	20±5
		Large	1600±50	2000±100	400±50
Siamese Fighting Fish	Single	Small	40±10	80±20	40±10
		Large	1700±50	2000±100	300±50
White Molly	Pair	Small	35±5	60±10	25±5
		Large	110±15	150±30	40±15
Red Tail Black Shark	Pair	1 size	150±20	200±50	50±30
Pearl scale Gold Fish	Pair	1 size	300±50	500±100	200±50
Calico	Pair	Small	120±20	150±50	30±30
		Large	450±30	600±100	150±70
Platy	Pair	1 size	20±5	40±10	20±5
Cardinal Tetra	Single	Small	200±40	300±50	100±10
Discus Fish	Single	Small	1200±50	1500±100	300±50
		Large	5000±300	6000±500	1000±200
Sword tail	Pair	Small	35±5	50±10	15±5
		Large	80±20	150±30	70±10
Oscar	Single	Small	300±30	500±50	200±20
		Large	1100±100	1500±200	400±100
Arowana	Single	Small	1200±100	1500±300	300±200
		Large	20000±500	25000±600	5000±100
Flower horn	Single	1 size	10000±500	15000±2000	5000±1500
Widow tetra	Pair	1 size	25±5	50±10	25±5
Neon tetra	Pair	1 size	90±10	150±20	60±10
Rummy nose	Single	1 size	200±40	300±50	100±50
Bolivian ram	Single	1 size	400±30	600±50	200±20
Balloon ram	Single	1 size	300±30	500±50	200±20
Balloon molly	Single	1 size	200±40	400±50	200±10
Moon tail balloon molly	Single	1 size	250±30	400±50	150±20
Bosemoni rainbow	Single	1 size	400±30	600±50	200±20
Red tail catfish	Single	1 size	700±50	1000±100	300±50
Bichir	Single	1 size	1200±30	1500±100	300±70
Mono angel	Pair	1 size	500±50	800±200	300±150
Silver dollar	Pair	1 size	150±30	250±50	100±20
LT sucker	Pair	1 size	20±5	50±10	30±5
Knife fish	Single	1 size	11000±1000	15000±2000	4000±1000
Alligator gar	Single	1 size	1500±200	2000±500	500±300

3.8.3. Marketing and distribution

The fishes reach the marketable size in around 4 to 6 months. Eight to ten crops can be taken in a year. The market is mainly domestic. There is a good domestic market which is increasing day by day. Some breeders of

Khulna region directly sell these ornamental fishes in Katabon area of Dhaka city. The export market for indigenously bred exotic species is not also beginning.

3.8.4. Annual income

Except winter, average annual income was recorded 13,140,000 Tk from the 12 aquarium shops. However, when temperature dropped during winter, sale became reduced; sometimes no selling was also observed during this time.

4. Discussion

In the present study it is very difficult to count the actual number of fish species used as aquarium fish because new species are introducing continuously in the country. During the survey 12 shops and 7 breeders have been found in Khulna district where 46 different aquarium fish species were marketed of which 12 species (Angel fish, Gold fish, Black moor, Fighter fish, Blue Gourami, Golden Gourami, Pearl Gourami, Calico, Comet, Guppy, Pearl scale gold fish, Tiger shark) were bred for fry production and some of other species (Balloon ram, Bolivian ram, Rummy nose, Discus Fish, Arowana, Flower horn, LT sucker, Knife fish, Alligator gar etc.) also breed but not in the study area they were imported and Glass catfish, Tengerrine swordtail, Sucker mouth catfish, Black molly, White molly, Red tail black shark, platy, Swordtail, Balloon molly, Moon tail balloon molly were not breeding conducted were bred for fry production and some of other species (Balloon ram, Bolivian ram, Discus Fish, Arowana, Flower horn, LT sucker, Knife fish, Alligator gar etc.) also breed but not in the study area they were imported and also some were not breeding conducted (Galib and Mohsin, 2010; Shajib *et al*., 2017). On the other hand, Mostafizur *et al*. (2009) stated that a total of 12 shops were established in this district where 29 aquarium fish species were found of which 12 species were bred for fry production. The findings of the present study were showed that the number of aquarium shops and breeders were same but the number of species was higher to them where 17species have been increased in Khulna district. In the study area, some ornamental fishes such as Gold fish, Black moor, Comet, Red parrot, Tiger barb, Angel fish, Black molly, Guppy, koi carp, Rosy barb, Silver shark, Rainbow shark, Tiger shark, Sucker mouth catfish, Blue gourami, Pearl gourami, Golden gourami, White molly, Pearl scale gold fish, Silver dollar, LT sucker fish were very common. Besides Glass catfish, Siamese fighting fish, calico, Swordtail, Oscar, Widow tetra, Neon tetra, Balloon molly, Moon tail balloon molly, Alligator gar were common and Tangerrine swordtail, Arowana, Flower horn Red tail black shark, platy, cardinal tetra, Discuss fish, Rummy nose, Bolivian ram, Balloon ram, Bosemoni rainbow, Red tail catfish, Bichir, Mono angel, Knife fish were the rare fish of the Khulna district. Galib (2008) found that Silver Arowana, koi carp, Oscar are the rare species of the Khulna district. The findings of the present study were showed that the availability of maximum species were same but only two species availability were differ from his opinion. From the aquarium shop present study found that koi carp were very common and Oscar fish were common but that showed that all these two were rare species. All the aquarium fish species are entirely imported from the international markets like India, Singapore, Thailand, etc. Importers/wholesalers and breeders market them to retailers, local breeders and shopkeepers. Finally, the shopkeepers sell them to the public. It has been also found that the aquarium fish species in Khulna district are distributed and marketed following a local channel, which is given as a flow diagrammed in Figure 4. All the aquarium fishes are sold to the wholesalers from the fish breeders. Fish breeders are also sold the fishes directly to the retailers. Again retailers are bought the aquarium fishes from the wholesalers. Finally the retailers sell them to the buyers. On the other hand, Wijesekara and Yakupitiyage (2001) showed that aquarium fish are imported from different countries in Sri Lanka such as Singapore, Thailand, Indonesia, Malaysia, Japan and the Maldives, while Hung *et al.* (2002) stated that aquarium fish are imported in Vietnam mainly from Taiwan, Thailand, Hong Kong, Singapore, Malaysia, China and the Philippines. Most of these fish are destined for the local consumer market with only a few ending up as brood stocks for the fish breeders. However present study showed that all the aquarium fishes were imported from mainly India, Singapore, Thailand and also local channel should also be distributed. But, their studies showed that only imported countries Singapore, Thailand and other countries but not India. However, the development of an aquarium fish export market hasn't been built yet in this area where more newcomers can enter this industry. Similar marketing study were also showed by Asif *et al*. (2014); Asif *et al*. (2015); Sharif and Asif (2015); Hossain *et al*. (2015); Rahaman *et al*. (2015); Leela *et al*. (2018); Hossain *et al*. (2018). The maximum wholesale price was recorded for large sized arowana (20000±500tk/piece) followed by knife fish (11000±1000tk/piece) and flower horn (10000±500tk/piece) (Table 2). The highest retail price was found for large arowana (25000±600tk/piece) followed by Knife fish (15000±2000tk/piece) and flower horn (15000±2000tk/piece) (Table 2). But these fishes were imported and price was very high so pricing and selling status was very rare. The most common profitable large aquarium

fishes were Gold fish which made a profit of (100±20 tk/pair) Black moor (150±20tk/pair), Red parrot (250±50tk/pair), angel fish (100±10tk/pair) Pearl gourami (300±50tk/pair). Guppy (400±50tk/pair), Siamese Fighting Fish (300±50tk /piece) Tiger Shark **(**40±10tk/pair) Sucker Mouth Catfish **(**50±5tk/pair) to the retailers. (Table 2). According to Frimodt (1995) and Shajib *et al*. (2017) goldfishes are valued as ornamental fish for ponds and aquaria; they are edible but rarely eaten. The most expensive aquarium fish was red or blood parrot (1000-1500 BDT/pair) in Khulna city followed by discus and Oscar. Galib and Mohsin (2012) recorded Arowana (*Osteoglossum bicirrhosum*) as the most expensive aquarium fish species in Bangladesh costing BDT 30,000 per piece. Galib (2008) found that Arowana are the most expensive species (20,000 Tk/piece) followed by large sized Assorted Koi Carp (12,000 Taka per pair) and Oscar (500 Taka/pair. I Could give an example for the price of arowana fish such as I recorded the price of arowana fish was 25000 Tk/ piece where Galib and Mohsin recorded 30,000 Tk/ piece so differences was 5000 Tk per piece and now it is lower price than them. The breeding procedure of ornamental fishes are followed by traditional hatchery breeding technique (Ali *et al.*, 2016a; Ali *et al.*, 2016b; Islam *et al.*, 2016). In the present study, most frequent culture facilities utilized for decorative fish are cement tank, glass aquaria, plastic tank, plastic jar, earthen tank, earthen pots etc. But at first it was used as recreational purposes in aquaria and cement tanks. (Source: Department of Fisheries 2001, Matshya Bhaban, 13 Shaid Munsur Ali Sharani, ramna, Dhaka). So a few changes observed from this source where at first aquarium owner used only aquaria and cement tank but present study showed that they used different medium. So medium and culture of aquarium fishes are increasing day by day. In the fish farm at the study area young fish are fed mainly with Infusoria, Artemia, Daphnia, Mosquito larvae Tubifex and Blood worms. For rearing, formulated artificial or prepared feed can be used. At present no indigenous prepared feed for aquarium fish is available. The amount and type of food to be given depends on the size of the fry. Feeding is generally done twice in a day or according to requirement. For rearing from fry stage dry/ prepared feed can be used. On the other hand the commercial culture of the ornamental fish in large scale needs the large amount of live feeds. The shortage of live feed affects the growth and survival rate of the fish. To compensate the live feed shortage, a new dry feed formulation is required that can substitute the live feed shortage in edible fish as well as in ornamental fish (James and Sampath, 2002). So their opinion about the type of feed of aquarium fish was same. In the present study, ornamental fish production unit requires a higher degree of expertise for greater water quality control as ornamental fish is very sensitive to poor water quality conditions. Many decorative fishes will perish in situations in which more powerful food fish species may survive. As cosmetic fish are stored in tanks longer quantities than their meals fish counterparts, water quality is the most critical. Where large quantities of fish have been stored in smallish distances, the buildup of nitrogenous wastes, most especially ammonia, requires the manufacturer to implement steps to handle it correctly. Standard water exchange together with appropriate aeration overcomes this kind of difficulty in the tanks. The water quality parameter tolerance varies from species to species and age, but there is no concrete evidence to support this view. However, the researchers have to find out how water quality parameters affect the reproductive activity of a particular ornamental fish under captive conditions. Another few management research (Rahman *et al*., 2015; Shabuj *et al*., 2016; Hossain *et al*., 2016; Vaumik *et al*., 2017; Islam *et al*., 2017; Asif and Habib, 2017; Shajib *et al*., 2017; Faruk *et al*., 2018; Ali *et al*., 2018; Yeasmin *et al*., 2018; Biswas *et al*., 2018) showed the similar management practices. In the study area appropriate water quality control in ornamental fish breeding and culture is the primary preventive measures since they are very sensitive to temperature as well as pH. The most common diseases of ornamental fishes are reported to be a white spot, mouth disease, tail and fin rot. Some of these easily available and economic chemicals and medicines may be used as preventive measures. The easily available chemicals and medicines for health management are typical salt @15-30 grams/Litre of water used as a bath treatment for 30 min as the disinfectant, methylene blue @ 2.5 grams/Litre of water inserted in aquarium water for water purification and aluminum sulphate or potassium permanganate @ 0.5-1 gram/Litre of water used as bath therapy for 1 min as disinfectant. Some disease and preventive measures research (Chowdhury *et al*., 2015; Shabuj *et al*., 2016; Yeasmin *et al*., 2016; Rahman *et al*., 2017; Neowajh *et al*., 2017; Adhikary *et al*., 2018; Rahman *et al*., 2019) of fish is conducted and similar disease management were stated in these research. Mortalities in the aquarium trade and acknowledged that high delayed mortalities of marine fish were probably associated with a variety of factors, including cyanide, stress, ammonia, oxygen depletion, disease and starvation. Present study showed the common diseases and treatment from the study area and that showed the factors of diseases of aquarium fishes though dissimilarities were shown but both phenomena were very important to know the improving of culture of aquarium fishes and it was very easy to minimize the diseases of aquarium fishes.

5. Conclusions

As breeding technology of several fish has been developed and practiced in Khulna city, it enhanced the supply and reduced the retail price. It is very much conspicuous that aquarium fish business in the study area is so popular. That why it is develop through producing ornamental fish locally which not only reduce the price but also offer a new option of employment or business. Moreover, indigenous ornamental fish should be included to the collection of aquarium shops. In addition to these, appropriate promotional activities are also required.

Conflict of interest

None to declare.

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