International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 1940-1944

Received: 01-09-2018
Accepted: 05-10-2018

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Comparative study of gold fish (*Carassius auratus*) breeding via induced and natural breeding

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Abstract
The present study was aimed to perform induced breeding of gold fish (*Carassius auratus*) in controlled environmental condition and its breeding success rate along with fecundity and hatching rate was compared with natural breeding method. The study was conducted during the period from June at Comprehensive Area Development Corporation (WBCADC), Debra Project, Dalapatipur, Debra Bazar, Paschim Medinipur, West Bengal, India. Gold fish brooders were exposed to single dose of ovatide @ 0.5ml/kg body weight for female and 0.2ml/kg body weight for male for induced breeding while the control females were exposed to natural breeding. Fecundity and hatching rate of eggs in induced bred fish was found to be significantly higher than the fish exposed to natural breeding methods. Also the survival rate was found to be higher in induced bred fish. The hatching rate and survival success of eggs may be affected by various factors, such as temperature, rate of water flow, water quality etc. Therefore, the optimum physico-chemical parameters of water was maintained and monitored during the entire experimental duration. The positive response of gold fish to synthetic hormone (Ovatide) with significantly increased fecundity, fertilization and hatching rate makes it possible to conduct the breeding of this species commercially and the method can be utilised to help the farmers to increase their economy.

Keywords: *Carassius auratus*, induced breeding, ovatide, natural breeding

1. Introduction
Ornamental fish keeping is becoming popular as an easy and stress relieving hobby. Nurturing Goldfish (*Carassius auratus*), the first of ornamental or live jewels organism, is one of the oldest and most popular hobbies in the world for ornamental fish lovers. Goldfish, *Carassius auratus* (Linnaeus) one of the best aquarium fish worlds wide belongs to the family Cyprinidae and is closely related to Indian major carps. Goldfish was bred by administering human chorionic gonadotropin (HCG) in India first time by (Reddy *et al*. (1990) [4]. Aquarium fish keeping is a centuries-old popular hobby, growing interest in which has resulted in steady expansion in its trade in more than 125 countries. With the increasing popularity of household aquariums, less than 1% of the global market for ornamental fishes belongs to the public aquaria sector, with the rest still confined to hobbyists (V.K. Dey 2016) [2]. Aquarium keeping is said to be the second largest hobby next to photography in the world. Aquarium fish and accessories industry is fast gaining importance due to its tremendous economic opportunities and prospects. Minimum requirement of space and/or attention compared to other pet animals is the reason for growing interest in keeping aquaria all over the world. Further setting up of an aquarium is relatively inexpensive and can be installed in any location at home, where there is a diffused light. Ornamental fish keeping and their propagation have been an attractive activity for many people in the world, which provide not only aesthetic beauty and pleasure but also financial benefits. Aquarium keeping has become increasingly popular in developed countries. In developing countries including India, keeping aquarium at home is gaining its momentum. The brilliant, flamboyant color and attractive appearance of certain fishes appeal to everyone. About ten per cent peoples in the world keep aquarium in their homes. People keep fish in their homes for variety of reasons: for decoration, children's education, enjoyment, good fortune and to collect rare species or even to propagate them. Indian waters possess a rich diversity of ornamental fish, with over 250 indigenous

varieties with rich biodiversity hotspots like north-eastern states, Western ghats, Andaman & Nicobar islands and Lakshadweep (Pramod K. Pandey and Sagar C. Mandal. 2017) [2]. On the other hand, Standardization of captive breeding technology of many of freshwater ornamental fishes has been established. In contrast only a few of marine species could be successfully bred in captivity. One of the main obstacles in the establishment of a marine ornamental fish industry is the complex nature of the reproduction and rearing of the larvae of these fishes in captivity. Due to the efforts of a small number of private entrepreneurs, a few species of marine ornamental fishes could be commercially raised but governmental support has been insignificant. Some important issues need to be considered in the propagation of marine ornamentals, such as broodstock development, larval management, larval tank characteristics, environmental conditions, water management, larval nutrition and disease control [2]. The comet or comet-tailed goldfish is one of the most common varieties of fancy goldfish in the world. It is similar to the common goldfish, except slightly smaller and slimmer, and is mainly distinguished by its long deeply forked tail. This goldfish variety is an excellent choice for beginners. They are an easy fish to keep as they are not picky and will readily eat what is offered. They are basically delicate but very peaceful towards other occupants and hence well suited to aquarium setup. There is various color variation of comets but comet with yellow, orange, red, white, and red-and-white coloration are common. Goldfish, like all cyprinids, are egg-layers. They produce adhesive eggs that attach to aquatic vegetation. The eggs hatch within 48 to 72 hours, releasing fry large enough to be described as appearing like "an eyelash with two eyeballs" (Lauria S. *et al*., 1987) [3]. Further, the technique of induced breeding was first evolved in Argentina after producing pituitary extract by Houssay 1930 where viviparous fish was injected with the hormone to make premature birth. In the year of 1934, Brazilians were succeeded in induced breeding by pituitary extract. This technique was also followed in America (Merlin & Hubs) and in Russia (Gerebilisky). In India first attempt of induced breeding was made by Khan in 1937 on Cirrhinus mrigala. Later in 1955 Dr. Hiralal Choudhuri applied this technique in minor carps (*Esomus danricus*, *Pseudeutropius atherinoides*) (Monjit Paul & Mukti Chanda., 2014) [5]. A common method used for induced breeding in fish is the administration of pituitary extract from a mammal or a fish. The hormones that induce breeding are gonadotropins. Chorionic gonadotropin, which is a placental hormone, is also found to be equally effective (Yadav, 1995) [6]. Reports are there to show that Natrum muriaticum can be used to induce breeding in fish (Visakan, *et al*., 2005) [7]. Furthermore, the aim of this study was to provide relevant information's of breeding and rearing of ornamental fishes to farmers (beginners) of the local area to develop ornamental fish farming as a small scale bio-industry especially for women. The criteria for selection of suitable species for culture basis depend upon its ecological adaptability, adjusting to certain fluctuation in the culture medium and accepting supplementary food etc. The Common Gold fish *(Carassius auratus*) is the most beautiful and popular freshwater fish species in the aquarium trade industry. It is a cold water fish but lives comfortably under tropical environment. The optimum temperature for goldfish is between 20°C and 25°C. It is an omnivorous fish. Goldfish, like all cyprinid, are egg layers. Their eggs are adhesive and attach to aquatic vegetation or a spawning mop. On the other hand, approximately 55,000 - 65,000/kg body weight. It also depends on environmental conditions [9]. In semi-tropical regions gold fish breed twice a year, during February-March and September-October. Goldfish were originally developed in China. This species was normally a silver or gray color, but early in the Jin Dynasty, somewhere between the years 265 - 420, it was noted that there was a natural genetic mutation producing a yellowish orange color. It became common practice to breed this pretty golden fish for ornamental garden ponds. In the recent years, the art of rearing and fish keeping in aquarium has become a passion and major hobby among millions of people around the globe. To many enthusiasts, watching these beautiful creatures swimming gracefully in the aquarium is a pure sense of joy and mental pleasure. It also adds to the aesthetic beauty of a house. The global trade of ornamental fish is about $ 9 billion dollar of which 85% are freshwater species and the rest are marine species. The ornamental fish is one of the fastest growing sectors in fisheries with an annual growth of over 10% in the world. The domestic growth of ornamental fish trade is also about 20% per annum. There are about 300 freshwater ornamental fish varieties that are available in the market and being traded with different trade names. (Nico *et al*., 2018) [10] Among ornamental fish, gold fish (*Carassius auratus*) is considered to be the most popular and attractive pet fish due its many variations such as colour, fin, tail, shape, size and body structure. Though similar in appearance to carp (Cyprinus carpio), gold fish lack barbels and a dark spot at the base of each scale. It is reported to grow up to 20-30 cm. It is the most common aquarium fish and one of the oldest and best known fish. Many aquarium fish keepers considered that a community aquarium fish tank is not a complete one unless it is having few varieties of gold fish. It can tolerate wide water temperature variations ranging from warm waters in tropics to cold waters where surface water freezes to ice during winter. They feed on aquatic plants and small aquatic animals and easily interbreed with carps under normal conditions. In recent years, due to advances in selective breeding and hybridization, numerous varieties with different colours, varied fin patterns and unbelievable shape and forms such as Comments, Calico, Fantail, Orando, Pyukin, Lion head, Pearl scale, Bubble eye, Telescope, etc., are available in the markets and has great demand both in domestic as well as international markets.

1.1 Current status of ornamental fisheries in whole world

Over 2500 species are involved in the global ornamental fish industry, of which over 60% are of freshwater origin. Although relying largely on captive-bred freshwater fishes, the trade also includes significant numbers of fish and invertebrates collected from the wild. It has been estimated that about 30 freshwater fish species dominate the global market, such as live bearers, neon tetra, angel fish, gold fish, zebra danio and discus. The guppy and neon tetra species alone represent more than 25% of the market by volume and more than 14% by value. Marine fish species constitute more than 15% of the market by value, with about 98% collected from the wild while the rest are captive-bred. Although more expensive than and not as easy to maintain as freshwater aquariums, keeping marine fish in aquariums is becoming more popular (V.K. Dey 2016) [1]. Besides this, the world trade of ornamental fish is estimated to be US$ 6.0 billion. The developing countries continue to be the major producer of ornamental fish. Above 60 per cent of ornamental fish is originated from developing countries in 2015. It is reported that global imports and exports of ornamental fish in 2015

were valued at US$ 271 million and US$ 304 million, respectively. In 2015, USA was the largest importer of ornamental fish accounting for US$ 49.67 million followed by United Kingdom (US$ 24.31 million), Germany (US$ 18.62 million) and Japan (US$ 15.71 million), Singapore (US$ 14.33 million). During 2015, India's import for ornamental fish was US$ 0.34 million, with a ranking of 51, in the world. In 2015, top exporters were Singapore (US$ 45.44 million), Spain (US$ 36.07 million), Japan (US$ 31.08 million), Czech Republic (US$ 20.43 million) and Indonesia (US$ 19.67 million). In the same year, India's export was only US$ 1.02 million, with a ranking of 29th in the world. Asia is still the major ornamental fish supplier for USA and Europe with Singapore remaining the hub of Asian ornamental exports. The export of Singapore has decreased recently and still significant player in the trade (Pramod K. Pandey and Sagar C. Mandal. 2017) [2].

2. Material and Methods

2.1 Experimental Place

Our research work experimental step up was installed at Comprehensive Area Development Corporation (WBCADC), Debra Project, Dalapatipur, Debra Bazar, Paschim Medinipur, West Bengal, India. It is a government organization which works for the development of rural people skill and training in the field of Agriculture, Animal Husbandry & Fishery and Aquaculture related activities respectively.

2.2 Collection of Brooders

The brooder fishes were brought from fish culturist of Dashnagar, Howrah, West Bengal. The fishes used for this experiment were more than 10 months old in age.

2.3 Required equipment and inducing agents

The materials required for the experiments purpose by me are very simple ones. I used the following materials: Cement tank, Glass Aquariums, Inducing agent, Insulin syringe, Fine mash net used as spawning mop, Aerator& Sponge filter, Natural food & Artificial feed and Hand net.

2.4 Water source

We used ground water during whole experiment with the help of bore well.

2.5 Selection of fish and brooders for experiment

The most common egg layer is the gold fish (Carassius auratus) in ornamental fishes. Gold fish is remarkably hardy & most commonly kept in an aquarium throughout the whole world. Gold fish has various varieties but we selected one of the most commons variety Carassius auratus this experiment. Breeding of gold fish is not an easy task if we are going to breed goldfish; we need to know the following things carefully like; it typically grows to 120 to 220 mm SL, with a maximum of 410 mm SL (Page and Burr, 1991) [8]. Approximately 9-12 cm size goldfish are used in my experiment purpose. Besides this, all Goldfish varieties, both male and female attain their maturity when they grow 3 to 5 inches (7.5 to 11 cm). Their maturity age differs from different types of fish and their living conditions. Nevertheless, they reach the maturity size from 10 months to 36 months. It is impossible to differentiate between the sexes of Goldfish until they reach maturity. Only professional breeders can tell the difference. The internal and external difference between a female and a male are as follows. We can only see these differences after they attain maturity. Goldfishes naturally breed during the spring. As the water temperatures rise with the oncoming of spring and with plenty of food goldfishes naturally prepare themselves for reproduction. However, in a tank or an aquarium if the seasonal natural breeding is unsuccessful, goldfishes can also be breed artificially during their breeding season during April to August [9].

Table 1: Representing characters during breeding season of Gold fish

Characters	Male	Female
Tubercles	Appear on head, Do not show breeding tubercles operculum, pectoral fins and other fins	Do not show breeding tubercles
Abdomen	Smaller, slender and firm and may have ridge	Large, fatty, no abdominal ridge and circular in outline.
Genital opening	Long, concave and smaller opening	Convex, large and protruding out side
151 ray of pectoral fin	Thicker edge and more pointed	Thinner edge and round pectoral fin
Lead (main) ray of anal fin	Thinner	Thicker
General body shape	Thinner, longer and symmetrical from the top	Fatter, shorter and asymmetrical from the top
Behaviour	Chase the female	Chased and harassed by male

(***Source*****:** of table no. 1 P. C. Thomas Book. 2003)

2.6 Brooder management

At first we collected good healthy and better quality Gold fish from farmer farm for this experiment. Then collected fish were transferred into the Brood stock tanks where we feed fish on 5% body weight and the feeding rate was 3 times per day. We used artificial feed for feeding purpose with crude proteins (32%), crude fat (4%), fiber (4%) and moisture (10%) respectively we used recommended better feed for brooders during this experiment. Before the breeding, day to day we observed experimental fish health and water quality of brood tank also respectively.

2.7 Breeding techniques of goldfish

2.7.1 Natural Breeding

At first Breeding tank was filled with 200 gallon water and air pumps were installed in the breeding tanks. Before the breeding period male and female fish should be place in separate breeding tanks. During breeding time frequently check brooder fish. If the brooder ready for breeding purpose than accumulate the brooder male and female for some time. Same pairs were collected and transferred into the main breeding tank. Besides this, add nylon net (spawning mop) for collection of sticky eggs. Allow brooder male and female for breeding. Within 36 hours brooder female released the eggs and male released sperm for fertilization. Fertilized eggs were gathered on nylon net then transferred male and female from breeding tank to another tank. On the other side, vigorous aeration starts into the breeding tank. After 18-20 hrs (depend upon the temperature) the spawn hatched from the eggs.

2.7.2 Induce Breeding

At first we selected healthy brooder fish in 2:3 ratio (female: male) in breeding tank. Secondly we injected synthetic

hormone (ovatide) through insulin syringe. Dose of the Ovatide for female was 0.5 ml/kg body weight and male 0.2 ml/kg body weight. Then injection is administered on the caudal region of the fish body at an angle of 45°. Before the injection, the fish were immersed in the $KMnO_4$ solution to prevent them from infection. After administration of hormone, brooder released eggs within 5-6 hrs. After 18-20 hrs the spawn hatched from eggs. Composition of Ovatide was Gonadorelin A (sGnrH-A) 20 mcg, Domperidone BP 10 mg and Benzyl Alcohol IP 1.5% v/v respectively.

3. Results

The study was conducted to compare the result of induce breeding and natural breeding of an economically important ornamental fish, *Carassius auratus* in the cemented tank under the captive condition. In this study, the inducing agent ovatide was used to breed the broodstock under controlled environmental conditions. Comparative results of both breeding methods adopted in gold fish brooders are summarized in Table 2. From the results, it is evident that out of various dose, 0.5 ml/kg body weight fish for female and 0.2 ml/kg body weight fish for male shown best results with breeding success of about 93% as compared to 87% success of natural breeding. The number of eggs laid by brooders in induced breeding was more as compared to brooders exposed with natural breeding techniques (Fig. 1). Hatching rate of ovatide induced breeders of gold fish were also higher (Fig. 2) as compared to naturally breeding fish. The graphical representation of success percentage in induced breeding as compared to natural breeding is given in fig. 3. Also, different water quality parameters were checked and maintained within the optimum levels during the entire experimental duration (Table 3).

Table 2: Comparison of different type of breeding method in Gold fish

Sr. No.	Date	Procedure	No of eggs Laid (/100gm)	No of eggs hatch (/100gm)	Success Rate (%)
1.	22/05/2017	Induced breeding	6400	5950	93
2.	16/6/2017	Natural breeding	6200	5400	87

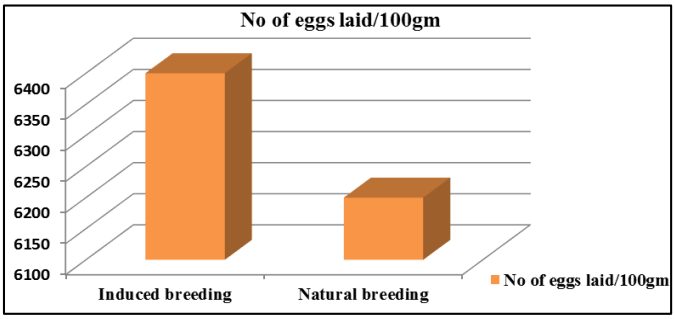

Fig 1: No of eggs released by goldfish using Induced & Natural breeding techniques

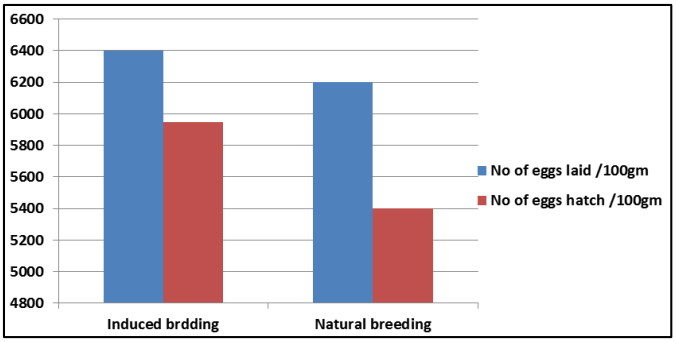

Fig 2: Hatching Rate of goldfish eggs

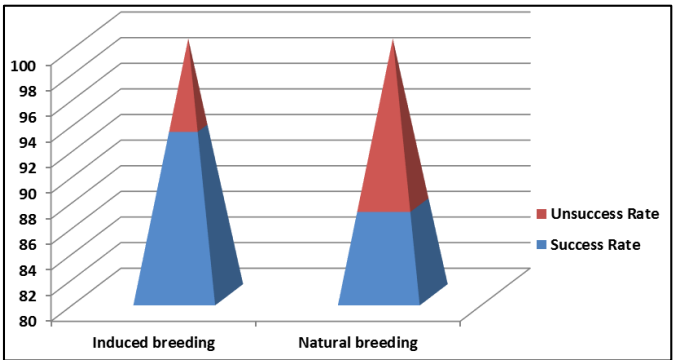

Fig 3: Breeding success & unsuccessful rate in goldfish

Table 3: Different Physicochemical parameters maintained in experimental duration

Sr. no	Water quality parameters	Value/Rang
1.	Water temperature	26-31 ºC
2.	Dissolve Oxygen	6.8-8.2 mg/L
3.	Water pH	7.2-7.7
4.	Hardness of water	100 mg/L
5.	Alkalinity	140-270 mg/L

4. Discussion

Since time immemorial, gold fish has been one of the most sought after ornamental fish by aquarium fish keepers throughout the world, particularly in tropical countries. Several varieties of gold fish that are available in the market today originated from the parental stocks developed by the Chinese, Korean and Japanese breeders and have been given different commercial names. In India, the breeding technology of the numerous varieties of gold fish is still remained in its infant stage. Considering the huge demand of gold fish both in domestic as well as international markets, the breeding of several varieties of goldfish needs greater attention. The breeding technology of all the varieties of gold fish is very simple and more or less similar. From the available references along with my present investigation on the induced breeding and natural breeding of the comet fish, it was observed that higher percentages of fertilization and hatching were achieved from a comparatively proper dosage of hormone and environment. Steel plate for fertilization must be avoided because steel plate reduces the fertilization rate and creates spoilage of huge number of eggs. In this induced breeding process quality hormone should be used to ensure better production.

The main objective of this experiment was to compare the fecundity and hatching of comet gold fish by natural and induced breeding method. The experiments were conducted in the month of June with temperature around 22-30^{0}C. Optimum temperature required for induced breeding is around 28^{0}C. Ideal weather for breeding of comet gold fish is maintaining the optimum temperature with little showers of rain. Proper aeration facilities were provided in the experimental tanks. In this study only a single dose of ovatide @ 0.5ml/kg body weight for female and 0.2ml/kg body

weight for male were used for induced breeding within 6 hr while the control females were exposed to natural breeding. The hatching rate may be affected by various factors, such as temperature, rate of water flow, water quality etc. The optimum temperature range for gold fish is 25-28^{0}C. The hatching and fertilization rate are slightly affected by environment and concentration of synthetic hormone. Finding of the present study indicates that both the hatching rate and the fertilization rate were increased in treatment. The incubation period of eggs depends largely on water quality parameters such as salinity and temperature. Hatching period of eggs was observed to vary from 18-20 hours at 29^{0}C. Fertilization and hatching rates also differ with the condition of brood.

The diameter of the fertilized egg capsule found in this study ranged between 0.8 mm and 1.00 mm while the yolk sphere ranged from 0.5- 0.7 mm while I found that the fertilized eggs were adhesive and transparent with diameter ranging between 0.9 mm and 1.10 mm. This slight variation can be caused by smaller size brood fish than the brood size selected for the study. The comet goldfish is typical of the teleosts in its general development. The eggs were very much adhesive in nature and were 0.9- 1.0 mm in diameter and hatch in approximately 20 hours at 25-28 ^{0}C. However, it was observed that eggs of 1.25 to 1.46 mm. in diameter were hatched at 22 ^{0}C. The difference in diameter of eggs may be due to the brood size and environmental variation. The first cleavage during our study took place an hour after fertilization, and in fifteen hours the blastoderm had completely encircled the yolk with the exception of a small spherical blastopore. In sixteen hours heart was found beating rhythmically. Further development to hatchling involved pigmentation by melanophores, enlargement of all the embryonic structures, and an elongation of the yolk sac posteriorly. At hatching the larva was 1.3- 1.7 mm in length, and restricted in movement by the weight of the yolk sac.

Proper knowledge on the embryonic and larval development will help to optimize the problem and will led us to a sustainable management of comet. Further studies on embryological development of ornamental fishes will give an opportunity to learn their development stages in detail and this would be helpful for the commercial production of this elegant fish. A good chasing behavior was observed in all the sets. The number of eggs released and fertilized was comparatively higher than the control both in goldfish. Indeed this is a qualitative estimate, since the eggs have been sporadically scattered and seen all through the tank and plants sticking here and there. A quantitative estimate of hatchlings could be made on fifth day. I just followed the basic guidelines of natural and induced breeding and I have got success and also got more well production through using universal protocol.

5. Conclusion

In this study this inducing agent was tried to breed a popular economically important ornamental fish, *Carassius auratus* in the Cement Tank under the captive condition. From the results, it is evident that induced breeding with ovatide @ 0.5ml/kg body weight for female and 0.2ml/kg body weight for male fish show higher breeding success about 93% as compared to 87% success rate of natural breeding. The number of eggs laid and hatching rate was also higher and far better in induced breeding than natural breeding. The commercial breeders, breeding the fishes without hormonal induction also claim success, nevertheless, the study proves that their efforts could be more meaningful, if they utilized inducing agent for breeding.

6. References

1. Dey VK. The Global Trade in Ornamental Fish. Infofish International, 4/2016.
2. Pramod K Pandey, Sagar C. Mandal. Present status, challenges and scope of ornamental fish trade in India. Conference: Aqua Aquaria India, At Mangalore, 2017.
3. Lauria S, Piironen J, Holopainen IJ. Notes on egg development and larval and juvenile growth of crucian carp (*Carassius carassius* (L.). Annales Zoologici Fenn. 1987; 24:315-321.
4. Reddy PSR, Subramanian R, Baskar IS, Shenoy AS, Elambarithy B. Induced breeding of goldfish, *Carassius auratus* with human chorionic gonadotropin. In: Special Publication Carp Seed Production Technology (P. Keshavanath and K. V. Radhakrishnan, eds.) College of Fisheries, Mangalore. 1990; 2:21-23.
5. Monjit Paul, Mukti Chanda. Induced Breeding of Carps. https://www.researchgate.net/publication/261994048. University of Calcutta, 2014.
6. Yadav BN. Fish Endocrinology, Hormones and Aquaculture, Daya Publishing House, Delhi, 1995, 137-139.
7. Vishakan R, Balamurugan S, Maruthanayagam, Subramanian P. Fish Genetics and Aquaculture Biotechnology. Homeopathic induction of spawning in ornamental fish, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, 2005, 119-120.
8. Page LM, Burr BM. A field guide to freshwater fishes of North America north of Mexico. The Peterson Field Guide Series. Houghton Mifflin Company, Boston, MA, 1991, 42.
9. Thomas PC. Book, Breeding and Seed Production of Fin Fish and Shell Fish, Daya Publishing House, published on, 2003.
10. Nico LG, Schofield PJ, Larson J, Makled TH, Fusaro A. *Carassius auratus* (Linnaeus, 1758): U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, FL, 2018. https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=508, Revision Date: 6/4/2018, Peer Review Date: 4/1/2016, Access Date: 12/6/2018