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Training Manual

Inland Ornamental Fisheries Management

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ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata

TRAINING MANUAL

NFDB Sponsored Skill Development Programme on

Inland Ornamental Fisheries Management for Income Generation

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ICAR-Central Inland Fisheries Research Institute

Barrackpore, Kolkata 700120

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FORWORD

Global exports of ornamental fish since 1976 rose steadily from US $ 21.5 million to US $ 347.5 million in 2014. Asian countries contribute more than 57% share of the trade and USA is the largest importer in the world. Ornamental fish trade with a turnover of US $ 6 billion and an annual growth rate of 8% offers a lot of scope for economic development. India is having large inland aquatic resource in the form of rivers, reservoirs, wetlands, canals. This vast water resource offers 374 freshwater ornamental fish. There are two hotspot biodiversity of freshwater ornamental fish in India in which the North-east India is harboring about 250 species and Western Ghat harboring about 155 species of indigenous ornamental fish. The North East Region shares its fish fauna predominantly with that of the Indo-Gangetic fauna and to a small extent with the Burmese and South China fish fauna. India offers a number of high priced fresh water ornamental fish like Barca snakehead, *Channa barca*, Kerala queen, *Puntius denisoni* etc. In Global fresh water ornamental fish trade the most popular fish are Neon tetra, Angel fish, Betta, Gold fish, Gourami, Discus, Arowana, Oscar, Barb, Danio among which India offers large number of Gourami, Barb and Danios. The indigenous ornamental fish trade has the potential to contribute to the economic growth of the nation and the sustainable development of aquatic resources. The indigenous ornamental fish market are mainly depends upon wild catch but the supply could not meet the demand in large scale. Hence large scale seed production of fresh water indigenous ornamental fish is becoming very important. The captive maturation, breeding, larval rearing and grow-out culture can check the further extinction of these fishes from India. The effort is made by the ICAR-CIFRI, Barrackpore to organize a three days Training programme sponsored by National Fisheries Development Board (NABARD), Hyderabad on the topic **Inland Ornamental Fisheries Management for Income Generation** for fish farmers and fishers. Hope the manual will be helpful for the beneficiaries.

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B. K. Das
Director

Preface

Ornamental fish farming is an emerging business for generation in India. In Kolkata itself, about 20 to 30 thousand women fishers are involved in this trade. Under the Government assistance ornamental fish production centers are set up at Howrah, South 24 Parganas, Uttar Dinajpur, Malda etc. They are engaged in the production and marketing of ornamental fishes and management of freshwater aquaria as natural nurturers. In addition to fish breeding, they have also developed the skill to prepare on farm feed, treat diseased fish, caring the young ones etc. Women have even taken over the marketing network from men. At some hatcheries, it is the women who squat by the tanks, painstakingly scooping out the stronger fish, packing them into poly bags. They have demanded the setting up of local markets to bypass the middleman. The average income of each member of a Self Help Group (SHG), involved in ornamental fish trade, ranged from Rs. 3000-4500/month. A system of accreditation/registration of production facilities, aquarium traders and service providers is the attention of the policy makers of the country. Keeping the possibility to enhance income of farmers the topic of Inland Ornamental fisheries management for income generation is selected and is implementing with the sponsorship of National Fisheries Development Board (NFDB) under Skill development training programme. The coordinators of the programme have tried their best to include, lectures; practical and field visits to mark it a success. The inputs from the beneficiaries will be helpful to improve the quality of the training.

Coordinators

CONTENT

Status of Inland Ornamental Fishes and Potential for Income Generation

Archana Sinha
ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120

Introduction:

The culture of colorful attractive fish in glass aquarium for aesthetic use is called ornamental fish culture. The beautiful, tiny, colored fishes or ornamental fishes are peaceful in nature, and suitable for keeping in captivity. These lovely fishes are usually kept in aquarium made up of glass and decorated with accessories viz. toys, plants, ceramics structures etc. for beautification. It displays the attractive fish living in natural environment decorated with aquatic plants, rocks, gravel, toys etc. and maintaining environmental parameters in tanks/aquarium by using aerators, heaters, filters, lights to control water movement, temperature, suspended organic matter, illumination etc. besides feeding. Keeping ornamental fish in glass tank is a very old and popular hobby. More and more people are getting attracted to this hobby and due to growing interest in aquarium keeping it has resulted in steady expansion in its trade in more than 125 countries. Household aquariums are more popular; therefore, less than 1% of the global market for ornamental fishes belongs to the public aquaria sector. Most of the ornamental fish is available from developing countries in the tropical and sub tropical regions. The international trade in ornamental fish breeding and culture provides employment opportunities for thousands of rural people in developing countries. As a result of advancements in breeding, transport and aquarium technology, more and more fish species are being recognized almost every year. The ornamental fisheries are recognized by many developing countries for employment generation and livelihoods. For sustainable growth, ecologically suitable culture systems must be developed by evolving micro, small and medium enterprises.

World Scenario

The export earnings from ornamental fish trade is US $ 347.5 million in 2014 and more than 60% of the production came from the household of developing countries. The wholesale value of the global ornamental fish trade is estimated to be US$ 1 billion while the retail value is US $ 6 billion. The entire industry, including accessories and fish feed, is estimated to be worth more than US $14 billion. The top exporting country (with percentage contribution to global trade) is Singapore (19.8%), followed by Czech Republic (7.8%), Japan (7.4%), Malaysia (7.3%), Indonesia (5.3%), Israel (4.3%), Thailand (3.9%), Sri Lanka (2.9%) and India (0.008%). The largest importer of

ornamental fish is USA, followed by Europe and Japan. The emerging markets are China and South Africa. More than 2,500 species are traded and some 30-35 species of freshwater fish dominate the market. The trade with an annual growth rate of 8 per cent offers a lot of scope for development. Individual hobbyists (home aquaria) control an overwhelming 99% of the market for ornamental fishes while only 1% of the market is controlled by public aquaria and research institutes. Global market demand is likely to grow to US $ 7 billion from present level of US $ 5.26 billion. Singapore being the largest producer of farm-bred ornamental fish handling about 50% of the available species and varieties is aptly called the "Ornamental Capital of the World". There are about 64 ornamental fish farms in Singapore that are registered – ten of these for the breeding of Dragon fish – occupying a total area of 133 ha. The Dragon Fish or "Royal" Fish that has a life span of 100 years is a protected species and can be traded only by permit; each fish could be fetching up to $ 50,000 in the retail market. Though Malaysia has entered the field only 30 years ago, Penang is already famous for Discus, Perak for Koi, Goldfish and Dwarf Gourami and Johore for live bearers like Guppy, Platy, Molly and Swordtail. Ornamental fish and aquatic plants have been assigned a priority in the Third National Agricultural Policy (1998-2010) of Malaysia with plans to produce 800 million ornamentals by 2010. In recent years, a mass propagation technique has been developed in Thailand to conserve the wild types of aquatic plants and is becoming an important industry. To promote the ornamental fish industry, Thai government has set up an Ornamental Fish Research and Development Institute to provide training and technical knowledge to the local breeders to promote the export.

Indian scenario

India is lagging behind in ornamental fish trade and its overall domestic ornamental fish trade is worth about Rs. 300 crore and contribution to global export remains only 0.32%. Indian waters are considered as "JEWEL MINE" for domestic traders, exporters and hobbyists of ornamental fish. In India, the potential of ornamental fish is very high. As per an estimate of MPEDA India has the potential to earn about US $ 5 billion as foreign exchange by export of ornamental fishes. Ornamental fish trade started in India in 1969 with an export earning of US $ 0.04 million. At present about 210 indigenous ornamental fishes are being exported from India to different countries. Kolkata dominates in export trade, followed by Mumbai and Chennai. Registration of exporters, fishing vessels and other processing entities is one of the statutory functions of MPEDA under Section 9(2) (b) and (h) of the MPEDA Act 1972. Registration as an exporter is granted under section 9(2) (h) of Marine Products Export Development Authority (MPEDA) Act 1972 read with rules 40-42 of MPEDA Rules, 1972. Registration is done for the following categories viz. Manufacturer Exporter, Merchant, Route through Merchant & Ornamental Fish Exporter and also for entities such as

Fishing Vessels, Processing Plants, Storage Premises, Conveyance, Pre-Processing Centers, Live Fish Handling Centre, Chilled Fish Handling Centre, Dried Fish Handling Centre, Independent Cold Storages And ice plants. Total 55 exporters registered for ornamental fish export, out of which the highest as 15 are from Kolkata and Chennai each, 11 from Kochi, 6 from Mumbai, 4 from Mangalore and 2 from Quilon (as on 15 July 2014).

India is known in international fish trade for its wild caught ornamental fish. The domestic market is also very good, which is mainly based on domestically bred exotic species. About 80% of ornamental fishes are exported to international market via Kolkata airport, of which major share comes from North Eastern States of India. Other states leading in the trade are Kerala and Tamil Nadu. However, there is a vast unexplored potential for production of indigenous ornamental fishes and promoting ornamental fish culture in India. The scientific and systematic exploration of these potential will be a source to provide employment to women SHGs, entrepreneurs and unemployed youth to generate income, improve their livelihoods and earn considerable foreign exchange. **T**he world's ornamental fish trade consists of about 80% freshwater species and 20% being the marine species whose contribution is increasing by establishing their breeding and rearing technology. Presently, 95% marine fishes are collected from the wild and only 5% fish are being bred in farm. The overall contribution of the cultured species is 90%, only 10% of the fish traded being collected from the wild because most of the freshwater species can be bred and cultured, A total of over 500 species of ornamental fishes are available in India having contribution of about 300 marine and over 200 in freshwaters. Among fresh water species, around 100 species each are known from the Western Ghats and the north eastern India, while, amongst the marine ornamentals, 165 species belonging to 20 families have been intensively studied and found to hold a great promise for export. Of the freshwater ones, 53 species from northeastern India have been designated to have a great potential for domestic and international trade that would help in the development of rural economy with special opportunities for the gender sensitive region with the matriarch system.

Opportunities for women/Unemployed youth

Women and youth have shown enthusiasm and expertise in different aspects of ornamental fish trade in India.

1) Capture of fishes from wild;
2) Culture of fishes;
3) Breeding of fishes;
4) Export of fishes; and

5) Marketing of accessories.

Capture of wild stock: Wild ornamental fishes are abundant in those rivers and streams, which are flowing through dense forests and mountain terrains in India. These species such as devil catfish have good export potential and are ruling the foreign market of aquarium fish and is reaping a value of about 1 to 2 $ a piece. In addition to these rivers and streams, the long coastline and several islands, which are stretching around with lagoons and coral reefs of India, abound in varieties of colorful marine fishes. These sources are presently exploited minimally at present but offer scope to enterprising persons to earn livelihood. It is essential to create awareness among people, for them to take up capture of these fishes and market them to earn maximum. Some of our indigenous fishes, which are often called as trash fish, have been identified in the recent period as ornamental/aquarium fishes. The tiny colisa, loaches, danio, gouramis of Indian origin are dominating in the market. However, no project has been undertaken by State Fisheries Departments on identification, survey, conservation, proper exploitation and mass production of ornamental fishes.

***Culture of Ornamental fishes*:** For culture of ornamental fish, the required infrastructure facilities have to be set up supported by the application of relevant technical knowhow. Rearing of commercial ornamental species can be undertaken in re-circulation and flow-through water systems designed and established to maintain good water quality and to stimulate natural running water conditions. Different types of live feeds and artificial feeds are available in the market to rear ornamental fishes. Several workers pursue research work on production of indigenous feed for these fishes. While in every major metropolitan city there are aquarists who own few small ponds/cement tanks where they breed many freshwater ornamental fishes exclusively for domestic markets, this industry needs to be adequately popularized. Women aquarists are more caring for the small babies of tiny fishes. It is required to encourage them by providing technical knowhow in local languages. Colorful handbooks on ornamental fish keeping and maintenance of aquarium are available for the hobbyists but the poor women entrepreneurs cannot afford that.

***Breeding of ornamental fishes*:** The demand for ornamental fishes in domestic as well as International market is increasing rapidly. As such, sustainable exploitation of wild stocks of these fishes will not be able to meet the increasing demand. It is therefore essential to evolve appropriate breeding and rearing technology to produce both marine and freshwater ornamental fishes under controlled conditions in land-based infrastructural facilities. The technologies of breeding different varieties of ornamental fishes have now been established to such an extent that most of the aquarium fishes can not be bred as a household activity, both in rural and urban areas. Most of the aquarists breed only the common varieties of aquarium fishes like gold fish, guppys, platys,

mollys, swordtails, gouramis, tetras, barbs etc., which are easy to breed. In order to enable to householders to upgrade their capabilities, the State Government should come forward to encourage aquarists and interested entrepreneurs to take up farming of these highly priced fishes. Simultaneously, technologies on the production of live fish food and nutritionally balanced dry feed in various forms such as pellets, powder, flakes, microcapsules etc., should be developed up by technologists so that they can be extended to the hobbyists and entrepreneurs.

***Export of ornamental fishes*:** In spite of having immense natural ornamental fish resources and technology for breeding and rearing them, not much of headway has been in the country in the matter of export of ornamental fishes to foreign countries. So as to move ahead in these endeavors, MPEDA, Kochi has prepared a directory of ornamental fish exporters in which they have identified 25 ornamental fish exporters in India especially, in Kolkata, Mumbai, Chennai and Kochi. The farmers and exporters have to be brought together, for the purpose of integrating the production and export activities in a manner that would be mutually beneficial. The establishment of such a relationship would push up the level of exports of ornamental fishes from the country, particularly to USA, Europe and Japan. It has been reported that 8% of the estimated 86 million houses in USA keep aquaria in their homes, 14% of the estimated 21 million houses in Great Britain, 4% of homes in Belgium and Holland and 5% of German and 20% of Dutch houses keep fish. China, South Africa and several other countries too have the hobby of ornamental fish keeping. In view of the huge demand for export of ornamental, it is possible to undertake mass production of ornamental fish by farmers, to be made available to exporters. In fact producers can become exporters so as to have the advantage of earning foreign exchange themselves. However, it is found that the women cooperative societies, which are breeding and rearing the ornamental fishes, are not getting justice in the market. They are not getting their reasonable share from exporters. It is due to lack of knowledge and communication problem. They are not aware of the export market and the outlets from where they can send the fishes directly. It is important to sensitized them and make aware about the marketing system.

***Marketing of accessories*:** In addition to the breeding, rearing and export of ornamental fishes, this trade has generated an ancillary business of abroad. For beautification and maintenance of aquaria, rocks and gravels, artificial toys, natural and artificial plants, dry feed, live feed, aerators, filters are in use. There is a great demand for all these accessories. Different types of decorative toys with beautiful colorations, attractive shapes that are non-toxic to fishes are gaining popularity in the market. Submerged varieties of simulated aquatic ornamental plants from the natural habitat of ornamental fishes for placement in aquaria, have a developing market. There are many aquatic plants for aquaria and some of them are costlier than ornamental fishes. Commonly

available attractive aquatic plants are ribbon grass (*Vallisneria* spp.), arrow weed (*Sagittaria* spp.), spike rush (*Acorus* spp.), lace plant (*Aponogeton* spp.), faneard (*Cabomba* spp.), Indian water fern (*Ceratopteris* spp.), hornwort (*Certophyllum* spp.), Amazon Sword Plant (*Echinoderus* spp.), Hydrilla (*Hydrilla* spp.), Mint (*Ludwigia* spp.), Water Star (*Hygrophila* spp.), etc. Most of these plants can be grown and multiplied under controlled conditions. Artificial, non-toxic plants are also available in the market and are now increasingly attracting customers due to their blended colors and durability.

Apart from plants, a number of decorative toys are available for imparting an attractive look to an aquarium. They include plastic bubblers in the shape of mermaid, underwater diver, oyster shell, angler human skull, tortoise, frog etc. These can be efforts to improve the material used for the manufacture of these, and also quality, texture, colour and material of these toys so that their utility can be enhanced, thereby providing a diversified activities status to the trade. Women can earn considerably from it even if they take it as a part-time engagement.

Breeding culture of Ornamental Fishes

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Breeding technique of goldfish (*Carrasius auratus*)

There are a few easy stapes to prepare the tank for breeding. We have needed at least 20 gallons of water to breed two goldfish properly. We have needed plants in the goldfish tank as well. Then we need 1 male and 1 female goldfish of at least 3 years old, anything younger and they may not breed and might cause the female become egg bound. We have needed another tank at least 3 to 5 gallons of water. There were also need gold fish baby foods, but we have get into that later. We have to make all the preparation and want to breed gold fish. The first gold fish were ready to mate; the male goldfish will get white pimples on the gill covering and the female goldfish will become very round looking. The male goldfish will chase the female goldfish around the tank endlessly (sometimes even tearing hurting her fins). The female goldfish will become very tired and will release her eggs, sometimes by the hundreds or thousands, all over the tank. Most of them will stick to the plants. The male goldfish will spray his milt over the eggs and the tank will get cloudy appearance (don't change the water!). After about three to four hours the courtship should be stop. Now that the eggs are fertilized and we have needed to remove them from the tank. We have needed to place them in the 3 – 5 gallon tank. This tank may be not more than about 6 inches of water to avoid the goldfish being crushed by the weight of the water. Too much water also makes it harder for them to swim to the surface. We have needed a weak filter system to avoid drawing fry into the filter. We have needed to aerate the water surface and a heater. The temperature of the tank will determine the incubation period generally 5 days at 23-280C. We have needed to keep a good eye on the eggs because some of them could wind up with fungus and infect of the rest of the eggs. Healthy eggs will look transparent in color and the non-fertilized eggs will be white and most lightly will get fungus. We have needed to remove the fungused eggs. After four days we should see growth inside the goldfish egg, a small black dot in the middle. After or around the 7th day, they will start to come out of the egg and stick to the plants. We will be able to see the yolk sack and they will feed off for the next 3 days. If the yolk sack was gone then they will be searched for a lot of food. Many goldfish will be died because of lack of food. We have needed very small particles of food such as frozen brine shrimp, micro warm crushed hard-boiled egg yolk, dried flack food and even liquid food if you can find them. We have needed to feed them 3 times a day (morning, noon and night), making sure that we only feed the goldfish fry enough food that they are able to it all. For best results keep males and females separated before breeding. Feed them well with

a variety of foods – goods quality dry food supplemented with live food. The ratio we recommended 3 males to 2 females. We can either let this happen naturally as weather patterns change, or spawning can be induced by simple raising the temperature a little. Goldfish will breed at temperature between 23-28^{0}C. It is important to remember that it is the change in temperature not the actual temperature, which triggers spawning activities. Since goldfish scatter sticky eggs haphazardly over the aquarium, it should be stocked with aquarium plants. Try to arrange the aquarium with floating rooted plants, along with some bottom plants or artificial spawning grass. We can also use soft willow or pong fronds. The fertilized eggs are about 1.5 mm in diameter and are amber-colored when first laid. Spawning is usually large, from about 500 to 2000 eggs, depending upon the size and condition of the female. The parents should be removed immediately after spawning, which usually lasts about 3 hours. Ten drops of 1 % Methylene Blue should be added to each 10 liters of well-aerated aquarium water. Although the eggs will hatch after 5 days, the embryo needs 3 days or so to absorb all the yolk. It is important not to feed the fry until after the 3rd day and they have consumed the yolk sac. Once the fry have digested the yolk sac they require copious amount of live food. Feed them on a diet of infusorians, newly hatched brine shrimp, and sifted daphnia. Liquefy, boiled egg yolk fed through a stocking and after a week finely powdered dry food may also be fed. Care must be taken not to over feed fry as excess food will quickly pollute the water and kill all the young fry. Make sure you give the fry plenty of good quality food, good water quality, along with plenty of space to swim in and watch how quickly they will grow.

Feeding schedule for goldfish fry After 48 hrs, crushed yolk of hard boiled egg and oat meal paste should be used as fry feed. After 2 weeks fry will be feed with brine shrimp and infusoria. After 3 weeks powdered foods can be used. First 4 weeks feed 3 times each day up to 4 months. After 4 months once daily (Feedings should be as much as they can eat in 20minutes).We should always siphon uneaten food. Once a month a table's spoon of salt should be added to the tank and artificial aeration should be provided. We can feed them with the usual rich foods like earthworm, bloodworm, tubifex and some flake food

Breeding technique of Zebra danio (*Brachydanio rerio*)

Brachydanio rerio is commonly known as zebra danio. The females were found to be more silvery and larger in size when compared to males. The belly is swollen in females, especially in gravid ones; while in males the body is generally slim. The zebra danio is a prolific breeder and their breeding season commences from April and continues till August. The eggs are non-adhesive and their breeding habit is of egg scatter type. The species can easily breed in aquarium tank. The spawning tank

contained about 10 cm of water with a steady temperature of 26-29^{o}C, and gentle aeration. A water pH of around 7.0 and hardness of normal to 250 ppm was maintained which gave good results. A net fixed along the bottom of the tank (at a height of 5 cm from the bottom) instead of pebbles was also found to be successful in protecting the eggs from the parent fishes. Both male and female are removed after spawning from the tank. The eggs require a hatching time of 2 days. The hatchlings took 2 days to absorb their yolk sac. After 2 days, they were fed with infusorians for 4 days.

Breeding technique of Dwarf Gourami (*Colisa lalia*)

The *Colisa lalia* is the most popular of the gouramis. The species exhibits striking sexual dimorphism, with males showing exquisite colours while females have a silvery colouration. The dorsal and anal fins are more developed in the male. The pair of ventral fins is filamentous and almost as long as the body. The breeding season is recorded in the month of May to August, but the maximum predominance occurs in the month of June. The species can easily bred aquarium tank. A piece of dried banana leaf or a piece of thermo coal are put to float on the surface of the water in breeding tank, for the male to build a bubble nest under the nest. The male picks up the eggs with its mouth and places them in the bubble nest and looks after the bubble nest and eggs. The eggs hatch in about 24-26 hours after fertilization and become free swimming in 3 days. The free-swimming hatchlings were fed with infusoria after the absorption of yolk sac for about 10 days and there after given sieved small zooplankton and chopped tubifex worms.

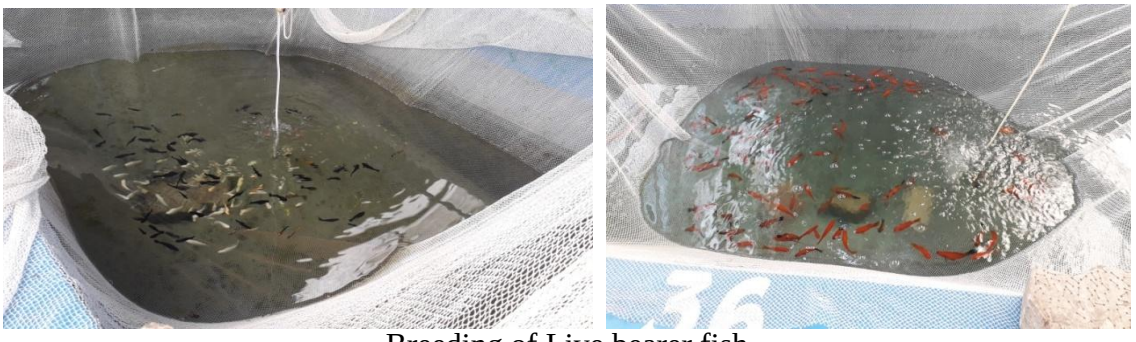
Breeding technique of Rosy barb (*Puntius conchonius*)

The *Puntius conchonius* popularly known as Rosy barb is an attractive ornamental fish. In ripe condition, the male blushes a brilliant rosy pink colour while the fin becomes red, with dense black tip. During the breeding season the females develop a swollen abdomen. The species can easily bred in aquarium tank. The gravid male and female were kept in glass aquarium breeding tank. Generally within one or two days female lay eggs. After the egg laying is over the parents may taken out of the breeding tank. The eggs hatch out within 24-26 hours at a temperature of 26-30°C. The hatchlings were fed with infusorians after the absorption of yolk sac for about 7 days and there after given sieved small zooplankton and chopped tubifex worms.

Breeding technique of Live bearer fish

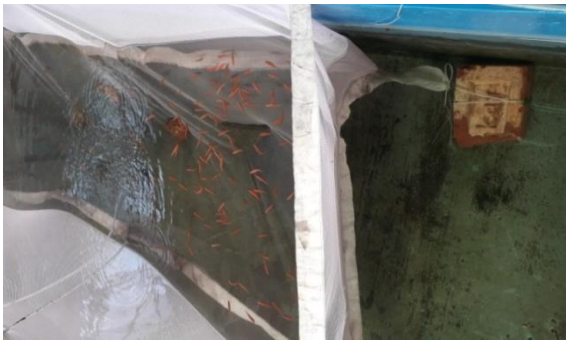
The guppy, molly, sword tail etc. are live bearer species .The sex ratio should one pair or a ratio of 2males 1 female or 1 male 1 female. They do not lay eggs like most fish

but instead give birth to young free swimming fry. As the male matures the anal fin develops into a structure for reproduction called the Gonadopodium. The Gonadopodium can be moved in almost any direction and stores the sperm in packs called sperm metamorphosis. Once the sperm is inserted into the female it fertilizers her eggs and the rest is stored in the oviduct walls for later use. The eggs are very rich in yolk and the young develop by consuming their yolk stores. In light colored females pregnancy can be recognized by the growing dark body marking in front of the anal fin. Young Live-bearers are fairly large at birth and their development is very advanced. They can swim right away, which is needed to avoid their enemies including their parents who give on natal care whats ever. The fry grow very rapidly and will eagerly accept fine flake food. The number of fry is variable due to the size differences in the species, but in larger female can give birth large number well over one hundred . When you get most female livebearers they are pregnant and should give birth to babies every 3or 4 weeks. Feed your livebearers plenty of floating flakes and some live food as well to supplement their diet and give them larger and healthier fry. As always remove any uneaten food after 5 minutes. Be sure to keep your aquarium clean and change about 25 % of the water in your aquarium at least once a week. Take care and feeding of the fry. A net breeder is a must if you wish to save large numbers of fry. Simply place it in a corner of the tank when one of the females has already spawned or place the female in it just before she spawns. Either way ensures the fry are the only fish inside the net. As a rough guide, a young female guppy and molly usually releases 12 to 30 babies in her first batch of young. In comparison a large molly may be able to release up to 100 babies. Change 25% of the water in the aquarium each day replacing it with de-chlorinated water which is as close to the temperature already in the water as possible; remember any differences will result in stress to the fish and more chance of your livebearer aborting her pregnancy. Fry should be fed with cucumber, flake but the adult one can be fed with blood worms or adult brine shrimp. The fry leave them in the net breeder or their own aquarium, feed them 3 times a day for maximum growth with finely crushed flake food (as fine as you can crush it) use your fingers and rub them together really grinding it up very finely because any large bits will remain uneaten and will polluting your tank. Growth will vary on quality of food.



Breeding of Live bearer fish






Breeding of Egg layerer fish

Aquarium Plants: A new dimension for becoming Entrepreneur

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Introduction

The concept of ornamental plants is used for decorative purposes in aquariums, gardens, home gardens, landscape design projects, squares, parks, street trees, indoor plants, and cut flowers. The decorative purposes in aquarium respond to aesthetic values assigned by people in different cultural contexts, that are related to some plant features: flowers, fruits, leaves, foliage texture, color, and scent (Li and Zhou 2005 ; Oloyede 2012 ; Estrada-Castillón et al. 2014). The importance of plants as food, medicine, fiber, fuel, timber, and others often has been treated by many researchers, but the aesthetic dimension was not very analyzed (Nirmal Kumar et al. 2005 ; Dafni et al. 2006 ; Kumbhar and Dabgar 2014). Hobbyists use aquatic plants for aquascaping, of several aesthetic styles. The freshwater aquarium plants provide natural filtration for the water, help keep fish healthy, and can even help in breeding fish. Aquarium plants are used by fish for any number of things, including safety, comfort, food, reproduction, and also used to give the freshwater aquarium a natural appearance, oxygenate the water, absorb ammonia, and provide habitat for fish, especially fry and for invertebrates so they're vital to any healthy aquarium environment. Some aquarium fish and invertebrates also eat live plants.

History

The aquarium was defined as a balanced system where the plant and animal life promoted each other's health. The aesthetic qualities of the plants held the second place. These first aquarium setups were not for pure aesthetic pleasure of an attractive object, but for using as instructional, contemplative and empirical tools. A devolvement of the plants' status as purifiers of water and placing of their appreciation as decoration to the first place seem to have been first intimated in the late 1900s (Wolf, 1908). Their role as the best means of keeping the aquarium water clean had been overthrown by the end of 1960s and relegated to the filters and the regular water changes. The plants were there to help design aquarium interior aesthetically (Brünner 1969; Weigel 1973). A new upswing, or just a continuation of the old, has been seen in the recent years: some authors hold that aquarium plants absorb heavy metals from the water and even have some antibiotic effects (Walstad 2003).

List of commonly used aquarium plants

There are three categories of plants for most aquariums: Foreground, Midground, and Background. Each type requires various types of light, and there are certain setups that make plants grow much more effectively. The following plants are also excellent for water quality, since they tend to grow very quickly, and thus filter lots of water.

JAVA MOSS

Java Moss is one of the most common plants in a tank. It's low-maintenance, difficult to kill, and grows quickly.

- **Appearance:** Low, carpet like growth pattern. Appears 'fuzzy'.
- **Water Preferences:** Tolerates anything between 72-90 degrees Farenheight. Growth is fastest around 73 degrees.
- **Lighting Preferences:** Grows well in any lighting. However, growth is fastest in medium-high lighting conditions.
- **Uses:** Decoration, substrate covering and stabilization, carpeting, protection, and breeding of certain types of fish.

DWARF BABY TEARS (DBT)

It's tough, hard-working, and a healthy carpet of DBT looks beautiful in many of the common aquascaping styles. As a bonus, if they're producing oxygen, Dwarf Baby Tears have beautiful little bubbles that form on their leaves.

- Appearance: Low, carpet like growth pattern. Healthy carpets of DBT are thick and vibrant.
- **Water Preferences:** Tolerates anything between 72-85 degrees Farenheight. Growth is fastest around 73-75 degrees.
- **Lighting Preferences:** Grows best in bright lighting conditions, thought amount of light affects growth patterns. Brighter light means more compact growth.
- **Uses:** Decoration, substrate covering and stabilization, carpeting, and protection.

DWARF HAIRGRASS

The aquascaping possibilities are endless with this type of plant. It looks beautiful next to Stone, as well as contrasting perfectly with dark sand or soil. It's incredibly easy to grow.

- **Appearance:** Small to medium sized strands of what would appear to be grass. Carpets easily in most environments.
- **Water Preferences:** Tolerates most environments. Grows best in water that's 72-78 degrees Farenheight.
- **Lighting Preferences:** Grows best in bright lighting conditions
- **Uses:**Decoration, accenting various hardscape features such as stone and wood, carpeting, and protection.

MARSILEA MINUTA

It's incredibly easy to grow. It looks beautiful next to Stone, as well as contrasting perfectly with dark sand or soil, the aqua escaping possibilities are endless with this type of plant.

- **Appearance:** Easily identified by the 'clover' appearance of its leaves. Carpets easily in most environments.
- **Water Preferences:** Tolerates most environments. Grows best in water that's 73-78 degrees Farenheight.
- **Lighting Preferences:** Grows in most lighting conditions. Does best in medium lighting.
- **Uses:** Decoration, accenting various hardscape features such as stone and wood, carpeting, and protection.

AMAZON SWORD

The Amazon Sword is the staple of most aquascapes. It's easy to maintain, fast-growing, and can be quite beautiful when arranged in the appropriate area.
Note that these can grow quite big (up to 20 inches), so they're most often planted in the mid-background area.

- **Appearance:** Large swordlike leaves
- **Water Preferences:** Grows best in water that's 72-82 degrees Farenheight.
- **Lighting Preferences:** Growth is optimal in medium lighting.
- **Uses:** Background decoration, hiding plumbing and hardware, and protection.

JAVA FERN

Java Fern is very a very low maintenance plant, and has a unique look that appeals to most aquascapers. Its biggest benefit is its ability to be planted in nearly any area of the aquarium without distracting from the hardscape. It also looks quite good

- **Appearance:** Semi-striped, thick leaves. Appears in bunches.
- **Water Preferences:** Grows best in water that's 72-78 degrees Farenheight.

- **Lighting Preferences:** Growth is optimal in low-medium lighting.
- **Uses:** Decoration and protection.

ANUBIAS NANA

Anubias Nana is one of the more appealing midground plants. It tolerates nearly any water quality or environment. With curved stems and large semi-round leaves, it's a great match for the stone aquascaping present in most aquariums.

- **Appearance:** Curved stems with medium-sized, semi-round leaves.
- **Water Preferences:** Grows best in water that's 72-78 degrees Farenheight.
- **Lighting Preferences:** Growth is optimal in medium lighting.
- Uses: Decoration and protection. Looks beautiful in any aquarium placement.

PYGMY CHAIN SWORD

This plant isn't often seen in aquascaping. Mostly because it's very similar to what we see everyday of our lives grass. It's useful for placement around hardscapes, and is beautiful when properly trimmed.

- **Appearance:** Strikingly similar to most lawn grass.
- **Water Preferences:** Grows best in water that's 72-78 degrees Farenheight.
- **Lighting Preferences:** Growth is optimal in medium-bright lighting.
- **Uses:** Decoration and protection. Good for placement around hardscapes.

POGOSTEMON HELFERI

Besides having an interesting name, this is one of the most unique foreground plants available to aquascapers today. It has a striking zig-zag shape in its leaves, and grows in a 'blooming' pattern that's visually appealing in front of hardscapes.

- **Appearance:** Beautiful 'blooming' growth pattern. Zig-zag shaped leaves.
- **Water Preferences:** Grows best in water that's 72-78 degrees Farenheight.
- **Lighting Preferences:** Growth is optimal in medium lighting.
- **Uses:** Decoration and protection. Good for placement around hardscapes.

DWARF SAGITTARIA

Dwarf Saggitaria is an easily-maintained plant that maxes out at around 4-6 inches, making it perfect for midground aquascapes. Placing Dwarf Saggitaria around stonework or driftwood is an ideal location, giving it a perfect place to root into the wood or stone, and is an ideal complement.

- **Appearance:** Vibrant green leaves with curved blades.

- **Water Preferences:** Grows best in water that's 72-78 degrees Farenheight.
- **Lighting Preferences:** Growth is optimal in medium lighting.
- **Uses:** Decoration and protection. Good for placement around hardscapes.

Maintenance of aquarium plants

For enjoying the right balance plants require care. Just as we would diligently check on the health and wellness of fish, give a little attention to the aquatic plants as well. Here's a list of things to do:

- **Supply the right substrate**
- Aquarium plants need substrate material used to cover the bottom of an aquarium in which to anchor their roots. Plants can grow in most types of substrate, but two to three inches of laterite covered with an inch of gravel is ideal.
- It's possible to keep plants in the pots in which they were sold. However, "planting" plants in substrate provides for a more natural look, and is more conducive to root development.
- **Provide the right light**
- Without proper lighting, plants won't survive. Plants need light for photosynthesis, a process in which they generate energy for growth. An added benefit of photosynthesis is that it produces oxygen for the aquatic life in aquarium.
- Full-spectrum, fluorescent lighting is a must. Make sure to give plants 10 - 12 hours of light per day. If using fluorescent lighting, remember to change light bulbs at least every 12 months, as their intensity may fade. If light fails to emit a full spectrum, plants won't thrive.
- **Use the right algae-reducing techniques**
- Like a garden weed, an alga competes with aquarium plants for light and nutrients. There are several solutions for eliminating algae. Algaecide, a formula based on antibiotics or chemicals, kills the algae but may have adverse affects on aquarium.
- There are a variety of herbivorous aquatic lives that can help keep algae in check and also physically remove the algae using an algae scraper. For best results, scrub algae weekly. And don't forget over feeding fish can cause algae growth.
- **Use the right fertilizer**
- We can enhance plant growth by adding a fish-safe, iron-based fertilizer. Look for special slow-release fertilizers that are designed to aid in freshwater

aquarium plant growth. never use a phosphate fertilizer, as algae thrive on phosphates.

- **Practice the right "Aquascaping" skills**
- Certain types of aquarium plants require pruning, especially tall stem plants like *Rotala Indica*. These plants will grow across the water's surface if not pruned back. When this happens, they can block precious light from other plants. Be sure to remove dead leaves and dying plants, too. Decomposing matter will affect aquarium's water quality.

Aquarium plants for entrepreneur

Now days, aquarium plants is having good demand both in domestic as well as Industrial market. People if starts business of culturing and marketing of these plants can earn a lot, its depend on the selected plants and location of the market. So, therefore they should focus on e-marketing to covering the all parts of the globe. Major important points to be consider for becoming an entrepreneur in the field of aquarium plants business:

- Selection of right plants to be culture and market – this can be done by listing the plants having good market demand and fit in the aquarium of particular ecological area
- Survey the area for the existing competition of plants business
- Make a plan for funding options and benefit & cost analysis
- Space required for Culture – Home terrace to farm yards can be used
- Marketing - Now a day there are many options, but e-marketing the best option. One can work for the E marketing options like Nurserylive, Plantsguru, Mybageecha, green wave nursery and Amazon.

Conclusion

If the grower wants to greatly expand the production capabilities of the farm, the culture of fish can be added to the process. This can be either ornamental fish or edible fish. Realistically, the ornamental fish will probably have a greater return than the food fish for many reasons. Since all fish production systems are based on the feed that is introduced, the return for ornamental fish is greater than for food fish. The other reason is that people are willing to pay more for things that they want than for things that they need. The nitrogen from the feed will be cycled through the fish, the solids removed and the nitrogen rich effluent will nourish the plants that will serve to act as a biological filter and remove the ammonia nitrogen that will be toxic to the fish.

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Java moss

Dwarf Baby Tears

Dwarf Hairgrass

Marsilea Minuta

Amazon Sword Plant

Java Fern

Anubias Nana

Pigmey Chain Sword

Pogostemon helferi

Dwarf Sagittaria

Important Water Quality Parameters for Breeding and Culture of Ornamental Fish

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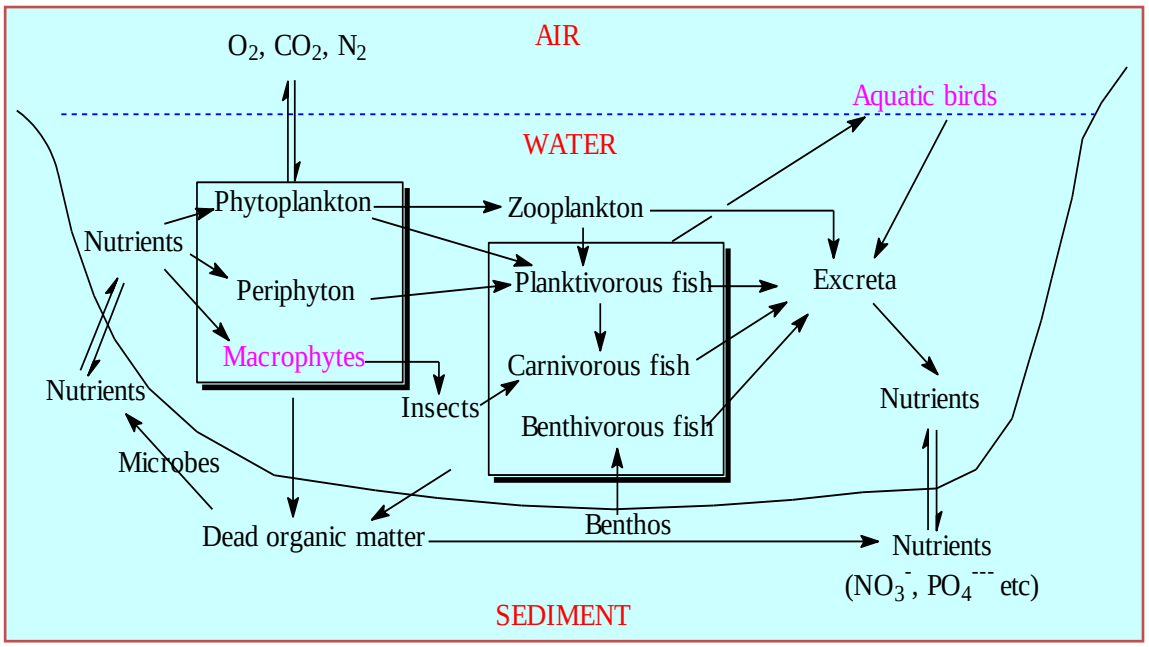
Introduction

Environment of a water body is directly dependent on its water parameters which in turn depends on the nature of its bottom sediment. Dynamic equilibrium between water and bottom soil control overall water environment to support a healthy aquatic life. Aquaculture in a water body generally involves addition of organic and inorganic fertilizer. In addition, supplementary feed wastages used to accumulate at bottom, decomposition of which controls water quality in a big way. Surface runoff from catchment areas also adds to the bottom carbon budget. Decomposition of this bottom organic matter load releases nutrient, which in turn helps to the growth of plankton and other aquatic macrohytes to support other aquatic lives through food web. As soil and water are two basic components in a water body, a proper knowledge of them is necessary for proper management of any water body.



Role of important water parameters

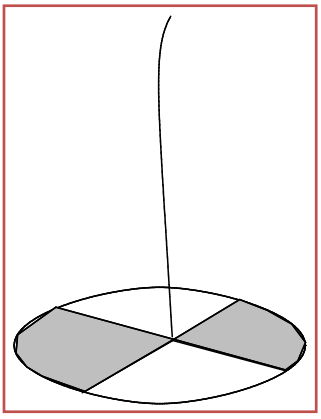
There are many water parameters which governs healthy aquatic life. Knowledge on those parameters is vital for proper management of those water bodies. Key water parameters are discussed below.

Temperature

Among physical properties, water temperature is of prime importance as it controls all metabolic activities including growth of all aquatic organisms. It also controls some other related events like solubility of oxygen in water, decomposition of bottom organic matter for nutrient release etc. Thermal stratification was observed in deeper water body. A temperature range of 15-40ºC is suitable for carp fishes though lower temperature hinders their growth as observed during winter season. Water temperature directly depends on climate, sunlight, depth and water transparency. A depth of 1-2 metres is [Grab your reader's attention with a great quote from the document or use this space to emphasize a key point. To place this text box anywhere on the page, just drag it.]

considered optimal for biological productivity of a pond. If the depth is very less, water gets overheated and thus has an adverse effect on the survival of the fish. An artificially created shade made of floating macrophytes / dry coconut leaves etc provide much required shelter to carp fishes during noon in peak summer months. Carps grow better in the temperature range of 20-30°C, whereas moderate growth is observed at a temperature range of 13-20°C. For reproduction, carps need a temperature greater than 18°C. In low temperature seasons, fish species which grows better may be encouraged for aquaculture.

Transparency



In a water body, solar energy gets reduced with depth. At euphotic depth of a water body light falls below 1% of the surface irradiation (too low for algae to maintain a +ve net photosynthesis). Euphotic depth is 1.7 times of Sechhi depth, by which the transparency is generally expressed. So, by measuring Secchi depth, one can easily understand the effective depth where photosynthetic primary production may take place. In addition to transparency water clarity is also expressed by turbidity. Turbidity may be due to suspended clay particles/ phytoplankton/ detritus.

Phytoplankton biomass may be measured by multiplying chlorophyll concentration with 100/70. Ash free dry weight of suspended solid minus dry weight of algae is considered to be detritus. Turbidity increases shading to penetration of sunlight inside water, decreasing photosynthesis with lower aquatic primary production. Turbidity is measured with turbidity meter, expressed in Nephelometric Turbidity Units (NTUs).

The pond transparency indicates a bloom of algae. In a normal bloom, the Secchi disc disappears at about 30 cm depth. When the Secchi disc disappears at 20-40 cm depth, the pond is very productive and fertile. No fertilizer is needed in a pond under these conditions. If the Secchi disc disappears at only 15 cm, the bloom is too thick. The green thick layer blocks the sunlight in the pond and no oxygen can be released by the phytoplankton. In this case, some of the thick layer of algae formed at the surface of the water should be removed. These ponds do not need any fertilizer. If the Secchi disc can still be seen at 43 cm depth, the plankton in the pond is not sufficient. It is, therefore, necessary to add fertilizer to the pond water in order to prepare a fertile pond.

Water turbidity due to suspended silt or clay may reduce primary productivity of water body. Electrolyte with +ve ions (Alum/ Gypsum/ lime etc) is effective against –ve ly charged colloidal clay particles. Though alum is more effective coagulator, it reduces total alkalinity, pH, available PO_4, etc. Gypsum also have similar problems like alum. In case of turbidity due to silt, submerged weed (*Hydrilla*, *Chara* etc) may be used to clear water as aquatic weeds facilitate quick deposition of silt. Use of raw cow dung followed by liming can solve the turbidity problem in such turbid aquaculture ponds.

Water pH

Water pH in the range of 7.0-8.0 is known to be ideal for fish growth. Low pH caused acid stress, respiratory problem and mucus secretion on gills of fishes. On the other hand, higher pH damages gill, eye lens, cornea and disturbs acid-base balance of blood of fishes. Constant pH in the environment is better than regular variation of pH for survival of aquatic organism. Fishes was observed to tolerate a pH range of 4.8 to 10.8. Reproduction and growth of fishes was observed to diminish at pH less than 6.45 or more than 9.5. High pH is normally associated with a higher photosynthetic activity in water. Decomposition of bottom organic matter releases CO_2 and humic acid to make water acidic. Plankton / macrophyte bloom caused high pH during day hours due to absorption of CO_2 resulting release of OH^- in the system.

Possible solutions of low pH in fish pond is liming @ 600 kg/ha/year (for pond management); 1/3rd during pond preparation, rest amount in ten instalments each month. The amount of lime may vary depending upon soil pH (see table below). To apply, lime is to be soaked in water, spray during day time with sufficient oxygen in water.

Usefulness of liming

1. Increases pH and alkalinity, reserves CO_2 and calcium.
2. Being anti-parasitic, prevent parasite spread in water/fishes; destroys short time algae, aquatic plant, water insect, larvae etc.
3. Increases mineralization of bottom organic matter.
4. Brings down suspended organic matter.
5. Facilitates nitrification of NH_4^+ into NO_3^-, NO_2^-.

Table: Doses of lime depending on soil pH

Soil pH	Dose of Lime (kg/ha/y)
4.0-4.5	1,000
4.5-5.5	700
5.5 - 6.5	500
6.5-7.5	200

If soil is highly acidic, use of Dolomite ($CaCO_3$) is recommended; otherwise slaked lime ($Ca(OH)_2$ or quick lime (CaO) can be applied.

Specific conductivity

Specific conductivity is an index of the amount of water-soluble salts present in water. It also dictates the state of mineralization in an aquatic ecosystem. The soluble salts may be harmful to the aquatic life, not necessarily due to toxicity but due to changes in osmotic pressure. It increases with mineralization, and so higher sp. conductivity was observed in old water than newly entered water in a water body.

Dissolved oxygen (DO)

Dissolved oxygen (DO) is one of the most important factors for existence of aquatic organism in a water body. It is the prime important critical factor in natural waters both as regulator of metabolic processes of biotic community and indicator of aquatic health. A series of oxygen determination along with knowledge of turbidity could provide sufficient information about the nature of water in any aquatic ecosystem than any other chemical parameters. Good productive water should have DO concentration more than 5 mg/l. However, very high concentration of DO leading to super saturation may become lethal to fish fry. Low dissolved oxygen forces

fishes to surface and grasp for oxygen. High DO, on the other hand, caused bubble trauma, bladder hyperinflation, swelling of brain and gills and protrusion of eyes. Sudden rain in summer days can cause mixing of anoxic bottom with surface resulting fish death as observed in deep water bodies. Fish are not the only consumers of oxygen; bacteria, phytoplankton, and zooplankton consume large quantities of oxygen as well. Decomposition of organic materials (algae, bacteria, and fish wastes) is the single greatest consumer of dissolved oxygen.

Possible measures against low DO in fish pond include bottom raking (by float and sinkers), bamboo/hand beating, aerator, liming to decompose bottom organic matter etc. Use of peroxide tablet (150 pc / ha) is also sometimes recommended in the event of long spell of low oxygen level.

Amount of dissolved oxygen is highly dependent on surrounding water temperature. Water bodies in cold water areas generally contain much higher dissolved oxygen. Cold water fishes like trout, Mahseer etc. are accustomed with that higher dissolved oxygen regime. Hence, lower dissolved oxygen will certainly create stress on those cold water fishes.

Dissolved carbon-di-oxide

Dissolved inorganic carbon, carbon-di-oxide and bicarbonate are the sources of carbon for photosynthesis of plankton as well as submerged aquatic plants and hence they can directly control the growth of them. Free CO_2 is directly utilized by aquatic plants for photosynthtic activity. As surface water involved higher rate of photosynthesis, concentration of free CO_2 is less in surface as compared to bottom. Due to very high consumption of free CO_2 in surface water of a eutrophic water body, it may be absent during most period of the day except early morning and late afternoon hours. Though the use of HCO_3^- is less efficient than free CO_2 use causing lower photosynthetic rate, absence of free CO_2 in eutrophic water body indicated possible HCO_3^- use for photosynthesis. Here, HCO_3^- is converted to CO_2 and OH^- between two cell layers of upper and lower epidermis of leaves. CO_2 is absorbed inside for photosynthesis releasing OH^- to the water causing increase in pH as observed.

Total alkalinity

Alkalinity or acid combining capacity of natural fresh water is generally caused by carbonates and bicarbonates of calcium and magnesium, Ca being the dominating constituent. Dissolved CO_2 in water forms an equilibrium with them which is of prime importance in determining productivity of aquatic ecosystem. Natural waters containing 40 mg/l or more total alkalinity (TA) are more productive. The greater productivity of waters of higher alkalinity is not due to alkalinity directly, but in turn

from phosphorus and other nutrients that increase with TA. Thus, TA could be a good index of productivity when phosphorus is not a limiting factor. Total alkalinity of 80-100 mg/l is generally recommended for aquaculture. If alkalinity is very low, we have to add more lime to increase it. On the other hand, if alkalinity is very high, we can reduce it using alum.

Total hardness (TH)

Total hardness (TH) refers to the concentration of divalent metal ions in water, expressed as mg/l of equivalent $CaCO_3$, which is usually related to total alkalinity as the anions of alkalinity and the cations of hardness are normally derived from the solution of carbonate minerals. Different species of fish have varied water hardness requirements. As a consequence of osmosis, freshwater fish are subject to a continuous influx of water, while marine fish have to live with a continuous outflow of water. Against this continuous movement of water into or out of the body, fish have to maintain a constant internal body fluid concentration – a process called osmoregulation.

Ecosystems having moderately hard (61-120 mg/l) to hard (120-180 mg/l) water are more productive. If TA falls below 15 mg/l, the water develops low buffering capacity. Again, very high TA (>200 mg/l) coupled with low TH (<20 mg/l) results in the rise in pH during afternoon beyond 11.0 and causes fish death.

Calcium and Magnesium

Calcium and Magnesium function in metabolism - Ca is an important part of plant tissue, increases the availability of other ions and reduces toxic effect of NO_2-N. Mg is a component of chlorophyll and at times it acts as a carrier of phosphorus and stimulates bacterial reduction of organic matter. Necessary quantities of Ca and Mg are generally present if TH is above 20 mg/l.

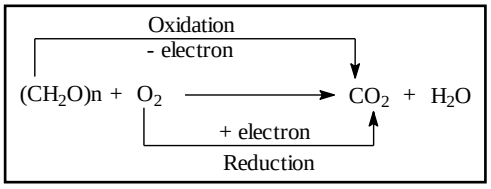
Chloride

Chloride is not only an index of eutrophication but also of pollution caused by cattle, sewage and other wastes especially where no possibility of salt water intrusion takes place. It was said that even a moderate level of chloride causes sufficient water pollution. Chlorides themselves don't perform any hazards with respect to water quality but behaves as a very good indicator of pollution. It is important in case of integrated fish farming where wastes / excreta are used to fertilize the water body.

Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is a measure of the amount of dissolved oxygen required for biochemical degradation of organic material and oxidation of inorganic material like S^{2-} or Fe^{2+}. A method known as the standard 5-day BOD determination normally is used to estimate BOD_5. Initial DO of the water is measured and final DO is measured after incubation of BOD bottle with water in the dark for 5 days at 20°C. The difference between initial and final DO gives an estimate of BOD. To avoid nitrification contribution, a nitrification inhibitor like 2-chloro-6-(trichloro methyl) pyridine (TCMP) is added. BOD represents the amount of DO that will be used up in decomposing readily oxidizable organic matter. In case of high pollution, BOD test is performed with diluted water when dilution factor is used for calculation. BOD increases, as water remains stagnant for longer duration. BOD is an important parameter in integrated fish farming where use of excreta etc may increase BOD to a very high level detrimental for fish as well as human.

Role of bacteria in sediment organic matter decomposition vis-a-vis water quality



Bacteria decompose bottom sediment organic matter and cause many transformations of chemical compounds (mainly at sediment surface). Carbon and nitrogen of dead organic matter are used in making protein, carbohydrate and other components of bacterial cells. In anaerobic respiration (fermentation), ethanol, lactic acid etc are end products. In anaerobic condition, NO_3^- is converted to NO_2^-, and finally nitrogen, Fe^{3+} is converted to Fe^{2+}, SO_4^{2-} to H_2S, CO_2 to methane.

Variation in sediment organic carbon is mostly governed by amount of organic matter used during integrated fish farming. It acts as a direct source of energy to microbes present in soils that take part in mineralization. Soil organic matter or humus controls soil property by aeration, increased water holding capacity, buffering and element exchange capacity. In general, soils with less than 0.5% organic carbon are considered as less productive. 0.5-1.5% and >1.5% organic carbon was considered as medium and high productive category. However, anaerobic condition at bottom sediment with high organic matter may produce accumulation of toxic gases which are highly detrimental to fish. The accumulated organic matter may be periodically removed and used in horticulture in case of integrated farming. This will benefit both fisheries as well as horticulture crops.

Nutrient status of water

Phosphate-P

Phosphorus is often considered to be the most critical single element in the maintenance of aquatic productivity. Phosphorus fertility for aquatic productivity ranges from 0.05 to 0.20 mg/l. Phosphorous is the main factor behind eutrophication of a water body. In tropical waters due to high temperature, phosphate was rapidly assimilated (95% within 20 mins) by plankton and micro-organisms and hence available phosphate concentration is always very low. Mineralization of dead organic matter at sediment surface releases phosphorous, it will be absorbed by the sediment unless it is quickly absorbed by plants or bacteria. Phosphate is trapped as $FePO_4$ or $AlPO_4$ in acidic sediment and $Ca_3(PO4)_2$ in alkaline sediment. Rooted aquatic macrophyte can utilize sediment phosphorous dissolved in pore water. Sediment contain much more phosphorous than water. Bottom soil should not be very adsorptive or very porous as slow release of phosphate is desired. Farm manure like cow-dung makes soil structure correction. For pond aquaculture it was recommended that 10,000 kg/ha/y of cow-dung (one fifth initially, rest amount in ten instalment each month) as organic manure and 300 kg/ha/year SSP (equal ten instalment) as inorganic manure.

Nitrate -N

Nitrogen, a major constituent of protein occupies a predominant place in aquatic ecosystem. When bacteria decompose dead organic matter, part of the nitrogen in organic matter is converted to organic nitrogen in microbial biomass and the remainder is released to the water as ammonia. Nitrate produced in nitrification of ammonia can be absorbed by plants and bacteria. Under anaerobic condition, nitrate can be transformed to nitrite, ammonia or nitrogen gas by denitrification. Dissolved inorganic nitrogen (NH_3, NO_2^- and NO_3^- form) in the range of 0.2 to 0.5 mg/l may be considered favourable for fish productivity. Nitrogen fertilization of 240 kg/ha/year urea (10 equal instalments) is recommended for pond aquaculture.

Silicate-Si

Silicon, structural constituent of diatoms, remains as silicate form in natural waters. Normally 1-30 mg/l silicate-silicon or more remains present in natural waters. At high temperature and pH, the solubility of silica increases greatly.

Toxic gases

Ammonia

Demand based feeding to avoid waste which may generate highly toxic free ammonia

Ammonia is produced by fish and all other animals, including ourselves, as part of normal metabolism. Fish excrete metabolic ammonia directly into the surrounding water via special cells in the gills. Being toxic, most animals immediately convert it to a less harmful substance, usually urea, and excrete it through urine. Ammonia is also produced from decomposing fish food, fish waste and detritus. At low levels (<0.1 mg/l NH_3), it acts as strong irritant, especially to the gills. Prolonged exposure to sub-lethal levels can lead to skin and gill hyperplasia (secondary gill lamellae swell and thicken, restricting the water flow over the gill filaments) causing respiratory stress. Fish response to sub lethal levels are similar to those to any other form of irritation, i.e. flashing and rubbing against solid objects. At higher levels (>0.1 mg/l NH_3) even relatively short exposures can lead to skin, eye, and gills damage. Normal ammonia excretion from gills suppresses. Rise in blood-ammonia levels results in damage to internal organs. Fish response to toxic levels would be lethargy, loss of appetite, laying on pond bottom with clamped fins, or gasping at water surface if the gills are affected.

During fish seed transportation, one of the major reasons behind fish mortality is accumulated ammonia (use sedatives like carbonic acid to reduce metabolic activity). Ammonia (NH_3) is highly toxic, whereas the ammonium ion is significantly less toxic. Only 1.2% of total ammonium nitrogen (TAN) would exist as un-ionised ammonia. In normal circumstances any readings above 0.1 mg/l TAN should be considered as unacceptable.

Fish should not be stocked immediately after addition of cow-dung addition, 2-3 weeks gap is necessary to establish nitrifying bacteria which convert ammonia into nitrate. Until the nitrifiers are well established, ammonia, and later nitrite, levels may be unacceptable and a threat to fish health. Partial water changes on a daily basis until an acceptable level is obtained. Reduce or stop feeding with feed of high protein content. Zeolite (40 kg/ha) may be used to absorb ammonia accumulated in pond bottom. Baker's yeast (3 kg) mixed with molasses (30 kg) per ha may be sprayed to reduce ammonia.

During pig-cum-fish culture in integrated fish farming, pig urine should not be mixed with their excreta for pond fertilization. This is because excess urine may increase ammonia to cause fish mortality.

Hydrogen sulphide

H_2S is produced in anaerobic conditions by the action of microorganisms on sulphur compounds. H_2S is toxic to fish and prawn. It should be less than 0.05 ppm in pond water. H_2S is responsible for respiratory problems. When H_2S increases, lime should be added.

Methane

To avoid methane and CO_2 accumulation at bottom, dewatering and desilting is necessary. Periodical removal of bottom accumulated organic matter is beneficial for to prevent production of toxic gases like ammonia, hydrogen sulphide and methane.

Table 1: Optimum ranges of different water parameters of a stocking pond

Parameter	Range
Depth	1-2 m
Temperature	20-35°C
Free CO_2	15-20 ppm
Dissolved oxygen (DO)	5-8 ppm
Water pH	7.0-8.5
Total alkalinity	100-125 ppm
Phosphate -P	0.2-0.4 ppm
Nitrate - N	0.06-0.10 ppm
Total NH_4^+ nitrogen	<0.1 ppm
Hydrogen sulphide	<0.05 ppm

Feeds and Feeding Management for Ornamental Fish

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Fish hobbyists, invariably, provide variety of commercial feed available in the market for rearing and maintenance their pet in aquarium. Feeds used for fish keeping are either formulated or live worms, insect larvae, cyst of crustaceans, zooplanktons and/or their dried, processed forms. Variety of formulated feed available in the market are dry mash, flakes and extruder pellets. Providing live feed on a regular basis is a cumbersome job for hobbyist. However, fish breeders and commercial traders have to arrange live feeds for broodstock maintenance, larval rearing and also colour quality maintenance for consumer attraction. Ornamental fish breeders generally purchase bloodworms, Artemia cyst from markets. Some of the farmers in Bengal collect zooplanktons from ponds or drains for feeding fishes in their holdings and the recent practice is in situ cage rearing in specially maintained rearing ponds.

On the other hand, large farms and fish keepers generally depend on market supply of commercial formulated feeds for rearing and maintenance of their fish stocks. Most of these feeds are imported and quite expensive. Of late, few companies are indigenously producing ornamental fish feeds which are comparatively cheaper. Now with the development of science and expansion of knowledge and availability of information, feed can be formulated and prepared at home. While formulating feed for ornamental fishes, special care is to be taken to meet every aspect of nutritional needs since the fishes will be reared in totally artificial environment, where they will be deprived of natural food. Therefore, while formulating and preparation of feed for ornamental fishes, precise knowledge of nutritional needs, feeding behaviour of the species, life stages of fishes, selection of quality ingredients and their processing are prerequisites.

In ornamental fish rearing and maintenance, the whole management is feed based. Since feed used in this sector is expensive, cost optimization through better management (ration level, frequency, feed disposal method, correct forms of feed) need to adopted for making the system sustainable and profitable.

Nutritional need: Basic knowledge and understanding of the nutritional needs of the species in question is pre-requisite for their feed formulation and preparation. Assured supply of macronutrients (protein, lipids and carbohydrates) and micronutrients (vitamins and minerals) are essential for maintaining growth, reproduction and health of the pet species. In case of feeding ornamental fish in artificial environment, supply of pigments and probiotics is very important for maintaining their brightness and activeness. Protein requirement of ornamental fishes varies with their feeding habit, growth stages and rearing objectives which are as follows:

Feeding habit	Protein need (% of the diet)
Herbivore/omnivore	30-40
Carnivore	45
Larval stage/juveniles	50
Maintenance feed	25-30

The macronutrients need of fishes varies with growth stages which are to be met from available natural ingredients that are given in the following table:

Nutrient requirements (%) of different life stages			
Nutrient	Young	Brood stock*	Sources
Proteins	40-45	30-40	Fish meal, squid meal, shrimp meal, clam meat, soybean meal, mustard meal, groundnut meal, wheat / maize gluten
Lipids	4-6	6-8	Fish oil, vegetable oil (sunflower, linseed, ricebran etc.)
Carbohydrates	40-45	40-45	Corn flour, rice bran, wheat bran
Vitamin-mineral	1-2	1-2	Pre-mix (synthetic forms)
*animal protein through live food is essential for gonadal maturation			

Incorporation of non-nutritive ingredients such as binders and preservatives are needed for improving stability and shelf life of formulated feed. Fortification of natural bio-pigments in the feed of ornamental fishes is indispensible for maintaining body colouration of fishes in aquarium.

Selection of ingredients for feed formulation has to be very judicious giving consideration towards their cost, availability, digestibility and nutritive value. These factors will determine cost of prepared feed, their performance and efficacy.

Good quality soybean meal, ground nut oil cake and mustard oil cake are commonly used as a source of vegetable protein for herbivorous fishes while fish meal, squid meal and shrimp meal are used as non-vegetable protein for carnivorous fishes. However, combination of both is a reasonable option for cost optimization and balancing amino acid composition. Carbohydrate need or energy source of feed are met from easily available corn flour, wheat flour and rice bran. After procurement of ingredients, their nutritive quality should be assessed before their inclusion in the diet preparation.

Feeding habit: Each fish species have specific preference for their favourite food and their feeding behaviour is also unique with the species. Based upon their natural source of food they fishes be categorised as herbivore, carnivore and omnivore. Various feeding habits observed in ornamental fishes are surface feeder, bottom feeder, browser, nocturnal feeder and day time feeder etc.,

Types of feed: Various types and forms of feed can be fed to ornamental fishes. Based upon the forms of feed, they can be termed as dry mash, flakes, sinking pellets, extrusion pellet (floating), moist cake, wet or paste feed. Surface feeder can be given mash feed. But in aquarium, mash feed will deteriorate water quality. Column feeder can be given slow sinking feed, while bottom feeder can be fed with moist cake or paste feed

a. Dry Feeds: Moisture content in the ingredients used for making dry feed varies between 6-10%.

Forms and types of dry feed:

i. Mash meal: Few powdered ingredients are simply mixed, with or without formulation, for feeding early stage of fish (fry).
ii. Pellets: Mixed ingredients are compacted by mechanical means (hand or electrically operated) into a definite shape and size.

b. Non-dry Feeds: Contains high amount of moisture in the range of 18-70%.

i. Moist Feeds: These are mixtures of either both wet and dry ingredients or only dry ingredients with added moisture. The moisture content of moist feeds varies between 18 to 40 %.
ii. Wet or paste Feeds: The wet feeds are made from wet feed ingredients and fed through mesh net or sieved platform. It generally includes wet ingredients such as trash fish, shrimps, beef heart etc. or live food with 45-70 % moisture. The wet feeds are mainly used for feeding the young ones, carnivorous species and brooders.

Forms of feed needed for different growth stages

a. Fry: Mash or meal, wet / paste feed / live food
b. Fingerlings/ grown up/brooders: Pellet feed / live food

Feed formulation

Feed formulation is the combination of raw materials to satisfy the nutrient requirements of the species and age of fish. Raw materials should be selected on their ability to supply particular nutrients (e.g., protein, energy, essential amino acids and essential fatty acids) at the lowest cost. This assumes that nutrients present in different

feedstuffs have the same nutritional value, which permits the combination of many different nutrient sources in different proportions to satisfy a given set of nutrient requirements for a particular fish. Feed formulation usually follows a certain sequence of virtually trial and error steps. Nutrient composition of some common ingredients are as follows:

Ingredients	Lipid (%)	Protein (%)
Fish meal	6.0	55.0
Groundnut oilcake	13.7	34.5
Soybean meal (fat extracted)	1.3	46.8
Rice bran	2.4	13.3
Maize meal	4.5	9.8

Steps

Remember that a better nutrient balance is likely to be achieved by using several feedstuffs in combination.

- Balance the crude protein level.
- Check and balance the digestible energy content.
- Check the levels of essential amino acids and essential fatty acids and if necessary, return to step 1 readjusting the protein until essential amino acid requirements are satisfied, and return to step 2 to adjust the lipid sources until the essential fatty acid requirements are satisfied.

Based on the proximate chemical composition of ingredients, formulations may be initiated. The mathematical techniques used for feed formulations are simple, and are becoming easier with the availability of various software packages. Diets that contain few feedstuffs or in which levels of protein, energy and minerals are fixed, may be formulated using simple equations.

Square formula

Formulations of diets with a few ingredients, and in which amino and fatty acids balances are not taken into consideration, is best and most simply achieved using “Pearson squares”. The complicated ‘least-cost formulae’ are based on series of simultaneous equations.

Steps of fish feed preparation:

Step 1. Grinding and sieving of feed Ingredients through fine mesh sieve.

Hand grinding

Grinder and mixer

Step 2. Weighing of sieved feed ingredients and vitamin-mineral mixture

Step 3. Thorough mixing of all weighed ingredients other than vitamin-mineral mixture.

Step 4. Cook in a big cauldron /Steam cooker or in a mixer for 15 minutes.

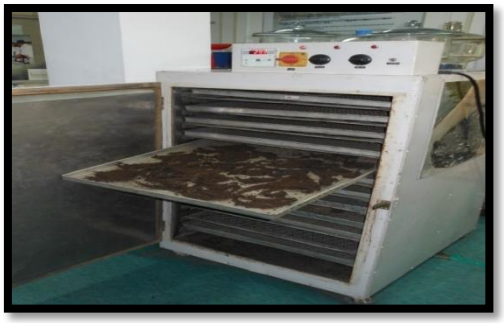
Step 5. Dissolve vitamin-mineral mixture in water and add to the cooked dough steam cooked ingredients mixture.

Step 6. Passed through the pellet machine and pelleted feeds are produced in the form of noodles. The dice of different diameters is used to produce pelleted feeds of different diameters. The diameters of pelleted feeds are adjusted according to the fish size.

Electrical

Hand operated

Step 7. The prepared feeds are then dried in the drier at a temperature of 50ºC to ensure minimum heating loss of vitamins.



Step 8. The dried noodle shaped pellets are grinded by hand grinder to produce smaller size pellets.

Step 9. The feeds are then stored in air tight containers, away from rats, insects and pests.

Packing in container or zipper bag

Diameter of pelleted feeds:

The recommended diameter of pelleted feeds is 0.8-1.2mm. The diameter of pelleted feeds depends on the fish size. Feed of smaller diameter is recommended for small fishes while for larger fish, feed of larger diameter is preferred.

Feeding

i. Hand feeding: Fishes should be fed daily at a fixed time preferably by the same person. Provide amount of ration that will be consumed readily.
ii. Tray feeding Provide feed (dry/dough/non-dry) in meshed / plastic trays
iii. Automatic demand feeders The automatic demand feeders are used to dispense calculated amount of feed depending upon the fish stock. The fish can take the feed according to the need. The Automatic demand feeders are effective time saving devices to dispense pelleted feeds.

Avoid feeding excessively. In order to avoid over or under feeding of the fish, work out the correct feeding rate at appropriate time of the day. Feeding rate, time and frequency depends on the stage as well as the body weight of the fish. Further, acceptance and utilization of feed also depends upon the optimum environmental conditions like temperature, DO, etc.,

Estimate correct biomass of fish stock for calculating right amount of feed It is very important to keep track of total numbers, average size and weight of fish in the tank. The amount of feed required per ration is given in the following table which can be calculated as follows:

Total Amount of Feed = Average fish size (body weight) x Feed rate (%) x Total number of fish in the pond/100

Estimated amount of feed for different developmental stages			
Period	Total Biomass (1000 nos.)	Feeding rate*	Amount of feed
1st to 4th Week 1st month	1.5 g	4-6 times of the fish body weight (BW). 6.0 – 9.0 g daily).	6.0 – 9.0 g daily
Fry	100 g	5-10 % BW	5 -10g daily
Fingerling	1000 g	3-5 % BW	30 – 50 g daily
Grow out	10000 g	2-3 % BW	200 – 300 g daily
* Co-feeding with natural / live food is essential for better growth and development			

Feeding frequency

Fish grows fast during initial days and need to be fed at frequent intervals to support their metabolic activity and overall growth. A generalized feeding frequency is presented in the following Table. However, the feeding frequency may also be reduced or increased depending upon various factors including growth rate, water quality parameters, environmental conditions, etc.

Frequency of feeding to ornamental fish		
Fish age	Frequency	Remarks
1st to 4th week	3-4 times a day	Alternate feeding with dry / live food for optimum fish growth / colour enhancement
Up to 3 months	Thrice a day	
After 4 months (for grow out & brooders)	Twice a day	

Live feed

The live food production facility should be an integral part of the ornamental fish production unit.

Live feeds are considered as “Living Nutritious capsule” as they contain all the essential nutrients (proteins, carbohydrates and fats) including micronutrients (vitamins and minerals). The use of live feeds enhances the survival, growth and breeding efficiency of the fish besides providing pigments for colour development.

Types of live feeds: Infusoria (protozoans), copepods, cladocerans, rotifers, Artemia nauplii etc. and other organisms like Tubifex, eartworms etc.

Size of live feed organisms and stages of preference			
Name of live food	Size	Stage of Uses	Important Characteristics
Infusoria	50-300 µm (0.05 – 0.3 mm)	Ist instar stage (freshly hatched)	Tiny and unicellular; Ideal starter food for larvae
Zooplankton	200-3000 µm (0.2 – 3.0 mm)	Larval stage	Rich protein (60-65 %) source for early life stages
Artemia nauplii	400-500 µm	Larval stage	Filter feeders, can be enriched with PUFA, vitamin C etc. for 6-8 hours
Beer/micro eels	Up to 1.2 mm	Larval stage	Highly digestible and very good food for fry / worms after infusoria and rotifer feeding
Chironomid larvae	10-20 mm	Larval stage	Rich source of iron and pigments (Bloodworm) (contain haemoglobin)
Tubifex (sludge worm)	Up to 20 mm long	Fry	-do-
Earthworms	Size varies according to species	Adult (chopped form)	Rich protein (60-65 %) and fats (9-10 %) source for growouts and broodstock

The pigmentation pattern and intensity of body colours determine the commercial value of an ornamental fish. An ornamental fish being reared in natural environment are very colourful due to the consumption of plenty of natural food in the form of phytoplankton and zooplankton, while, under indoor rearing conditions, fish has to be fed on carotenoid supplemented diets.

Carotenoids are found in a variety of natural and synthetic sources that results in yellow, orange and red pigmentation of fish skin.

a. Sources of natural carotenoids

i. Animal Origin: Algae, zooplankton, tubifex, chironomid larvae, Artemia, crayfish meal, shrimp meal, crab meal, yeast, etc.

ii. Plant Origin: Several types of flowers and vegetables

b. Synthetic carotenoids: Astaxanthin, β-carotene, lutein, zeaxanthin, etc. are few of the commercially available carotenoids.

The carotenoids can be easily supplemented in all those formulated feeds which are prepared at the farm. Plant materials, which are to be used as carotenoid source, need to be grated, dried under shade, grounded and mixed with the other ingredients before pelletization. The carotenoid are supplemented when feeding with dry feed is started for a period of 2-3 months. Carotenoid could also be added in finishing diets for 1-2 months at the end of the rearing period; so that the harvested fish stock to be sold in the market should have bright colouration for maximum profits.

Percentage level of carotenoid to be added in the feed	
Source of Carotenoid	**Incorporation level**
Carrot	4-5 %
Beet root	3-4 %
Marigold petals (powdered)	3 %
Rose petals (powdered)	3-4 %
Gooseberry (Amla)	1 – 2 %
Green Peas	1 – 2 %
Lettuce	1 %

Biosecurity and Quarantine Protocols for Ornamental Fish

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1. Introduction

An ornamental fish which reaches to a hobbyist could be either from wild or farm. Different categories of people are involved in both the cases in the supply chain before it reaches to the end user i.e. hobbyist.

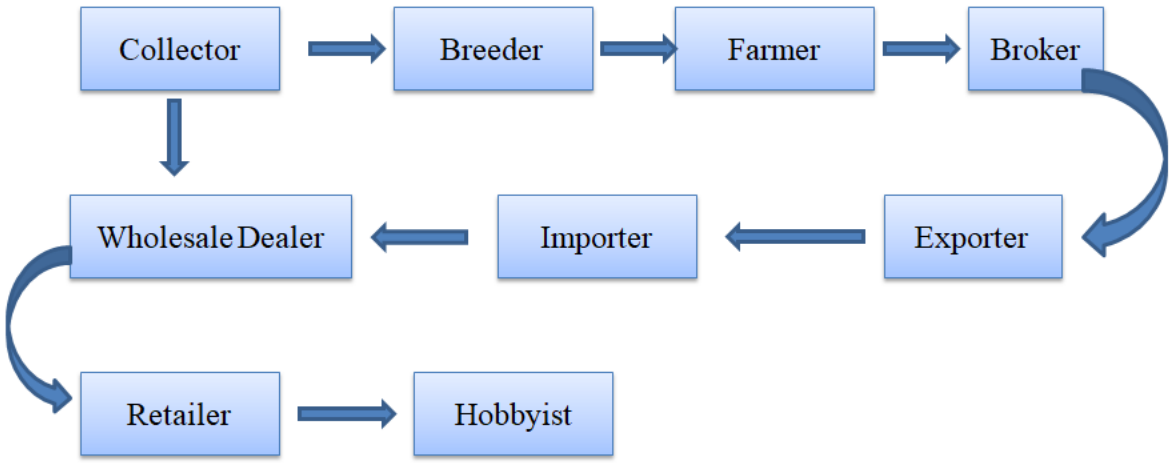

Fig. 1. Chain of custody of ornamental fish from source of origin to end user

Many a times, a fish covers large distances involving a complicated transport system and several numbers of intermediaries in the chain. As a fish moves from one source to another in the supply chain, it is either stocked in a new-holding facility for a varied period of time or also re-packed or both. As a result, there is repeated & quick change of environment and fish is subjected to stress. Many a time's fish may die because of stress only or it becomes susceptible to infestation by other pathogens initially and subsequently mortality may occur if not controlled. It is estimated that about 50% fish dies in Indian domestic trade during different stages of transit. Hence, there is need of acclimatization of fish as and when it is introduced to a new environment. A proper quarantine is a must in export-import trade following some standard set of practices.

2. What is biosecurity?

Biosecurity is a general description of the measures you may take to protect your business (or for Governments, their country) by taking actions to prevent the entry of new or unwanted organisms, especially infectious agents. It can also include species that may have an adverse effect on indigenous species or ecosystems e.g. invasive aquatic weeds or pest species.

Biosecurity has no single definition but a working definition for our purposes could be "the sum of all procedures in place to protect ornamental aquatic organisms (fish, invertebrate or plant) from contracting, carrying or spreading disease."

Otherwise, it is the sets of practices that will reduce the probability of a pathogen introduction and its subsequent spread from one place to another (Lotz, 1997). Biosecurity refers to the activities with the goal:

1. prevent
2. control
3. eradicate risks to life and health
4. reduce the economic impact of diseases

3. What is quarantine in ornamental fish production/trade?

Quarantine means keeping the newly arrived animal or group of animals or plants in isolation for observation without any direct or indirect contact with other animals so to prevent the spread of infectious pathogens and treated if necessary. Newly introduced animals could be carriers of diseases even if the animals appear to be in good health. Quarantine is an important risk management measure and a key activity that should be considered when developing national strategies for aquatic animal health management. It can also be used effectively to increase biosecurity at the farm production level.

Quarantine should be seen as one of a wide range of risk management options that can be applied, either alone or in combination, to reduce the risk posed by aquatic animal pathogens.

4. What are the quarantine protocols?

Practicing proper quarantine procedures will protect the fishes in the farm from being infected by newly introduced animals. Similarly, fish intended for sale from the farm also could be quarantined before shipment to reasonably ensure that they do not carry any contagious disease.

- Every species of ornamental fish imported into the country shall have to be subjected to the quarantine procedures in a quarantine facility accredited by the Competent Authority.
- The imported ornamental fish shall be accompanied by an import permit issued by the Ministry of Agriculture along with pre-quarantine certificate issued by the competent authority of exporting country stating that the farm (from where the consignment is exported) is covered under their national aquatic animal health surveillance or a pre-quarantine certificate showing status of OIE and NACA listed diseases of the farms and exporting country.
- On arrival of the consignment, accompanying pre-quarantine certificate should be verified and imported species should be rechecked at the quarantine facility and certificate of quarantine would be issued by designated authority.
- Upon clearance from the port of entry, the consignment shall be transferred immediately to the accredited quarantine facility as indicated in the letter of permit.
- On receipt of consignment at quarantine facility, the species should be subjected to quarantine protocol prescribed for particular species.
- The imported fishes would undergo quarantine in approved quarantine premises as follows. a) Gold fish – 21 days. b) Other ornamental fishes – 15 days.
- After satisfactory completion of quarantine, the consignment should be released to the importer with quarantine certificate.
- Direct sale of imported broodstocks in the domestic market shall not be allowed and only F1 and F2 progeny shall be released for domestic or international market.
- No import of the ornamental fish species shall be allowed if the fish species is found to fall in any or all of the following categories. Aquatic organism identified as dangerous as it:
    - Can cause injury to human beings (possess venomous spines/poisonous flesh/toxins/special defense mechanism).
    - Has possibilities of attacking and inflicting injuries to human beings and animals
    - Is a known vector or carrier of pathogen
- Species as listed under the Convention on International Trade in Endangered Species (CITES) or in the threatened list of International Union for Conservation of Nature (IUCN) or that of the exporting country's threatened list. However, if the source of the endangered fish is cultured and the exporting country's competent authority certifies it, then it can be permitted.
- Species under any other ban imposed on the import due to national legislation or international treaties/conventions.

- Invasive species exhibiting well documented deleterious impacts in India or other countries having environmental conditions similar to India.

5. Steps in quarantine process

5.1. Pre-requisites in setting up of quarantine facility

The quarantine facility should be isolated and separated from the main production and marketing facility. It is one of the most important pre-requisites while setting up a quarantine facility. It is because of the reason that there are high probabilities that fish which will be kept in quarantine facility is infected. In case, quarantine facility is located close to production facility, there will be high possibility of disease transfer from quarantine facility to production facility. The guiding factors that are to be considered while developing a quarantine facility are:

- The fish holding systems in the quarantine area should be smaller and less extensive than main facility.
- The quarantine tanks should have viewing facility that is adequate to observe fishes for behaviour and signs of pathology, easier to monitor, capture and treat the fish and also remove mortalities.
- The system should be able to comfortably accommodate the largest fish size and numbers you expect to receive. The habitat and hiding places in the tank should be simple in the construction and easy to clean and disinfect and not have any parts that could injure the fish.
- Only properly trained and authorized people should be permitted to enter the area. 2.5 The restricted nature of this area is emphasized by appropriate and well-placed signage

5.2. Monitoring and maintenance of water quality at quarantine facility

Precise monitoring and maintaining of the water quality at the quarantine facility is of prime importance. A sudden change of water quality during the quarantine process may lead to undesired results.

- Water quality parameters should be both optimum and stable. New fish are always much stressed and it is essential that they be placed in a stable environment while they undergo quarantine and acclimation.
- Each quarantine tank should have its own set of equipment (nets, totes, bowls, siphons) and disinfectant baths. It will be desirable to install ultraviolet lights and/or an ozoniser in the incoming water supply line from over head tanks so to sterilize the water coming to quarantine tanks.
- Each tank should have a separate filtration system. A poorly designed or complicated quarantine systems that are difficult to access are generally not well maintained

5.3. Quarantine period

The fish should be quarantined only for a specific period with a practice of "All-in-All-out" methodology. The quarantine period should be time-specific. A period of less duration is considered ineffective whereas a longer period is undesirable as well as uneconomical.

- The duration of quarantining may vary from species to species. Ideally, tropical fish should be quarantined at 22-25°C and cold water fishes at no less than 12-15°C. At lower temperatures, it is best to double the quarantine period.
- The period of quarantine could be 21 days for Goldfish, 14 days for gouramis & cichlids and 7 days for other freshwater fin fish. If the fish are brought for breeding purposes the quarantine period may last for 15-30 days depending on the species.
- Lights should be kept off for the first 12 to 24 hours.
- No new stock of fish should be added to the quarantine tank while an old stock is already being quarantined. Only "All-in-All out" methodology should be adopted. If new fish are added to the quarantine system before the quarantine period is completed, the quarantine period resets to day 0 for that system.
- Fish from each supplier should be quarantined in separate systems and not mixed together. In the event that a group of quarantined fish develop disease, this separation will allow you to accurately identify the source of the diseased fish.
- At the completion of the quarantine period, all fish in a quarantine system are moved out and the tank and support system housing those fish are disinfected before another new lot of fish is moved into quarantine.

5.4. Process of acclimatization

1. Turn off aquarium lights

2. Dim the lights in the room where the new arrivals will be opened. Never open the bag in bright light - severe stress or trauma may result from sudden exposure to bright light

3. Float the sealed plastic bag in the tank for 15 minutes (Fig. A). Never open the bag at this time. This step allows the water

in the bag to adjust slowly to the temperature of the tank while maintaining a high level of dissolved oxygen.

4. After floating the sealed bag for 15 minutes, cut open the bag just under knot or rubber band (Fig. B) and roll the top edge of the bag down one inch to create an air pocket within the lip of the bag. This will enable the bag to float on the surface of the water (Fig. C). For heavy pieces' bags that will submerge, place the bag in a plastic bowl or specimen container

5. Add 1/4 cup of tank water to the plastic bag (Fig. D).

6. Repeat step 5 every ten minutes until the arrived bag is full.

7. Lift the plastic bag from the tank and discard half the water from the bag (Fig. E).

8. Float the shipping bag in the aquarium again and proceed to add 1/4 cup of tank water to the arrived bag every four minutes until the bag is full.

9. Use a very soft hand net to gently catch the fish from the bag and release them into your tank (Fig. F)

10. Remove the filled plastic bag from the tank and discard the water. Never release water from the newly arrived plastic bag directly into your tank.

5.5. Monitoring and record keeping

A practice of regular & frequent monitoring and record keeping on behaviour, feeding and health of the fish should be followed. A fish is subjected to quarantine in order to revive it from any stress and also to confirm that it is not the source of any disease. Many a times, a fish may appear healthy initially but may show sign of disease after few days. Therefore, a regular monitoring and record keeping of behavioural changes, feed acceptance and fish health is very important. Record keeping is important because it allows the facility manager to ensure that the fish are being observed regularly, the system is being properly maintained, and that disease problems are tracked and reported in a timely manner.

- A work sheet shall be developed for various parameters viz; swimming behaviour, feed acceptance, water quality, fish mortalities (if any), etc. and shall be kept along with the quarantine tank.
- The values/remarks on these parameters shall be recorded daily by a trained staff
- The format once developed shall remain in use for a long period of time without any change

- The period interval and time of recording data should be same throughout the total period of quarantine.

5.6. Standard prophylactic treatments

The application of various prophylactic treatments acts as preventive measures. Some of the commonly used prophylactic treatments for fish include dip, bath or prolonged immersion in common salt, formalin, potassium permanganate, acriflavin and hydrogen peroxide.

- Common salt: Only un-iodised and preferably rock salt shall be used. Freshwater fishes entering quarantine should be given a saltwater dip (Sodium chloride crystals 5gm/litre) if feasible, two more saltwater baths at 3- to 5-day intervals.
- Formalin: Dissolve 1 ml formaldehyde in 10 litre of water and give an immersion treatment for about 1 hr. Formaldehyde could be easily obtained from a supplier of laboratory chemicals. Do not use a solution of formaldehyde which appears milky
- Potassium Permanganate ($KMnO_4$): Dissolve 4 gm $KMnO_4$ in 1000 litres of water and give immersion treatment for 1-3 hrs. In case of prolonged treatment for 24 hrs quantity of $KMnO_4$ is reduced to 2.5 4 g per 1000 litres.
- Acriflavine: Dissolve 500 mg of acriflavine in 1 litre of water and keep it as a stock solution. Stock solution could be diluted and used as per requirement.

5.7. Appropriate sanitation procedures should be strictly followed for eliminating entry of pathogens

It may also happen sometime that the fish was disease free when it was brought to quarantine facility but it was subjected to pathogens there only. It could be because of non-adherence of sanitation procedure and maintenance of hygiene in the premises.

- All tanks should be kept free of fish waste and uneaten food.
- Ensure that all dead and moribund (sick) fish are removed promptly.
- Equipment should be cleaned and placed in a disinfection solution for the appropriate amount of time after each use.
- It is important to use an appropriate disinfectant, at the proper concentration, and allow the recommended contact time with all equipment and tank surfaces to assure efficacy (Table-1).
- Buckets of disinfectants should be placed by each quarantine tank and each tank should have its own set of nets, bowls and siphons.
- After fish leaves the quarantine system, all tanks should be sanitized and if possible, allowed to air dry.

Table 1: Common disinfectants for use in ornamental fish production facility

Disinfectant	Dosage	Duration	Remarks
Sodium Hypochlorite (Household bleach at 5.25%)	200mg/l (approx. 35 ml [2.5 tbsp] per gallon of water)	1 hour	Not recommended for nets or metal Maybe neutralized with sodium thiosulfate Toxic to fish
Quaternary Ammonium Compounds	2000mg/l	1 minute	Toxic to fish
Calcium Hypochlorite	100-200mg/l	20 seconds	Toxic to fish

6. Penalties for violations

* The importer shall keep in mind the biosafety, biohazards and economic interest of the nation. Any biosafety and other related hazards arising out of release of the imported fish into the natural waters entirely the responsibility of importer/importing organization/indenter and should be liable to be proceeded against with the accordance with the relevant rules of Government of India.
* In case, the consignment does not pass quarantine, the entire consignment shall be destroyed at importers cost as per the prescribed protocols. If during the course of inspection, it comes to the notice of the Competent Authority that the importer wilfully suppressed certain important information/deliberately furnished wrong information or that the species sought to be imported and the one actually imported are not the same or that the species sought to be imported and the one actually imported are not the same or that the imported specimens also consist of species for which approval has not been obtained, the import permit shall be cancelled forthwith and all the specimens imported destroyed without any notice to or permission of the importer.
* The importer shall take abundant care to prevent any accidental escape and wilful release of the exotic ornamental fish into natural waters. In spite of this in the event of accidental escape/wilful release of fish into natural waters, the matter should be reported to the competent authority and the nearest quarantine centre.

7. Post quarantine Inspection

The CA shall have right to carry out the post quarantine inspection of hatchery, rearing facility and farms of the importers to confirm the specified norms for assuring the imported fishes are used for the purpose for which they are imported; and to look at the magnitude of multiplication and horizontal spread of the imported fish species. The importer shall submit quarterly status report on transport, breeding, rearing and retail etc. within the after the import.

8. Important points to be remembered:

- ☞ It is always better to have a quarantine facility at your hatchery/trade place.
- ☞ Quarantine area should be isolated and separate from your main facility.
- ☞ Acclimatize the fish properly, which is the foremost requirement of quarantine.
- ☞ Water quality parameters should be not only optimal but stable.
- ☞ Quarantine tanks should have viewing facility that is adequate to observe fish.
- ☞ Each quarantine tank should have its own sets of equipments/filter system.
- ☞ Standard prophylactic treatments should be carried out to reduce the stress and consequent incidence of diseases.
- ☞ Bottom of the tanks should be bare, without sand, plants or anything.
- ☞ Only authorized persons should be allowed to enter the quarantine area.

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Diseases of Ornamental Fishes and their Control

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Introduction

The concept of ornamental fish keeping has its origin in Japan and China and recently many countries U.S.A, Singapore, Malaysia and European countries have made these as a flourishing business. Since 1960's the global trade of these ornamental fishes has reached to US$8 billion. All together 1800 species of fishes are traded globally of which majority are from marine environment. Among freshwater fishes, mostly 35 species dominates the entire market. The species are Guppy, Platy, Sword tail, Molly, Neon-tetra, Angel fish, Gold fish and Koi carp. While in India, there are 120 varieties of fish collected from nature, predominantly from North East states and the Western Ghats (85%) are of ornamental values. The value of these ornamental fishes has increased to US$ 1.7 during 2008. India has large untapped water bodies at present and these potential resources may be utilized for ornamental fish captive breeding and trade.

Maintaining a healthy stock is necessary to achieve a substantial production. Ornamental fish farming is mainly concentrated in a few pockets of the country and most of the farming is of backyard in nature. Even the owners/farmers face the problems of fish health issues and loose their stock, health concern is least important in these sectors. In confined environment like in aquarium or ornamental-fish ponds, fish are susceptible to various kinds of diseases. Many limiting factors viz. water quality, overcrowding, nutritionally imbalance poor food, rapid fluctuation in water temperature, lack of oxygen or poor husbandry practices influence the health status of the stock. The symptoms /signs indicate whether the fish may be suffering from a particular disease or not. Stock improvement in terms of disease prevention must be a top priority issue. Fish health management is an important issue of concern at any of the ornamental fish production facility. It is not given priority either due to lack of awareness and knowledge of the persons concerned or improper husbandry practices.In order to achieve this, it is necessary to have a health management protocols in every farming practices.In this context, the important diseases, their clinical signs and preventive health management practices are discussed.

Common diseases of ornamental fishes:

1. Bacterial Diseases
2. Fungal Diseases
3. Protozoan Diseases
4. Parasitic Diseases

Bacterial diseases and treatment:

1. Fin and Tail Rot:

Symptoms: Disintegrating fins that may be reduced to stumps, exposed fin rays, blood on edges of fins, reddened areas at base of fins, skin ulcers with grey or red margins, cloudy eyes. Possible predisposing factors: Poor water quality/ aquarium conditions and injury to the fin and tail. The affected area slowly breaks down.

Treatment: It is advisable to treat the water or fish with antibiotics @ 20 - 30 mg per litre. For mixing with feed, 1.0% of antibiotic can be used and fed to the fish. Antibiotics such as tetracycline will be effective in controlling fin and tail rot conditions.

2. Scale Protrusion:

Symptoms: Protruding scales without body bloat. Scale protrusion is essentially a bacterial infection of the scales and/or body.

Treatment: An effective treatment is to add an antibiotic to the food. With flake food, use about 1 % of antibiotic such as chloremphenicol or tetracycline. In the water, add about 10 mg per litre of the required antibiotic.

3. Dropsy

Symptoms: Bloating of the body, protruding scales. Causes: Dropsy is caused by bacterial infection of the peritoneal area including kidneys, causing fluid accumulation. The fluids in the body build up and cause the fish to bloat up and the scales to protrude.

Treatment: Recommended dose of antibiotic.

4. Ulcerations, Red sores or redpest:

Symptoms: Bloody streaks on fins or body. Causes: Bacteria penetrates inside the body tissue.

Treatment: Disinfect the rearing water with suitable antiseptics such as acriflavine or onacrin (monoaminoacridine) with 0.2% solution @ 1 ml per litre followed by antibiotic treatment.

Fungal Diseases:

Saprolegniosis:

Symptoms: Tufts of white cotton-like growth on the skin or fins. Eggs turn white.
Predisposing factors: Usually fungus is a secondary infection. Fungal attacks follow an injury, parasitic attack or after a bacterial infection.
Treatment: For attacks on fish eggs, use 3 to 5 mg/ 1 methylene blue as a preventative measure after the eggs are laid. In addition, 10 ml of 1.0% phenoxethol per l of aquarium water can be added. It is advisable to repeat for a few days as per the requirement. If the symptoms are severe the fish can be removed from the aquarium and swabbed with a cloth immersed in weak solution of povidone iodine or mercurochrome.

Protozoan diseases

1. Ichthyphthiris Disease

Ich disease or 'white spot disease' is the most common disease in aquaria.

Causative agent: Ichthyophthirius multifiliis
Symptoms: White glistening spots or Salt-like specks on the body/fins. Excessive slime on body, difficulty in breathing, clamped fins and loss of appetite are other symptoms
Treatment: The free-swimming phase of the parasite is susceptible to chemicals. Quinine hydrochloride or Quinine sulphate at 30 mg per litre (1 in 30,000) can be used. Others such as acridine orange, acriflavine, mild formalin solution, benzalkonium chloride, malachite green or malachite green with copper are effective.

2. Costia

Symptom: Milky cloudiness on skin.

Treatment: Copper at 0.2 mg per liter (0.2 ppm) to be repeated once in a few days if necessary. Acriflavine may be used at 0.2% solution (1 ml per litre).

3. Chilodonella

Symptom: Dulling of the colors due to excessive slime, fraying of the fins, weakness and gill damage.

Treatment: Acriflavine at 1.0% solution (5 ml per litre).

Parasitic Diseases

1. Argulus and (Lerneae

Symptoms: The fish scrapes itself against objects, clamped fins, visible parasites about 1/4 inch in diameter are visible on the body of the fish.

Treatment: With larger fish and light infestation, the lice can be removed with forceps. Weak formaldehyde is also useful to remove the parasites.

2. Ergasilus

This parasite is like the anchor worm, but is smaller and attacks the gills instead of the skin.

Symptoms: Whitish-green threads hang out of the fish's gills.

Treatment: Bath for 10 to 30 minute in 10.0mg/ litre of potassium permanganate or continuous exposure of the whole tank with 2 mgt litre of potassium permanganate. In addition, 3D-minute dip with 1.0 ppm of Copper control followed by 3D-minute dip with 1.0 ppm of BKC will be helpful to control gill parasites.

3. Flukes:

Flukes may be one of two microscopic parasites infecting the fish’s skin (*Gyrodactylus*) or the delicate gill membranes (*Dactylogyrus*). *Gyrodactylus* is called skin fluke and *Dactyologyrus* is called gill fluke. *Gyrodactylus* causes the fish’s colour to fade, skin becomes slimy, sometimes with blood spots. *Dactylogyrus* affects the gill membranes and the fish would pant at the water surface with its gills inflamed and extended. Affected fish should be isolated in a well-aerated treatment tank and given

bath of proprietary remedies.Gill-fluke causes surfacing in fish, low oxygen levels in the water though may also cause the same especially in overcrowded tanks. The fish swims to the surface to gulp air. A rapid aeration would bring relief, but thinning out may also help.

Treatment: Dip or bath treatment with saline water will help in removing the flukes

Viral diseases:

Koi Herpesvirus (KHV)

Till date no record of the disease in ornamental fish in India. Koi herpesvirus, caused by Cyprinid herpesvirus-3 (CyHV-3). The disease is endemic in USA and other europian countries.. It affects the koi and common carp fishes. Clinical disease is seen at water temperatures of 22°–25.5°C. Mortality rates can reach up to 80–100%. The mortality rate due to this virus is more in young fishes and gills are affected which become mottled red and white appearance with hemorrhage in some cases. Affected fish become lethargic, swim at the surface and may show behavioral signs of respiratory distress. Exposure to carrier or infected fishes spreads the disease in healthy ones.

Treatment: As there is no cure this disease, better management practises is best.

Lymphocystis

Symptoms: Nodular white swellings (cauliflower) on fins or body. Lymphocystis is caused by virus and hence affects the cells of the fish. It usually manifests itself as abnormally large white lumps (cauliflower) on the fins or other parts of the body. This is a rare disease.

Treatment: it is better to remove and destroy the infected fish as soon as possible.

Miscellaneous Diseases/infections

Eye problems are more common in aquarium fishes .

Symptoms: pop eye, cloudy cornea, opaque lens, swelling, blindness.

Treatment: Pop eye (exophtalmia) can result from rough handling, gas embolism, tumors, bacterial infection, or vitamin A deficiency. It can be treated successfully with

penicillin or amoxicillin. Cloudy cornea can result from a bacterial invasion. Antibiotics may help. Opaqueness can result from poor nutrition or a metacercaria invasion (grubs).

Preventive health management practices

Preventing disease is much more economical than providing expensive treatments following a disease outbreak. There is not a single, ideal, universal preventive programme that can be applied by every producer. Specific considerations must be taken into account for individual enterprise, however, some general preventive recommendations that can be made.

1. Provide adequate and clean water
2. Provide sufficient space
3. Provide adequate and balanced feed
4. Prevent high temperature fluctuations
5. Remove fecal matters as often as practicable, remove dead fish, prevent the accumulation of other organic matter such as uneaten feeds and the accumulation of befouling community i.e. algae and slime.
6. Intermittently clean and disinfect the system
7. Always maintain compatible species
8. Avoid unnecessary handling
9. Control internal and external parasites
10. Provide diligent surveillance to recognize early signs of disease
11. All new incoming fishes should be quarantined from resident stock. Movement of fishes should be restricted from a suspected or unknown disease status area.
12. Separate the infected fishes
13. Provide adequate nursing for diseased fishes
14. Begin treatment of diseased animals as soon as possible after disease is diagnosed

Aquarium fabrication, setup and maintenance

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An aquarium (plural: *aquariums* or *aquaria*) is a vivarium of any size having at least one transparent side in which aquatic plants or animals are kept and displayed. Fish keepers use aquaria to keep fish, invertebrates, amphibians, aquatic reptiles such as turtles, and aquatic plants. The term "aquarium" is coined by English naturalist Philip Henry Gosse. Aquarium is a showpiece in the drawing room and hence, hobbyist keen to make it more attractive. To set up or construct an aquarium number of scientific factors are need to be taken into consideration. The size of the tank , its shape, how it harmonize with surroundings, and the number of fishes which need are to be accommodated in the tank must be perceived before start the set up of tank. Choose the place where direct sun light does not fall on the aquarium and the water quality need to be maintained. Hobbyist and entrepreneurs can construct an aquarium as per their choice. The detail of materials required and the method to construct and maintain an aquarium is dealt here.

1. Size:

The aquarium tank has to be constructed after due consideration given because resetting or changing the dimensions will be difficult. The various factors need to be considered like the nature of aquascaping intended, financial involvement, space available, size of fish, number of fish to be kept. Oxygen is depleted in the tank due to respiration and decomposition of organic materials while carbon dioxide is liberated by both plants and fishes. Though part of the carbon dioxide is absorbed by plants for photosynthesis, the major exchange of these gases are taking place at the air water interphase. The size of fish is to be determined by the type of fish and the dimension of the intended site. The thumb rule is generally followed is to allow 75sq.cm space area for every 2.5cm of fish, excluding tail.

It is always better to opt for a large tank. In small tanks the water quality parameters, particularly temperature fluctuates widely while larges tanks such fluctuations are gradual and less likely to affect the fishes. The ideal ratio of length to height of aquarium tank is 3:2. Any flat surface can suffice to hold a fish tank, but it is preferable to use a stand. Various kinds of stands are available. The main frame should be made of sufficient thickness. Weight is also a factor which should not be overlooked.

Table 1. Dimension of rectangular tank along with its capacity and glass thickness

Aquarium size (in cm)			Volume of water		Thickness of glass
Length	Width	Height	In gallons	in litres	in mm
50	25	25	6	28	4
60	30	30	12	54	4
90	30	38	20	103	5
120	30	45	30	162	6
150	45	60	70	405	10
180	45	60	80	486	12

2. **Shape:** The selection on the shape of tank varies viz. rectangular, square, trapezoid (glasses pointed inward or outward), triangular, hexagonal or global, depending upon the essential requirements as well as aesthetic sense.

Making of Aquarium:

- **Materials and specifications:**
  Glass: All glass tank have become very popular since they are attractive and can easily be constructed**.** The all glass aquaria with the bottom, sides and ends made of glass sheets cemented together with 100 % silicone sealant has been very successful. Handling these glass aquaria should be done with utmost care. Large aquarium should be properly reinforced with strong frame in top and bottom. The glass panels of required size (4 side panels plus 1 base panels) are cult and thoroughly cleaned, particularly the sealing edges. The bottom and side panels are fixed to the appropriate position by using adhesive “Silicon sealant” for sealing and cellophone tape for keeping a fixed position.
  - Annealed glass is the best option and laminated glass, toughened glass and polycarbonate plastic are also can be used but do not use tempered glass. Aquarium Height / Sheet Thickness:
  - 1 to 12 inches (2.5 to 30.5 cm) / 1/4 inch
  - 12–18 inches (30.5–45.7 cm) / 3/8 inch
  - 18–24 inches (45.7–61.0 cm) / 1/2 inch
  - 24–30 inches (61.0–76.2 cm) / 3⁄4 inch (1.9 cm)

  - **Adhesive:** 100% silicone sealant. Regular household silicone like GE Door & Window clear silicone, Dow-Corning "DAP", and Napa All-Glass 100% clear silicone are also viable options.
  - Masking or duct tape

- A caulk gun

  Fibre Glass: For the front, back and sides of the aquarium, normal fibre glass is used. The fibre glass is hard. It is non-corrosive and can be obtained in a variety of colours.

- **Process of making:**

- The order of construction should start with the bottom glass, then put the front glass on, then the 2 side glasses and at last the back.
- When applying silicone on the glass, run a continuous 1/4-inch bead with no gaps or bubbles. For the best bonding results, apply only as much silicone as you can work within 3 to 5 minutes because after this the silicone tends to skin over and will not bond well to the glass.
- Lay down a bead of silicone on the bottom glass for the rear and one side glass panel, and on one side edge of the back panel, installing the back glass panel on the bottom, and then the side panel to the bottom and rear panel.
- When any section to be joined has been set into place, the silicone needs to be smoothed out.
- Hold it there briefly, adheres the rest of the tape up the sides and it should stay up.
- The silicone will be dried in 12 - 24 hours (depending on the air temp and humidity), but let it sit for at least 24 - 48 hours.

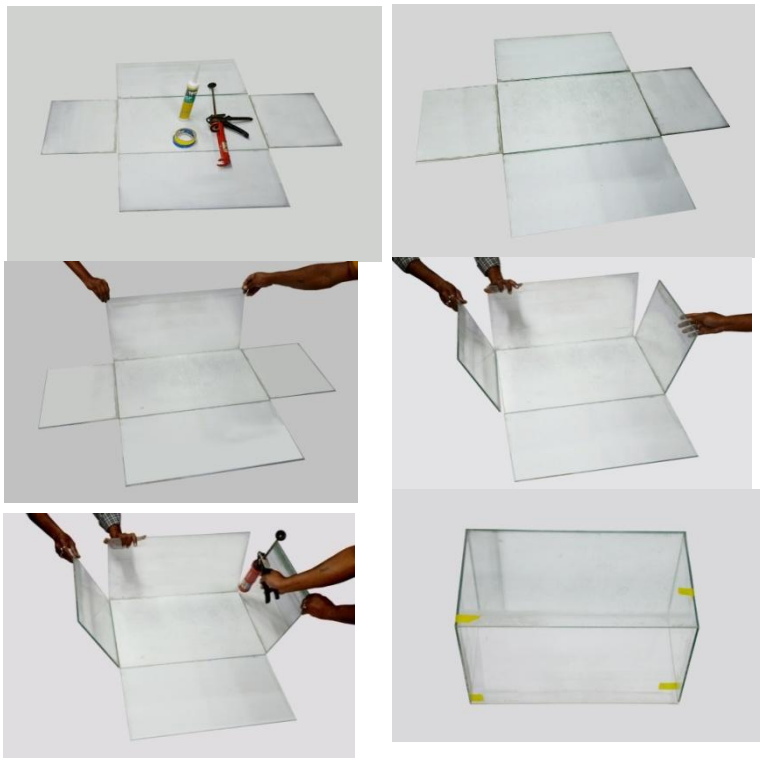

Plate: Steps of aquarium fabrication

Setting up of Aquarium:

- **Materials and specifications:**

1. **Hood:** A slant hood or lid is put on the roof of the aquarium to prevent entry of any undesirable things or creatures, evaporating water and also to prevent fishes from jumping out of water.
2. **Aquarium filter:** The purpose of the filter is to remove excess food, decaying organic matter, free-floating particulate, dangerous chemicals, and the fish's waste products from the water.
3. **Air-Pump:** Oxygenates and circulates water by creating a stream or curtain of bubbles.
4. **Lights:** Direct sunlight on the aquarium must be avoided as it causes algal growth and turns the water green. However, proper illumination in the aquarium is important as it not only makes the fishes visible but also enhances the beauty of the tank. So, it is better to provide light artificially.
5. **Thermometer:** A thermometer is installed at vertical position to monitor the changes of temperature of the aquarium water.
6. **Thermostat:** Helps to regulate tank temperature during temperature fluctuation
7. Resin, rock & driftwood ornaments: Provide hideaways or cover for fish and provide interest and enrichment for fish.
8. **Plants:** Original aquarium plant as well as plastic and silk fish-safe plant can provides shelter and spawning mop for fish and gives a more natural look.
9. **Backgrounds:** Natural or fun scenes photographs to the back wall of tank can give the impression of depth and texture.
10. **Gravel & Substrate:** The most important function that gravel serves is to provide a home for beneficial bacteria to colonize.
11. **Feeding Rings:** The feeding rings are made of plastic in the form of a square or a circle. They float on water and the dried food gets limited within it.

- **Process of setting:**

  - The aquarium poster fixed at back side with tape.
  - After confirming that there is no leakage, the aquarium keeps dried.
  - The preferable filter is placed inside the aquarium.
  - The gravel is then washed thoroughly with $KMnO_4$ and normal water. The gravel is then spread on the tank bottom in a slanting manner (4 cm at the back and 2 cm at the front).

- Colourful pieces of rocks, pebbles, toys, driftwood etc. are then placed on the top of the gravel.
- Natural or artificial plants are also placed inside the aquarium.
- The tank initially is half-filled with water, and aerators are placed in it.
- Heater and thermostat are then fixed in appropriate places, connecting each other but not to mains.
- The feeding ring is attached with the side glass.
- Then the aquarium filled up with water. But 4-6 cm should be left vacant.
- The cover is then placed on the top of the aquarium and the lights, thermostat and aerators are checked for proper functioning.
- Now the aquarium is fully prepared to keep the fish. The ornamental fishes should be given a bath in KMnO4 or copper sulphate before keeping them in the aquarium.

Number of fishes in aquarium

- There are various types of ornamental fishes available for hobbyists. The selection and combination of fishes in the aquarium depends up on their availability and compatibility in the group.
- It's advisable to select small fishes for aquarium. The common species are black molly, platy, guppy, swordtail, fighter, angel, barb, goldfish etc. In addition to these fishes any fish having ornamental in nature and suitable for captive rearing can be selected for aquarium.
- Their behavior with other fishes in the group should be studied before keeping them together in aquarium for rearing. Fishes of small size of 2-3 cm. are advised for rearing in aquarium. A space of about 50 sq. cm for a fish of size 2.5 cm is recommended for the best rearing.
- Considering this recommendation, 35 fishes of size 2.5 cm are allowed to keep in 60 × 30 cm size aquarium having 1800 sq.cm water surface.

Materials require for construction of aquarium tank for hobbyist

Maintenance of aquarium:

- **Materials and specifications:**

1. **Hand-Net:** A hand- net is generally required for catching a fish for inspection and for transfer to elsewhere.
2. **Algae Cleaner:** To clear the glass of the aquarium of algae, a fine steel wool held in the hand can serve the purpose.
3. **Siphon pipe:** This is used to siphon water out of the aquarium at the time of exchanging water.
4. **Water-Testing Kit:** Water-testing kit is used to test the nature of the water from time to time, such as pH, dissolved oxygen content, free carbon dioxide, etc.

- **Process of maintenance:**

1. Overcrowding of fishes in the aquarium should be avoided.
2. Overfeeding the fishes in the aquarium should be avoided as the left over will cause pollution. It is better to feed the fishes twice a day.
3. Temperature and pH should be monitored regularly.
4. Wipe down outside surfaces, scrape inside glass and shake debris off plants are done weekly to clean up the aquarium.
5. Siphoning substrate and partial water changing (preferably one third) are need to be done.
6. Water testing and changing and cleaning of the filter media should be done once in a month.



Conditioning and packaging of ornamental fish for transportation

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Introduction

Ornamental fish keeping is the second largest hobby in the world next to photography according to the International statistical data. Aquarium fish trade is a multimillion-dollar industry today. According to FAO (2003a), world trade of ornamental fishes accounts to approximately US $ 498.04 million of which export consists of US $ 277.96 and import US $ 220.08 million.. Aquarium fish keeping is believed to have begun in AD 960 both in China and Rome. People in china used a variety of containers such as dishes, bowls and small tanks which could be viewed from top for the purpose of keeping ornamental fishes. First public aquaria were established in London and in Paris in 19th century. There are more than 120 countries involved in ornamental fish trade. About 1,800 species of fish are traded, of which over 1,200 are of freshwater origin. The guppies and neon tetra alone represent more than 25% of the global market in volume. In export market, Singapore is the top country in trading of ornamental fish (20% share of global market). In India, ornamental fish keeping is nearly 70 years old. The first public aquarium "Taraporewala" located in Mumbai, Maharashtra was established in mid 20^{th} century. By the end of 20th century, ornamental fish keeping had become popular all over India. Indian waters possess a rich diversity of ornamental fish, with over 100 indigenous varieties. The Western Ghats and the North-Eastern region of India are endowed with a variety of brilliantly coloured and high value ornamental fishes. Indian ornamental fish industry is expanding every year in terms of economics, hobbyists, employments etc. According to MPEDA, the Indian export of ornamental fish during 2009-10 was US $ 1.17 million (Rs. 55 million).

Importance of conditioning and packaging of fish

In ornamental fish business, the ability to meet customers' needs for high quality fish is always a critical factor. As most ornamental fish are destined for export, the fish must not only be pleasing to look at but also robust enough to withstand the long journey by any means of transportation. Transportation of live fish from area of collection site to destination or area of farming to destination is an important activity of ornamental fish industry. With the rapid development of ornamental fish industry, transport of ornamental fish by road, water and air from local to national and international stakeholders is on the increase. If the transportation of fish is not planned properly, large mortality may occur resulting in heavy loss. Mortality during the transportation is mainly due to poor conditioning and packaging of fish. The success of ornamental fish

business (particularly exporters) largely depends on effective conditioning, good packaging techniques and careful handling practices prior to and during shipment. Therefore, it is very essential to conditioned a fish and followed by a good packaging practices to minimal the mortality during the transportation.

What is conditioning of fish?

Conditioning of fish refers to holding a fish in aquarium/ cemented tank/ FRP tank for several days prior to transportation from a collection site/ production facility to a destined location. Conditioning includes provision of prophylactic treatments and starvation of fish (not fed). It is during the conditioning processes that fish are graded according to the size and dead/ damaged fishes are removed. Conditioning help fish to acclimatized new environment.

Purpose of conditioning a fish

The main purpose of conditioning is to improve the survival of fish during transport. Prior to packing, prophylactic treatment is given to fish to ensure fish are free from any disease (good health condition) and starvation of fish is done to empty their stomachs and intestines in order to prevent regulations of partially digested food materials during transport. Other advantages of starving the fish include a decreased amount of excreta from fish and reduced metabolic rate, hence minimising pollution of the water during the journey. Starvation is also known to reduce stress response to handling, and this will reduce the mortality of fish during packaging.

How conditioning of fish is done?

a. Removal of dead or damaged fish

Once all the fish are shifted to tank from pond, dead fish, if any, should be removed and disposed off safely. Any damaged or injured fish should also be removed and shifted to quarantine tanks.

b. Grading as per size

Ornamental fish will attract better price if these are of the same size. Hence, fish are graded according to the size. Grading could be done manually or by auto grading systems that uses screens of different mesh sizes.

c. Water exchange

The water of the conditioning tanks is treated with common salt @ 3 gm/litre and about 70% water is exchanged daily. Fish are kept in conditioning tank for 1-2 days. Fish should be visually examined very carefully for any external parasites, or any sign of distress like erratic swimming, clamped-fins, abnormal opercular movement etc. Tank should be provided with aeration and water re-circulation facility.

d. Prophylaxis treatments

To ensure fish are free of pathogens, parasites etc. few days before shipping. The water is treat with potassium permanganate @5 ppm or methylene blue @ 3-5 ppm to fish free from pathogens and 2-3% of salt may added to control parasites. Sometime fish fed with Vitamin C supplementary diet (8-10%) for 1 weeks to reduce the stress and to improve resistance to disease.

Starvation of fish

Starving a fish before transportation has a several reasons such as it voids digestive tract (fish may vomit or defecate in the bag), it slow the metabolic rate of fish (Reduces oxygen requirements and Reduces ammonia and carbon dioxide output).

Generally, a small fish are starved for 12 to 24 hours before transport while for middle sized fish, it is 48 hours and larger fish should be starved for 3 days before shipment. Thereafter, fish should be carefully transferred into transparent polyethylene bag (TPB) with oxygenated water for transport with minimal disturbance.

Figure 1: Conditioning facility (cemented tank, aquaria)

Transport system

There are basically two type of live fish transport systems:

1. Open system comprising open carriers, with or without artificial aeration/ oxygenation/ water circulation
2. Closed system in which fish are packed in sealed polyethylene bags filled with water and over saturated with oxygen.

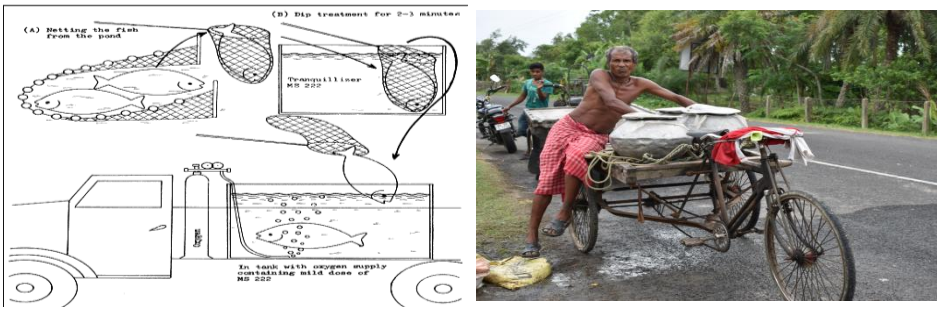

Figure 2: Open system in truck or hundies

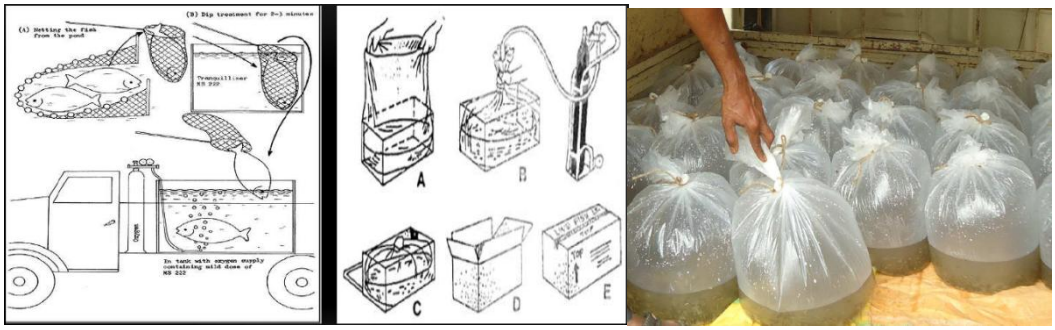

Figure 3: Closed system in sealed polyethylene bag

The transportation of ornamental fish involved the use of oxygen, transparent polythene bags, an insulating box, cello tapes, rubber bands, anaesthesia, styrofoam and water. The fish in the oxygenated transparent polythene bags are then packed in boxes and can be transported as cargo by road, rail or air.

Packaging material

Fish, which is packed in LDPE bags and kept either in corrugated or polystyrene boxes reaches its destination either through road, rail or air or a mix of all. Sometimes these boxes are not kept properly in the warehouse/ cargo of the railway station/airport and also not handled properly. Hence, it is needed that packaging bags and boxes are convenient to handle and don't get damaged during transport. A water leakage from any bag is also a matter of serious concern.

Thickness and shape of packaging bags

Proper thickness of LDPE packaging bags is very important. A LDPE bag of 250 micron thickness is more desirable. Many a times some supplier will select bags of less thickness but it is unsafe. The shape of packaging bag is also important. In domestic market packaging bags that are sealed straight at corners are commonly used whereas in international trade curved sealing is preferred. The use of bags with straight corners is not good for smaller size of fish as these will conglomerate at these corners. Therefore, the corners could be tied with a rubber band.

Size of packaging bags

Size of packaging bags is also very important as the number of fish packed depends on the size of bag. The number of fish that could be packed in a bag is directly proportional to size. In domestic trade, the most commonly used bag sizes are 5” x 12”, 12” x 20” and 18”x 24” whereas in international trade the bags of 3” x 9” to 13” to 26” are used.

Size and material of packaging box

The poly bags are packed in a box for safe handling of fish. The boxes of large sizes are not preferred as poly bags are arranged in a layer only and not stacked one upon other. Secondly, it is difficult to handle large size boxes. In domestic trade corrugated boxes of 3-5 ply are used whereas in international trade boxes of polystyrene are used. The most common sizes of polystyrene boxes used by exporters are 60 (L) cm x 42 (W) cm x 30 (H) cm and 49 (L) cm x 38 (W) cm x 38 (H).

Advantage of poly-styrene boxes

The poly-styrene boxes provide insulation against temperature and also reduce the risk of water leakage from box. The minimum wall thickness of boxes should be 2.5 mm but should be thicker if temperature of the destination country is very low.

Figure 4: Poly bags packed in boxes for safety

Optimization of packaging density

The number of fish that are to be packed in a bag needs to be perfectly calculated. It depends on the size of fish as well as duration of transport. The quantity of water, quality of oxygen and process of packaging are other important factors for consideration.

Determining of stocking density

The stocking density of fish is determined considering many factors such as species tolerance to stress, size of fish, transit time, temperature, health condition of fish, sedatives used. In general practice, about 200 g (25 fishes of 3" length) total biomass of gold fish or 30 g (100 fishes of 1.25" length) of guppies could be packed in one litre of water under standard conditions.

Ratio of water and oxygen

It is to be ensured that there is enough reserve of dissolve oxygen in the bag when it reaches at destination. Fish are packed in plastic bags filled with 1/3 water and 2/3 oxygen. However, it is to be ensured that only pure oxygen is used not air. Secondly, it shall be ensured that all the air is removed from the bag before filling-in with oxygen. Other points to be remembered are that bags should be properly inflated and reasonably

tight but should not be overfilled as during a flight the bags decompresses a bit and expand leading to burst or leak in flight.

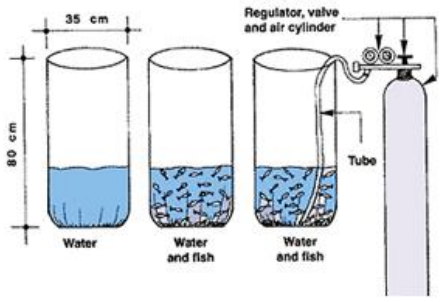

Figure 5: Ratio of fish, water and oxygen

Removal of ammonia

Ammonia is highly toxic to fish in its un-iodised form. It accumulates in packaging bags due to excretion of fish and bacterial action on the excreta. A level of 0.05 ppm could be harmful for the fish. It could be controlled by adding granules/rings of zeolite @15-20 g/litre of water.

Use of tranquilizers/ sedatives

Increased physical activity during transport can adversely affect the health of the fish in several ways. First is physical damage by the abrasion with the packing container, second is by a physiological reaction to a physical activity and other environmental factors such as low dissolved oxygen. Therefore, success of transportation could be further enhanced by adding in tranquilizers/ sedatives in packing bags. The most commonly used sedatives are Eugenol (5 mg/l), Quinaldine (5 mg/l) and MS-222 (20 mg/l). However, it should be ensured that dosages are proper and the use of sedatives is permitted by the importing country.

Benefits of sedating fish are a. decrease the rate of oxygen consumption and reducing the rate of excretion of carbon dioxide, ammonia and other toxic wastes b. controlling the excitability of the fish and thereby reducing chances of injury c. Reduce the time required for handling them.

Process of packaging

Subsequent to preparing of consignment for packaging, a standard set of operating protocols shall be followed to reduce the transport mortalities. It includes preparing the water to be used in packaging, pre-packaging acclimatization and final packaging. The practice of pre-packaging acclimatization is not followed in domestic trade but is better to be followed in case of long distance transportation. However, it is a compulsory component in export trade.

Preparing of water for packaging

Water to be used for packaging shall be prepared in advance. The required quantity of clean water is stored in clean tanks and it is treated with common salt (3 gm/l) and methylene blue (2 mg/l) or acriflavine (7 mg/l). The addition of common salt will aid in osmoregulation whereas methylene blue or acriflavine acts as anti-microbial agent.

Pre-packaging exercise ensures high transportation survival

Once fish are sufficiently starved they can be pre-packed into bags so as to acclimate fish to packing conditions. It allows 'weak' or stressed fish to be identified and removed from consignments prior to shipping. This stage is also important in terms of a final quality check before packing and shipping. Pre-packaging involves oxygen packing of counted numbers of fish in standard poly bags at densities mentioned above. The bags are placed on racks/trolleys in an air-conditioned room at 22-23°C in dark for 4-6 hours in case of tropical fish and at 15-18°C in case of Coldwater fish. The details of species, total number of fish and their average size shall be mentioned with the help of a marker pen on the bags.

Final packaging

A required quantity of pre-treated water is filled up in poly bags as specified above according to the size of bags. It shall be ensured that the temperature of water being filled in bags is same as that of pre-packed bags after acclimatization period. The bag filled up with water is now placed in another bag of same dimensions. Inserting of a news paper in between the two bags provides additional safety against water leakage and also reduces stress to fish due to excess light. Thereafter, fish are transferred to the new bag with the help of a hand net of very soft material. The air inside the bag is expelled and replaced with oxygen. The bag is then sealed by twisting the top of the bag and folded over, with rubber bands or metal clips used to fasten the top of the bag. In domestic trade bags are tied with rubber bands while in international trade tying with metal clips is popular and a fast process. The details of species, total number of fish and average size are again mentioned with the help of a marker pen on the bags.

Packaging of aggressive fish

All aggressive fish like fighter fish and most of the cichlids, or fish with fragile finnage like veil tail angel, pearl gouramis, bubble eye gold fish or costly fish like arowana or discus are packed individually to prevent them from attacking each other or that the fins remain intact on arrival.

Box packing of poly-bags

It shall be ensured that poly-bags stocked with fish are properly kept in boxes meant for transportation. The important points to remember are:

- Bags are kept straight and not stacked upon each other.
- There is not any sharp object inside the box.
- Once all the poly-bags are kept in the box, these are to be covered with a news paper before closing the box.
- In case of a very long duration transport ice packs can be placed in the box but not inside the poly-bags.

Labelling of box for transportation

Labelling of box is very essential during the transportation of ornamental fish. Labelling must be included on each box. Boxes must be marked as 'this end up', 'Live Fish', 'Handle with Care', Customer contact details, etc.

Figure 6: Labelling of boxes

Conclusion

In ornamental fish trading, transport of fish either caught from wild sources or produced at a production facility to different places is important activity. Fish can be transported in a open tanks system or packed in Low Density Polyethylene (LDPE) bags. A wrong decision or practice results in increased cost, heavy mortalities and loss of goodwill of the supplier. A proper planning about conditioning, packaging and transportation system not only maximizes the number of fish to be transported with smaller quantity of water but also ensure bio-security during the transportation process.

Domestic and Export Marketing of Ornamental Fishes

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1. Introduction

Keeping colourful and fancy fishes, known as ornamental fishes, is one of the oldest and popular hobbies dating back to many centuries. The global trade of aquarium fishes has been growing steadily and the entire industry, including accessories and fish feed, is estimated to be worth around US $18-20 billion. Among the 2,500 species which are traded, 30-35 species of freshwater fish dominate the market (Aquaaquaria, 2018). About 120 countries import ornamental fishes and the major importers are European Union, United States and Japan. Singapore is the largest exporter for many years and is regarded as a major trade hub.

India is blessed with diverse climatic conditions suitable for growth, maturation and breeding of many ornamental fishes. India possesses rich resources viz., the lagoons and coral reefs of Lakshadweep and Minicoy islands, Andaman and Nicobar islands, Okha- pin tan, Gulf of Kutch complex, Coast of Kerala, Cape Comorin, Gulf of Mannar and Palk bay are abound with highly attractive and varied species of ornamental fishes. India has recorded at least 150 commercially important ornamental fish species and trade mainly indigenous freshwater species collected from rivers (Madhu et al., 2009). Prominent among the fresh water Indian ornamentals are Loaches, Eels, Barbs, Catfish, and Goby (Ayappan et al, 2006). About 90 percent of ornamental fish is traded from Kolkata port followed by 8 percent from Mumbai and 2 percent from Chennai (Ghosh et al., 2003). The Western Ghats and the North-Eastern Region of India are considered to be two biodiversity ‘hotspot’ areas of the world. However, India’s share in global ornamental fish trade is negligible. The entire supply of Indian ornamental fish is primarily dependent on wild catch (85 per cent) and a few artificially bred varieties (15 per cent) of exotic fish (Mandal *et al.*, 2007). Hence, this

sector offers good opportunity for rural and urban households to augment income. Agribusiness opportunities existed in both collection and marketing of native ornamental fishes (wild catch) as well as rearing of exotic ornamental fish species (captive breeding).

2. Domestic marketing of ornamental fishes

Ornamental fishes marketing is an excellent business opportunity in India since there is strong demand from domestic and export markets. According to Sane (1982a), it was in Bombay in the first or second decade of the last century that aquarium keeping commenced as a hobby on a small scale which led to the formation of societies in Madras and Bombay and especially the Taraporewala aquarium in 1951. He further added that the aquarist society of India had held shows in Bombay while some were held in Madras a little later and as the hobby increased on one side, the number of public aquaria grew through out India. According to Dayal and Kapoor (2001) the domestic market of India is quite promising for tropical ornamental fish with the demand exceeding the supply.

Sekharan (2008) reported that Uttar Dinajpur, Howrah, South 24 Parganas, Nadia and Murshidabad were the major districts concerned with the ornamental fish breeders of West Bengal, viz. while Uttar Dinajpur, Nadia and Howrah were the predominant districts for ornamental fish rearers. Wholesalers were mainly concentrated in Howrah district. De and Ramachandran (2011) found the following domestic marketing channels of ornamental fishes in West Bengal.

Channel I: Breeder-cum-Rearer – Wholesaler in Howrah – Retailer – Consumer

Channel II: Breeder- Rearer – Wholesaler in Howrah – Retailer – Consumer

Channel III: Breeder - Retailer – Consumer

As per them in the domestic market, 50% breeding units were selling fishes to rearing units while 40% to large scale wholesalers. Only 10% breeding units was involved in direct marketing. The marketing system for ornamental fishes in north eastern region is

highly unorganized and no direct export was being done. Only a few traders collect the native ornamental fishes through local collectors and supply them to different exporters based in Kolkata, Howrah, Mumbai, Chennai, Trivandrum and Cochin. The most prevailing marketing channel of ornamental fish marketing was: collectors – unregistered small traders –wholesalers – exporters at various ports. Estimation showed that exporter enjoyed the lion's share of profit (45 per cent), followed by wholesaler (30 per cent), unorganized trader (20 per cent), and a meager share of 5 per cent was realized by the collectors (Mahapatra et al., 2006).

3. Exports of ornamental fishes

Spain, Singapore, Indonesia, Malaysia and Thailand are the major players in the ornamental fish trade globally. India is still a marginal player in the $3.5 billion global trade. India's ornamental fish export touched Rs 9.5 crore last year, an almost 40% increase from a year earlier (ET, 2019).

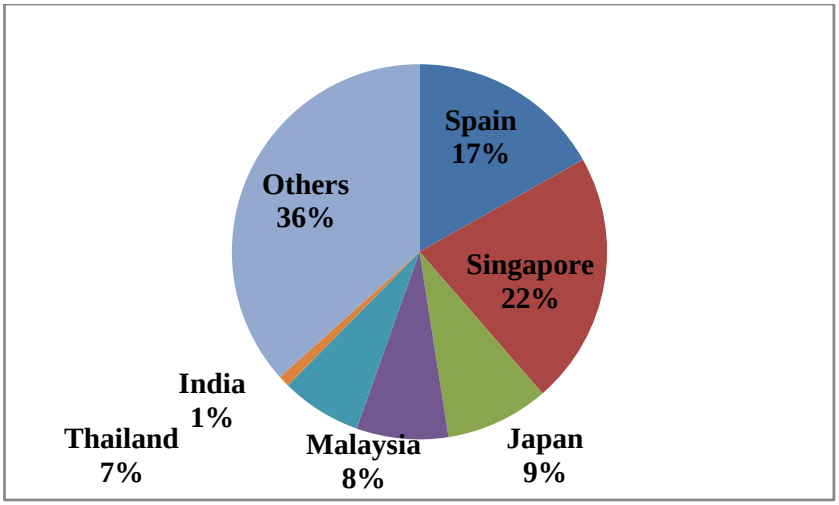

Fig. Major exporters of ornamental fishes in the world (2009)

Table 1: Exports of ornamental fishes from India

	2013-14	2014-15	2015-16	2016-17	2017-18
Quantity in ton	34.44	69.26	39.00	46.00	42.00
US$ Million	0.95	0.93	1.04	1.11	1.32

The major destination for export of ornamental fishes from India during 2018 was China and Bangladesh. Markets for Indian ornamental fish have never been consistent and there has been a regular fluctuation with respect to destinations since the geographical spread of the markets has exhibited an ever changing hue.

Table 2: Major importers of ornamental fishes of India (2018)

Sr. No.	Country	Share in Indian exports (2018)
1.	China	23.81
2.	Bangladesh	23.81
3.	Singapore	14.29
4.	Taiwan	7.14
5.	Thailand	7.14
6.	Qatar	4.26
7.	Germany	4.76
8.	Japan	2.38
9.	USA	4.76
10.	Bahrain	2.38
11.	Jordan	2.38
	Other countries	2.89

China, Bangladesh, Singapore, Taiwan and Thailand were India's favourite top five market destinations during 2018 which jointly accounted for more than 75 percent of total export of ornamental fishes from India.

Table 3: Region-wise exporters as on 30-07-2019

Sl.No.	Office	Manufacturer Exporter (MT)	Merchant Exporter (ME)	Route-through Merchant Exporter (RX)	Ornamental Fish Exporter (OF)	Total
1	RO Kochi	114	91	4	9	218
2	SRO Quilon	20	12	1	0	33
3	RO Vizag	28	22	0	0	50
4	SRO Bhimavaram	32	36	2	0	70
5	RO Chennai	97	141	8	10	256
6	SRO Tuticorin	42	79	0	1	122
7	SRO Goa	12	0	0	0	12
8	SRO	34	18	0	3	55

	Mangalore					
9	RO Mumbai	50	73	10	3	136
10	SRD Ratnagiri	9	0	0	0	9
11	SRO BBSR	23	22	4	0	49
12	RO Kolkata	70	134	18	18	240
13	SRO Guwahati	1	8	0	0	9
14	RO Veraval	74	55	31	0	160
15	SRO Porbandar	29	12	0	0	41
16	TPO New Delhi	1	8	0	1	10
		636	711	78	45	1470

RO: Regional Office; SRO: Sub-Regional Office
Source: MPEDA

Registration of exporters and other entities by MPEDA

Registration of Exporters, Fishing Vessels and other Processing entities is one of the statutory functions of MPEDA. Registration as an exporter is granted under section 9(2) (h) of MPEDA Act 1972 read with rules 40-42 of MPEDA Rules, 1972. The exporters are categorized into four, viz:-

1. **Manufacturer Exporter** – is an owner of an approved processing plant, or an approved fishing vessel having onboard processing facilities, or live fish handling facility, or chilled fish handling facility or dried fish handling facility.
2. **Merchant Exporter** – is an exporter who does not own a processing plant, but utilizes the surplus capacity of an approved processing or handling facility.
3. **Route through Merchant Exporter** – is an Export House or Trading House or Star Trading House or Super Star Trading House, possessing a certificate of approval issued by the DGFT.
4. **Ornamental Fish Exporter** – is an exporter who exports only ornamental fish **but not an exporter of live marine products for human consumption.**

For manufactures-exporters the Field offices concerned, on receipt of applications along with all its enclosures for registration as an exporter as per guidelines, may process the same and complete the checklist. Regional and Sub-regional Offices shall

not register new Merchant Exporters and the application and supporting documents complete in all respects shall be forwarded to Head Office online for further action. Regional/Sub-regional Offices may after duly filling the check lists for verification of application for registration as a Route Through Merchant Exporter issue certificate online to those who holds a certificate of approval issued by the DGFT indicating that the firm is having the status of either an Export House, or a Trading House, or a Star Trading House or a Super Star Trading House.

Major exporters of West Bengal

Following are the major exporters of ornamental fishes of West Bengal.

Table 4: Major exporters of ornamental fishes of West Bengal

Exporter	**Place**	**Exporter**	**Place**
Aqua Adventure	Howrah	J. K. Udyog	Barrackpore
Aquafine Kolkata	Kolkata	East India Aquariums	Dakshin Jagaddal
Bengal Aquatic	Howrah	Modern Pet Centre	Kolkata
L. G. Enterprise	Boinchi	Minit Meals	Dakshin Jagadal
Qute Aqua Pet	Howrah	Umang Exports	Gariahat Road
Rainbow Aquapet	Kolkata	Pescina Indica	Kolkata
Blue Star Aquarium	Howrah	Asian Exports	Kolkata
M/S Malabar Tropicals	Kolkata	Jagannath Fish Aqua International	Howrah
Modern Pet Centre	Kolkata	Qute Aqua Pet	Howrah

Export Competitiveness of Indian ornamental fishes

Rani and her co-workers (2014) estimated the Export Competitiveness Index (XCI) for India in ornamental fish export for the period 1991-2009. They found that India registered highest XCI value of 4.14 during 1994 and a rise in the value of XCI reflects consistent higher growth in ornamental fish exports in world market. The export

competitiveness index for India was around 1 for most of the years, which undoubtedly proves positive export competitiveness for Indian ornamental fish over the years.

Determinants of Indian ornamental fish exports

Study found that the world volume of ornamental fish exports, world price of ornamental fish excluding India and also exchange rates (US$/Rs.) existing during the export were the major factors which determine ornamental fish trade from India during 1991-2009 (Rani et al., 2014). These factors jointly explained 71 percent of the total variation in ornamental fish exports from India. The coefficients for all the variables except exchange rates were statistically significant. Thus exchange rate does not play any significant role in ornamental fish export from India. As world ornamental fish exports increased, Indian ornamental fish exports also increased. This again shows that world trade has significant impact on Indian ornamental fish trade.

Conclusions

The demand for both freshwater and marine ornamental fishes are increasing. Most of the traded marine and inland ornamental fishes are being collected from the wild and so, the development of ornamental hatchery technology and production of young ones to fulfill the increasing demand in the export market is necessary. Jayashankar (1998) noted that ornamental fish trade has emerged as a resource with considerable economic potential and pointed out that apart from improving foreign exchange reserves this trade can generate more job opportunities and self employment.

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জীবিকা নির্বাহে রঙিন মাছের চাষ ও প্রজননের ভূমিকা

শ্রেয়া ভট্টাচার্য্য

মাছকে ঘর সাজানোর উপকরন হিসেবে ব্যবহার বহুকাল যাবত্। চীন ও জাপানে প্রায় ১০০০ বছর ধরে গোল্ড ফিস এবং কৈ কার্প বাহারী মাছ হিসেবে পালন করা হচ্ছে। বিভিন্ন মাছ নানান রঙ ও বৈচিত্রের জন্য বিভিন্ন দেশে সমাদৃত হয়। এই শখ পূরণের জন্য প্রথমের দিকে প্রাকৃতিক জলাশয় থেকে সংগ্রহ করা শুরু হলেও ক্রমবর্দ্ধমান চাহিদা পূরণের জন্য এর প্রজনন ও চাষ শুরু হয়। বর্তমানে মালয়েশিয়া, সিঙ্গাপুর, আমেরিকা, ইজরায়েল, শ্রীলঙ্কা প্রভৃতি দেশে রঙীন মাছের ব্যবসায়িক ভিত্তিক চাষ হচ্ছে। আমাদের দেশে রঙিন মাছ পালনের যথেষ্ট সম্ভাবনা রয়েছে। ভারতবর্ষের মধ্যে রঙিন মাছ পালনে পশ্চিমবঙ্গ অন্য রাজ্য থেকে অনেক এগিয়ে। রঙিন মাছ রপ্তানী ও ব্যবসায় ভিত্তিক পালনে পশ্চিমবঙ্গের স্থান প্রথম। এই রাজ্যে প্রায় ২০ হাজারের বেশী পরিবার রঙিন মাছ পালন বা তার সহযোগী কোন পেশায় যুক্ত জীবিকা নির্বাহের জন্য। প্রযুক্তির যথাযথ প্রয়োগ করে ব্যবসা ভিত্তিক রঙিন মাছ পালনের মাধ্যমে বহু বেকার যুবক-যুবতী স্বনির্ভর হতে পারেন। পছন্দের সৌখীনতার উপর ভিত্তিকরে রঙীন মাছেদের চারিত্রিক বৈশিষ্ঠ্য অনুযায়ী প্রকারভেদ করা যায়, যেমন- সুন্দর রঙ, ডোরা কাটা এবং ফিতের ন্যায় সরু ডোরা, বহুরুপী বা রঙ পরিবর্তনের অভ্যাস, লাফানোর আচরণ, শিকারী অভ্যাস, শান্ত আচরণ, স্বচ্ছ শরীর, ছোট আকৃতি, কষ্টসহনশীল, চোষকের উপস্থিতি ইত্যাদি। বর্তমানে প্রায় ২৮৮ টির অধিক বিদেশী রঙিন মাছ আমাদের দেশে জনপ্রিয়। এর মধ্যে ২৬১ টি মাছ ডিম পাড়া বা অন্ডজ জনন গোষ্ঠীর অন্তরগত এবং ২৭ টি মাছ বাচ্চা পাড়া বা অন্তজ জনন গোষ্ঠীর অন্তরগত। বিদেশী রঙিন মাছের সাথে সাথে আমাদের দেশের বিভিন্ন প্রজাতির মাছও বিদেশের বাজারে ইন্ডিয়ান অর্নামেন্টাল ফিস হিসেবে বেশ জনপ্রিয়তা অর্জন করেছে। বর্তমানে প্রায় ৩০০ টির অধিক দেশীয় রঙিন মাছ দেশে এবং বিদেশে জনপ্রিয়।

রঙিন মাছের চাষ খুবই সহজ হওয়ার জন্য বাড়ির উঠানে বা ছাদে বা ঘরের মধ্যে ছোট ছোট টাব বা, হাঁড়ি বা চৌবাচ্ছায় রঙিন মাছের চাষ করা যায়। বাইরে থেকে মাছের চারা কিনে বাড়িতে তাকে বড় করে বাজারোপযোগী করে বিক্রি করেও জীবিকা নির্বাহ করা যায়। আবার রঙিন মাছের বীজ উত্পাদনের সাথেও যুক্ত আছেন অনেক চাষীভাই। কেবলমাত্র দেশীয় বাজারেই নয় রঙিন মাছ উত্পাদন করে তা বিদেশী বাজারেও চালান করছেন অনেকে। ঘর সামলে মহিলারাও নিজেদের প্রচেষ্টায় ব্যবসা করছেন রঙিন মাছ চাষ করে।

রঙিন মাছের চাষের সাথে সাথে অ্যাকুয়ারিয়াম তৈরি, অ্যাকুয়ারিয়ামের সাজানোর জিনিস যেমন কৃত্তিম গাছ, ফুল, খেলনা ইত্যাদি তৈরি করেও অনেক টাকা উপার্জন করতে পারেন। এছাড়াও অ্যাকুয়ারিয়ামের গাছের চারা তৈরি, ফিল্টার, এয়ারেটর ইত্যাদি প্রয়োজনীয় দ্রব্য অনেকেই তৈরি করেন। শুধুমাত্র ছোট ব্যবসাই নয় তারা বড় বড় শিল্পপ্রতিষ্ঠানেও কাজ করছেন। এমনকি বেশ কিছু মহিলা আছে যারা নিজেরাই বড় বড় শিল্প প্রতিষ্ঠান গড়ে তুলেছে যেখানে অজস্র মহিলারা কাজ করে নিজেদের রুজি রুটি চালাচ্ছে।

মাছের খাবার উত্পাদনেও আরেকটি জীবিকা অর্জনের উপায়। স্বল্প খরচে কিছু পচা খাবার, গরুর গোবর, সবজির খোসা এবং মাটির সাহায্যে ছোট জয়গাতেই কেঁচো উত্পাদন, ব্লাড ওয়ার্ম উত্পাদন করে তা থেকে ভালো উপার্জন সম্ভব। এছাড়া মহিলারা বিভিন্ন সহজলভ্য দ্রব্য যেমন: গমের আটা, চালের কুঁড়ো, ভুট্টার আটা, শুঁটকি মাছ গুঁড়ো, হাঁস মুরগীর নাড়ি ভুঁড়ি, তেল ইত্যাদি সহযোগে কৃত্তিম খাবার প্রস্তুত করে তা বিক্রি করতে পারেন।