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Training Manual

on

Freshwater Ornamental Fish Breeding and Aquascaping Techniques

सत्यमेव जयते

NFDB

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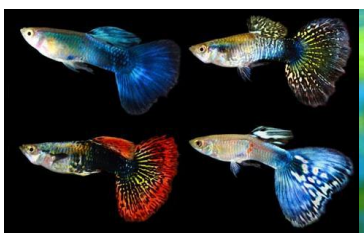

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(25 – 27 February 2019)

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PREFACE

Ornamental fish is an important commercial component of aquaculture. The culture of living jewels in the confined aquatic system is one of the most favourite commercial business and, second largest hobby in the world. Fishes with attractive colour pattern, swimming behavior and more resistant to captivity stress are considered as good candidate species. Among the commercially important ornamental fishes recorded from the country, export trade is mainly dominated by the indigenous fresh water species collected from the wild. The indigenous species like barbs and loaches have a huge potential towards contributing to the economy of the nation. Considering the importance of this sector, there need to develop different varieties by selecting proper breeding techniques which is an area that still remains least explored. Breeding of the ornamental fishes and the protocol and management methods are species specific. For proper management of fishes in closed captive conditions, a well-designed aquarium is required. Arranging the components such as aquatic plants, rocks, stones, or driftwood, in a pleasing manner within an aquarium is called Aquascaping. Aquascaping itself is a flourishing industry and income generation to many.

Colour enhancement of the ornamental species is an area of current attention, which is influenced by several factors, like feed, water quality, and the surrounding environment. Feed plays a major role in the ornamental fish. Feed and feeding management decides the sustainability, profitability, and well-being of an aquaculture system and is essential for the growth, health and reproduction of ornamental fishes. For sustaining the system, health management in the ornamental fish sector is also essential mainly due to the financial investments involved in it. Awareness and knowledge of fish health management is the need of the hour to sustain the industry without major economic loss. Present generations always have a demand for better options that brought value addition in the sector to develop colored varieties which enhances the aesthetic appearance and generates higher income.

This training manual on "Freshwater Ornamental Fish Breeding and Aquascaping Techniques" describes in brief about the important candidate, protocol for an aquarium set up, different breeding techniques, feeding and health management as well as value addition in the freshwater ornamental sector.

Editors

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OVERVIEW OF ORNAMENTAL FISH INDUSTRY

Ornamental fish keeping is a hobby, in which attractive colourful fishes also known as 'live jewels' are kept as pets in confined spaces of an aquarium or a garden pool with the purpose of enjoying their beauty for fun and fancy. In addition to the aesthetic beauty to the home and mind relaxation, ornamental fishes serve self employment to the youth by taking to various job activities such as culture of native varieties of ornamental fishes and their export. Aquarium hobby in India started during the British rule and now it is blooming industry all over the country. Along with the aquarium keeping India exports a large quantity of ornamental fishes and earns foreign money.

The world trade of ornamental fish is estimated to be US$ 6.0 billion. Globally ornamental fish industry, a multibillion industry in global and in 2015 the sector earned USD 304 million, 2/3rd of the export from developing countries. Asian countries account for nearly 60% of the total export trade in ornamental fishes in 2015. The developing countries continue to be the major producer of ornamental fish. USA was the largest importer of ornamental fish accounting for US$ 49.67 million followed by United Kingdom (US$ 24.31 million), Germany (US$ 18.62 million) and Japan (US$ 15.71 million), Singapore (US$ 14.33 million). During 2015, India's import for ornamental fish was US$ 0.34 million, with a ranking of 51, in the world. In 2015, top exporters were Singapore (US$ 45.44 million), Spain (US$ 36.07 million), Japan (US$ 31.08 million), Czech Republic (US$ 20.43 million) and Indonesia (US$ 19.67 million). In the same year, India's export was only US$ 1.02 million, with a ranking of 29th in the world. More than 90 percentages of the ornamental fishes from India exported from a single state West Bengal and traded from Kolkata port followed by 8 percent from Mumbai and 2 percent from Chennai.

About 150 commercially important ornamental fish species recorded from the country but the export trade mainly dominated by indigenous freshwater species collected wild and some captive bred exotics. The indigenous fish groups like Loaches, Eels, Barbs, Catfishes, Gobies, Shrimps, Gouramies, killi fishes, glass fishes and shrimps are the ruling species in the industry. In addition to the fresh water species the brackish water candidates like Scats, Tiger perches and Pearl sports export from India. The wild collection of marine ornamental fishes from, Laccadives and Minicoy on the western side and Andaman and Nicobar Islands on the eastern side and Mannar play a major role in the marine live fish export along with a few amount of captive bred clowns. Various methods are used by the fishers to exploit the fishes from wild but have often received negative publicity in relation to ecosystem damage,

mortality and depletion of stocks. The skilled personals are the important fact of the industry for the species specific and sustainable harvest of the organism. Scuba diving, species specific traps, Lines with small barbless hooks and tubular nets may be used to catch species are the major methods adopt by the industry for the sustainable exploitation. Along with this some fishers adopted the indiscriminate fishing methods like dynamite poison fishing, which devastating the whole ecosystem along with the species.

Intensive and selective catching techniques and dynamite fishing pose major threats to the delicately balanced ecosystem and this is of particular concern in marine ornamental fish trade. Aquariculture, the ornamental fish culture comprises techniques, such as broodstock management and captive breeding and supply the fishes to traders for export, which reduces the excess pressure on the species in the ecosystem. Standardization captive breeding technology is the keystone factor and India accomplished with captive breeding technology of more than 35 indigenous fishes.

Effective extension education and scientific management and quality improvement is required for such practices. MPEDA (Marine Product Export Development Authority of India, under the Ministry Commerce and Industry) has introduced developmental assistance for the promotion of exports of ornamental fishes from the country Under this pilot scheme, exporters would be reimbursed 10% on the FOB value of exports effected, subject to a maximum of RS.2.00 lakh per exporter. Aquariculture is becoming a source of income day by day for the rural people and semi-urban areas. As part of the poverty alleviation and women empowerment the Government of India launched the Swarnjayanti Gram Swarozgar Yojana (SGSY) in 1999 where the major emphasis is on self help group (SHG) formation, social mobilization and economic activation. They bcan also adopt the ornamental fish culture technique through the microcredit for their economic sustainability and income generation.

References

Anon (2015) List of freshwater and brackish water ornamental fishes that are being exported from India, In: *MPEDA Newsletter July 2005*, pp 10-17.

Ghosh A., Mahapatra B.K., Datta N.C., 2003. Ornamental Fish Farming - Successful Small Scale Aqua business in India, *Aquaculture Asia*. 14-16

Jayalal L., and Ramachandran A., 2012. Export trend of Indian ornamental fish industry, Agriculture And Biology Journal Of North America ., 2012, 3(11): 439-451

Ramachandran. A., 2012. Export trend of Indian ornamental fish industry. Agriculture And Biology Journal Of North America. 3(11): 439-451

Rani P., Immanual S. and Kumar N. R., 2014. Ornamental Fish Exports from India Performance, Competitiveness and Determinants, *International Journal of Fisheries and Aquatic Studies*. 1(4) 85-92.

CANDIDATE SPECIES IN INDIAN AQUARIUM TRADE

Ornamental fishes provide aesthetic beauty to home and garden along with the mind relaxation. Fishes with attractive colour pattern, swimming behavior and more resistant to captivity stress considered as good candidate species. In aquariculture farmers chooses the criteria of economic value of the fish and the familiarized breeding technology. The ornamental fishes are known to their brand name and top ten groups in the freshwater aquarium are tetra, guppy, gold fish, catfish, molly, gourami, platy, loach, cichlid and the barbs.

Freshwater ornamental fishes

Barbs

Barbs are cyprinid fish group with small one or two pairs of barbels around their mouth. Roughly 400 species over the world only 150 species of barbs have ornamental value. *Puntigrus tetrazona* (Tiger barb), *Pethia conchonius* (Rosy barb), *Puntius titteye* (cherry barb), clown barb (*Barbodes everetti*), Silver shark (*Balantiocheilos melanopterus),* stripped barb (*Desmopuntius johorensis*), Melon barb (*Haludaria fasciata*) are the most dominant species in Indian trade. *Sahyadria denisonii* commonly known as Miss Kerala, most demanded species, wild caught barb species mainly found in rivers of Kerala and Karnataka.

Puntigrus tetrazona

Pethia conchonius

Puntius titteye

Sahyadria denisonii

Balantiocheilos melanopterus

(Source: *(Image source: https://www.thinkfish.co.uk/#)*

Loaches

Loaches, commonly known as cleaners of aquarium are belonging to the family Cobitidae and Balitoridae known as cleaners of aquarium. There are around 40 species of

loaches known today, belonging to the genus *Botia, Chromobotia, Pangio, Ambastaia*. Zebra Loach (*Botia striata*) Clown Loach (*Chromobotia macracanthus*), Dwarf Chain Loach (*Ambastaia Sidthimunki*) Rainbow Shark (*Epalzeorhynchos frenatum*) and Yoyo loach (*Botia almorhae*) are the most demandable specie in Indian trade.

Botia striata

Chromobotia macracanthus

Ambastaia Sidthimunki

Botia almorhae

(Image source: https://www.thinkfish.co.uk/#)

Danio/ Rasbora

Danios, member of the Cyprinidae family, are knowns as egg scatters. They are found in a variety of habitats from boulder strewn mountain torrents to small pools in dry zone streams with pebbles. There are more than 12 species reported today of which *Danio malabaricu*s (Pearl Danio), *D. albolineata,* Celestial Pearl Danio (*Danio Margaritatus*), Harlequin Rasbora (*Trigonostigma heteromorpha*) Giant Danio (*Danio aequipinnatus*), White Cloud Mountain Minnow (*Tanichthys albonubes*) Axelrods Rasbora (*Sundadanio axelrodi*) and *Brachydanio rerio* (zebra fish) are common in the hobbyist market. *Brachydanio rerio* is mainly found in Kerala and Karnataka

Danio aequipinnatus

Danio Margaritatus

Brachydanio rerio

Sundadanio axelrodi

Trigonostigma heteromorpha

Tanichthys albonubes

(Image source: https://www.thinkfish.co.uk/#)

Gourami

Gourami, are the ornamental fish with acessary repiratory organ known as labyrinth. *Colisa lalia*, the indigenous fishes found in freshwater ponds, streams and paddy fields of northeastern India and Bangladesh. Important varieties group gourami include The Honey Gourami (*C. chuna*), Indian Gourami (*C. fasciata*), Thick-lipped Gourami (*C. labiosa*), three spot gourami (*Trichopodus trichopterus*), Pearl Gourami (*T. leeri*), Snakeskin (*T. pectoralis*), Moonlight Gourami (*T. microlepis*), Chocolate Gourami (*Sphaerichthys osphromenoides*) Kissing Gourami (*Helostoma temmincki*).


Trichopodus pectoralis


Trichopodus


Trichopterus trichopterus


Helostoma temmincki


Colisa lalia


Sphaerichthys osphromenoides

(Image source: https://www.thinkfish.co.uk/#)

Cat fishes

These are beautifully coloured bearded fishes under the order Siluriformes. The common species found in the hobby market are *Corydoras ambiacus, C. agaassizii, C. leucomelas, C. schwartzi, C. punctatus, C. parallelus, C. pulcher* and *C. ornatus.*


Corydoras panda


Chaetostoma sp.


Phractocephalus hemioliopterus


Hexanematichthys seemanni


Pseudoplatystoma fasciatum

(Image source: https://www.thinkfish.co.uk/#)

Spiny eels

Spiny eels or swamp eels are members of the family Mastacembelidae. *Macrognathus aculeatus* (spotted spiny eel), *Mastacembalus tinwini, Mastacembalus armatus*, (zigzag eel) are of much importance as far as the ornamental fish market is concerned.

Macrognathus aculeatus

Mastacembalus tinwini
(Image source; https://www.aquariumglaser.de/fischarchiv/)

Puffer fishes

Puffer fish or balloon fishes comes under the family, Tetraodontidae, distributed in both marine and freshwater. The fresh water puffers include *Carinotetraodon lorteti*, *C. salivator*, *Carinotetraodon travancoricus*, Green Pufferfish (*Tetraodon nigroviridis*), *Chonerhinos amabilis*, *C. nefastus*, *C. modestus*, *C. remotus*, *C. asellus*, *Colomesus asellus*, and *C. psittacus*, are the candidate species of ornamental industry. *Carinotetraodon travancoricus* popularly known as Malabar or dwarf pufferfish is a native of India and is considered as the smallest puffer in the trade.

Colomesus asellus *Carinotetraodon travancoricus* *Colomesus psittacus*
(Image source: https://www.thinkfish.co.uk/#)

Snakehead

The snakehead is the fishes with air breathing organs come under the family Channidae and genus *Channa*. Around 28 species of *Channa* are known today, *C. bleheri, C. burmanica*, *C. gachua*, *C. micropeltes*, *C. lucius*, *C. pardalis* and *C. orientalis*, are well known in the aquarium trade. *C .bleheri* is widely known as the rainbow snakehead because of its body colouration.

Channa bleheri

Channa pardalis

Channa gachua

Channa lucius

(Image source; https://www.aquariumglaser.de/fischarchiv/)

Glass fish

Glassfish, belonging to the family Chandidae or Ambassidae, have transparent body. There are four species commonly referred to as glassfish in the trade: *Chanda ranga*, *C. lala*, *C. nama* and *C. baculis*, *Parambassis siamensis*

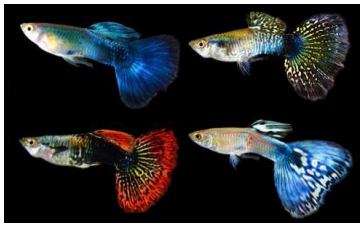
Parambassis siamensis

C. lala,

(Image source; https://www.aquariumglaser.de/fischarchiv/)

Live bearers (Guppy, Molly, platy and sward tail)

Four groups, guppy, molly, platy and sward tails belonging to family Poecillidae, give birth to the young ones known as live bearers in aquarium industry. The guppy (*Poecilia reticulata*), Platy (*Xiphophorus maculates*), Variatus Platy (*X. variatus*) and Swordtail Platy (*X. xiphidium*), Swordtails (*Xiphophorus hellerii*), Black Molly (*Poecilia sphenops*) are the candidate species.


Poecilia sphenops *Poecilia reticulata* *Xiphophorus maculates*



Xiphophorus hellerii *Ameca splendens* *Poecilia wingei*
(Image source: https://www.thinkfish.co.uk/#)

Gold Fish

The gold fish (*Carassius auratus*) common and attractive exotic cyprinid fish in the aquarium trade. Large varieties like lion hear, Oranda, fan tail, Lair tail etc. known in trade. Koi carp (*Cyprinus carpio*), known to the garden ponds which is morphologically common carp.


Carassius auratus *Cyprinus carpio*
(Image source: https://www.thinkfish.co.uk/#)

Oscar

Oscar fish *Astronotus ocellatus* a cichilid fish, have high economic value in international ornamental fish trade. The species also termed as the tigers in the industry, highly carnivore in nature. They are native of Amazone river.

Astronotus ocellatus (tiger)

Astronotus ocellatus (marbled)

(Image source: https://www.thinkfish.co.uk/#)

Fighter

Fighter fish (*Betta splendens*) popular live jewel in the industry belonging to family Osphronemidae. Male are beautiful coloured than female and are aggressive towards other males. Apart from coloration, the finnage also have varieties like veil tail, crown tail, half moon, butterfly, double tail etc. Indian fighter also known as paradise fish (*Macropodus opercularis)* an indigenous variety of ornamental fish distributed in ponds and paddy fields of India.

Betta splendens

Macropodus opercularis

(Image source: https://www.thinkfish.co.uk/#)

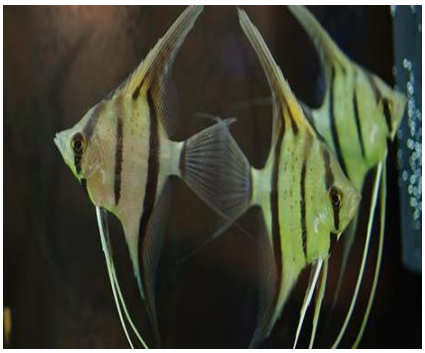
Severum

Severums (*Heros severus* and *Heros efasciatus*) cichlid fish species common in freshwater aquarium trade. There are several different color variations available, including the "Gold," Green, Brown, and "Peruvian Green" strains.

Heros severus
(Image source: https://www.thinkfish.co.uk/#)

Angel Fish

Angel fish (*Pterophyllum scalare*) important fish in freshwater aquarium belonging to the family Cichlidae. About 25 varieties of the species available in Asian trade and are single coloured ones like black, silver and gold and multi coloured pattern ones such as leopard, striped or zebra and lacelike, mottled or marble, half black etc. Black veil tail, diamond, ghost, blushing, golden marble, pearl scale and koi are common in trade. They originate from Amzone river where the water bodies have densely over grown by aquatic plants.



Pterophyllum scalare
(Image source: https://www.thinkfish.co.uk/#)

Discus

Discus (*Symphysodon discus*), member of cichlid group have high value in aquarium trade. The species is native of Amazone river. The species is an example of lepidophagy, in which young ones feed the mucus of parent fish.

Symphysodon discus
(Image source: https://www.thinkfish.co.uk/#)

Tetra

Tetras are the fishes belonging to family Characidae. There are ten varieties of tetras known, which Neon tetras (*Paracheirodon innesi*) are, Cardinal tetra (*Paracheirodon axelrodi*), Black neon (*Hyphessobrycon herbertaxelrodi*), Black tetra (*Gymnocorymbus ternetzi*), Bleeding heart tetra (*Hypessobrycon erythrostigma*), Blood fin (*Aphyocharax anisitsi*), glow light tetra (*Cheirodon erythrozonus*), Head and tail light tetra (*Hemigrammus ocellifer*),

Lemon tetra (*Hyphessobrycon pulchripinnis*), Serpae tetra (*Hyphessobrycon callistus*). They are peaceful and pose no threat to any other fish in the aquarium and are ideal for a community aquarium with other fish of similar disposition. Cardinal Tetra (*Paracheirodon axelrodi*) Golden Pencilfish (*Nannostomus beckfordi*) Blue Tetra (*Boehlkea fredcochui*)Neon Tetra (*Paracheirodon innesi*)

Paracheirodon axelrodi

Nannostomus beckfordi

Boehlkea fredcoch

Paracheirodon innesi

(Image source: https://www.thinkfish.co.uk/#)

References

http://mpeda.gov.in/MPEDA/

https://www.aquariumglaser.de/fischarchiv/

https://www.thinkfish.co.uk/#

BREEDING OF FRESHWATER ORNAMENTAL FISHES

Breeding protocol and management methods are different for different fishes. The fishes can be broadly classified into two based on the mode of reproduction as egg layers and live bearers.

A. Breeding of Egg-Layers

The majority of aquarium fish are egg-layers with external fertilization. Egg-layers can be divided into four groups: egg-scatterers, egg-depositors, egg-burriers, and nest-builders.

1. Egg-scatterers

a. Laying Non-adhesive Eggs:

Zebra fish or zebra danio is considered as egg-scatterer that lays non- adhesive eggs. Other important varieties of danios include giant danio (*Danio aequipinnatus*), pearl danio (Brachidanio albalineatus) and zebra danio (*Brachidanio rerio*). Before setting up the breeding pair in any aquarium tank, the broods are to be well fed with live-food. The male and female ratio should be maintained at 2:1 or 3 : 1. The female is introduced into the breeding tank one day earlier than males. It is very difficult to know whether female has already laid eggs or not, because of smaller size of eggs, and they remain hidden behind pebbles. After successful hatching of eggs, hatchlings are seen in the aquarium tanks, and at that time their parents are removed. Hatchlings take two days to absorb yellow yolk sac. After that, they are fed with infusorians for 4 days. Subsequenty, rotifers and smaller zooplanktons can be fed for a week, after which they are provided with powdered formulated feed.

b. Laying Adhesive Eggs

Gold fish (*Carassius auratus*) is an example of egg- scatterer laying adhesive eggs. The varieties seen in the market are gold fish, fringe tail, lion head, oranda, comet, shubunkin, telescopic eye, veil tail and red cap. When secondary sexual characters appears male and female gold fishes are selected and kept in circular tanks or ferrocement tanks after disinfecting containers with 1 ppm solution of potassium permanganate ($KMnO_4$). The water should be mixed preferably with 50% groundwater and 50% filtered pond water. The containers should be kept in such a place where it can receive early morning sunshine, and no sunlight afterwards. Since gold fish eggs are sticky in nature, they require some surface for adherence such as submerged aquatic plants like *hydrilla* or artificial nets like spilt nylon

ropes and food grade polythene strips etc. The nest should float close to Water surface, and additional nests should be spread on the bottom of the spawning tanks for the eggs that sink instead of adhering. The water temperature should be maintained between 20 and 28^0 C, and the ideal temperature is 24-28^0C. Female and Male in the ratio of 1 : 2 are released into the breeding tank in the late evening hour. The male chases female, presses its operculum against female's abdomen and fertilizes eggs while swimming besides her. Egg-laying usually takes place within 6-12 hr of releasing males and females. The moment spawning is over nest is transferred to a different container or alternatively parent fishes are transferred from the breeding tank. If this is not done, the parents are most likely to eat away eggs to compensate post-spawning loss of energy. Generally female lays about 2000-3000 eggs. Healthy eggs are golden transparent at the beginning and gradually transparent area decreases. Under ideal conditions within three days, eggs hatch out with a hatching rate of 80-90%.

2. Egg-depositors

Angel fish (*Pterophyllum Scalare*) one of the egg-depositers, has originated from Amazon region of South America. The ideal water quality pH remains between 6.5 and 6.9, and successful breeding occurs at pH 6.8. The water should be soft with an alkalinity of 50-100 $CaCO_3$ mg/litre.

In mature fish, breeding can he stimulated by a partial change in water and a rise in temperature between 26 and 28°C. One sure sign that spawning is about to occur is the appearance of the genital papillae, nipple-like projections called ovipositors or egg-placers in both males and females. The female's ovipositor is larger and blunt than the male's, which is slender and pointed. These protuberances, which appear at the vent, are used respectively for depositing eggs and fertilizing them. The differences in genital papillae are the first reliable indication of the sex. The pair selects a spawning site and thoroughly cleans it about two three days before actual spawning. Female fish lays egg in the cleaned spawning site. The male then moves over the string of eggs just laid and fertilizes them.

Male and female angel fishes take turns making passes over spawning site until several hundred or more eggs have been laid, depending on the size and condition of the female prior to spawning. Generally a healthy angel lays maximum of 500 eggs at a time; rarely an angel lays more than 700 eggs. The parents hover closely over spawn and fan continuously with their pectoral fins to create a circulation of water over and around eggs.

Some unfertilized eggs turn white in a matter of hours and are removed by parents. It has been observed that male guard eggs and continuously fans eggs till hatching.

3. Egg-buriers

Killifishes are egg burriers. *Aplochelius panchax*, *A. lineatus* and *A. blochii* are important killifishes. They are shade sensitive fishes. Their egg laying is naturally in a soft peat at the bottom of the tank. In drought conditions, parents may die but fertilized eggs remain dormant until next rains. A tank of 10 to 20 litres is used with fresh de-chlorinated water and a sponge filter. The fishes are kept in the tank with spawning mops to receive eggs. After ten days adult fishes are removed and eggs are left to hatch. Fry can be raised in the tank until they attain stockable size. They accept brine shrimp nauplii and infusorians with addition of finely crumbled protein rich supplementary diets, when they get little bigger. In a well-planted aquarium, they lay eggs in leafy environment.

4. Nest-builders

Among nest-builders gouramis and their relatives are most popular. The species under this group are dwarf gourami (*Colisa lalia*), banded gourami (*C. fasciata*), pearl gourami (*Trichogaster leeri*) and siamese fighter fish (*Betta splendens*) and the Chinese paradise fish (*Macropodus Opercularis*). For breeding purposes, males and females are kept separately in different tanks for a few weeks with all kinds of prepared feed and also live-foods. When the abdomen of the female becomes grossly distended with eggs, it is transferred to a smaller breeding tank with water level of 12.7 cm -15.2 cm at a temperature of 28-30^{0}C. The tank should contain plenty of fine-leaved plants such as Cabomba or Myriophyllum and some of the floating weeds like Eichhornia or Pistia. The required ideal hardness and pH of water is at 100-200 ppm and 7.0-7.5 respectively. After one or two days, a good male is introduced in the breeding tank. A transparent perforated plastic sheet or a glass is placed over the tank to keep humidity and temperature at high level which helps maintain bubble nest in a good condition. The male soon begins building a bubble nest. During and after making the nest, the male displays it to female, and this usually ends with both fishes embracing near nest resulting deposition of a large numbers of eggs in the nest. After breeding, female is removed. The male guards eggs, which remain attached to floating bubble nest. Hatching takes place within 24-30 hours. The moment, the fry begin leaving nest, male is also removed from the tank.

B. Breeding of Live Bearers

Livebearers are fish that bear live young ones. The important live bearers are guppy, molly, swordtail and platy. Usually live bearers mature between 4 and 6 months. However, guppy and platy may mature even within two months. Male and female can be easily distinguished. Males are small and attractive with bright colour, whereas female are larger and dull coloured. Mature females possess bulged belly and males possess gonopodium which is a tube like modification of anal fin.

In live bearing fish, the eggs are situated in the egg duct where they are fertilized. The female is fertilized by the nearest touch of the gonopodium on her vent. Male inserts its gonopodium with milt into female fish and eggs are fertilized inside mother's body. Gestation period is 20-35 days. Gravid females need to be removed from community tank as soon as they start swelling with developing young ones and are placed in the breeding tank (30 x 20 x 20 cm), individually or in pairs. Tank should be provided with plants like *cobomba* or *hydrilla*. Once the female has given birth to the full brood she can be removed. After 2-3 days the female again becomes pregnant even without the contact of male. The sperm transferred during first mating is stored in the female body and when eggs are formed the sperm will join with eggs and form young ones. Thus by single mating young ones can be released 8-10 times. In a year it is possible to get young ones 10 times from one female.

References

Angelfish Varieties - Actwin.com. (n.d.). Retrieved from http://fins.actwin.com/fish/species/angelfish.html

Breeding Egg Layers - Celkau.in. (n.d.). Retrieved from http://www.celkau.in/Fisheries/CultureFisheries/Ornamental%20Fishes/breeding.asp

Breeding Methods For Tropical Freshwater Fish. (n.d.). Retrieved from https://fish.mongabay.com/breeding.html

Egg Buriers Of Ornamental Fish — Vikaspedia. (n.d.). Retrieved from http://vikaspedia.in/agriculture/fisheries/fish-production/culture-fisheries/orn

ICAR, 2011. Handbook of Fisheries and Aquaculture.

Livebearers Of Ornamental Fishes — Vikaspedia. (n.d.). Retrieved from http://vikaspedia.in/agriculture/fisheries/fish-production/culture-fisheries/orn

Russian Federation : The construction of the second mega-farm will begin in 2018 in the village of Oktyabrskoye, the Pronsky District of the Ryazan Region. (2018). MENA Report.

Thomas, P.C., 2003. *Breeding and seed production of fin fish and shell fish*. Daya Books.

FABRICATION OF AQUARIUM TANK

An aquarium is a closed container which displays the aquatic organism in a simulated natural environment. Making an aquarium tank is not a difficult task. The most popular aquaria are the all glass tanks bonded by silicon sealant. In this type of tank, frames are not needed and are easy to make.

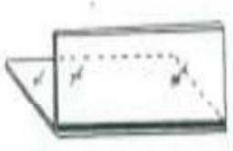
Materials Required:

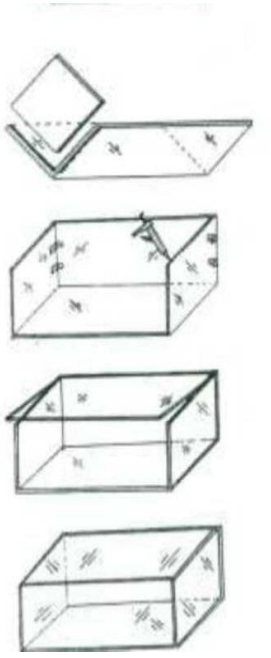
The materials required for making an all glass aquarium are as follows:

1 Glass panes
2 Silicon rubber and squeezing gun
3 Polythene tapes
4 Adhesive tapes
5 Sharp knife or a blade
6 Glass cutter
7 Scale
8 Carborandum stone

Aquarium making

- Decide the size of the aquarium tank and thickness of the glass panel. The thickness of glass depends upon the depth of the tank. Normally, for 30 cm deep water column 5 mm thick glass panes are used.
- Cut the glass pane into required sizes accurately, using a scale and glass cutter.
- Select an even and plain surface for making the aquarium.
- Spread a polythene or old newspaper sheet on the surface of the selected place.
- Place the bottom glass on the plane surface.
- Apply a thick string of silicon rubber sealant along the edges of the back surface.
- First, raise the back panel and squeeze out the sealant with the help of silicon gun along the edges carefully.
- Next, apply the sealant similarly on the edges of the bottom and back glass panes.





- Place the side glass on the laid silicon and carefully join the back panel glass with side glass.
- Follow the same process for other side glass.
- Apply the sealant at all edges of glass panes from outside.
- Place the front glass panel and join carefully from the bottom and side glass panel.
- Tape all the corners from outside to give extra support during setting.
- Smoothen the sealant at the inside joints sealant with the finger.
- Leave the sealant to get hardened at least for a day.
- When the tank gets set, remove the extra sealant, if any, with a sharp knife or a blade.
- Check the aquarium for any leak.

A cover for the tank is essential to prevent falling of dust, escap holding the electrical fittings. It can be made of wood or galvanized iron or aluminium sheets in different shape. The inside of cover should always be painted white or coated with aluminium foil to facilitate better light reflection. The top of the cover can accordingly be painted with some colour, matching with the room where the aquarium is to be placed.

PRECAUTIONS:-

1) Don't move the aquarium tank unless it is properly set.
2) Select glass panes of the appropriate gauge according to the size specifications of the aquarium.
3) The measurement of the base pane must conform well to the dimensions of the aquarium.
4) The sealant must be laid in a continuous string, making a bubble-free bond. If the bond is not bubble-free, leak may occur.

AQUASCAPING

A. Introduction:

Aquascaping is the craft of arranging aquatic plants, as well as rocks, stones, cave work, or driftwood, in an aesthetically pleasing manner within an aquarium in effect, gardening under water. Aquascape designs include a number of distinct styles, including the garden-like Dutch style and the Japanese-inspired nature style. Typically, an Aquascape houses fish as well as plants, although it is possible to create an aquascape with plants only, or with rockwork or other hardscape (rocks and wood) and no plants.

Although the primary aim of aquascaping is to create an artful underwater landscape, the technical aspects of aquatic plant maintenance must also be taken into consideration. Many factors must be balanced in the closed system of an aquarium tank to ensure the success of an aquascape such as filtration, fertilization, lighting, and algae control etc.

B. Principles

1. Plant all groups in odd numbers.
2. Fine leaved plants look best in the mid to back center of a tank, with heavier leaved plants toward the edges.
3. Don't use red in the middle as they have a heavy, dark, feel.
4. Dark leaves (red or dark green) look best toward back edges, with light colored leaves toward the center.
5. Arrange plants and hardscape to provide good contrast of light and dark areas
6. Light colored sand provides good contrast to plants.
7. When rocks are used, use multiple sizes, mixing large and small rocks, as in nature.
8. Rock edges should generally be rounded.
9. Aquascapes with unplanted sand in front is a good alternative to the traditional "Nature Aquarium" style of all foreground covered with foreground plants.
10. An attractive layout alternative is a slope up from near the middle up to the two back corners.

C. Design and styles

1. Dutch Style:

The Dutch style aquascaping utilises multiple plants with different leaf colours, sizes, and textures. This style was developed in 1930s in Netherlands, as freshwater aquarium

equipment became commercially available. More than 80% of the aquarium floor is covered with plants, and little or no substrate is left visible.

2. Japanese Style:

A contrasting approach is the nature aquarium or Japanese style, introduced in 1990s by Takashi Amano. This style draws particularly from the Japanese aesthetic concepts of Wabi-sabi, which focuses on transience and minimalism as sources of beauty. Plants with small leaves like, small aquatic ferns, and java moss are often used to emulate grass or moss. Colours are more limited than in the Dutch style, and the hardscape is not completely covered. Fish or freshwater shrimp are usually selected to complement the plants and control algae.

3. Iwagumi style:

The Iwagumi term in Japanese means "rock formation" and refers to a layout where stones play a leading role. Aquarium with gray stones arranged to form a tall pointed structure at the

right, and a similar but smaller structure at the left. The stone peaks and the foreground are largely but not entirely covered by a short layer of fine textured green plants.

4. Jungle Style:

Some hobbyists also refer to a jungle (or wild jungle) style, separate from either the Dutch or nature styles, or incorporating some of the features of them both. The plants are left to assume a natural, untrimmed look. Unlike nature style, the jungle style does not follow clean lines, or employ fine textures. A jungle canopy effect can be obtained using combinations of darker substrates, tall plants growing up to the surface, and floating plants that block light, offering a dappled lighting effect.

5. Biotopes Style:

The styles above often combine plant and animal species based on the desired visual impact, without regard to geographic origin. Biotope aquascapes are designed instead to replicate exactly a particular aquatic habitat at a particular geographic location, and not necessarily to provide a gardenlike display. Plants and fish need not be present at all, but if they are, they

must match what would be found in nature in the habitat being represented, as must any gravel and hardscape, and even the chemical composition of the water. By including only those organisms that naturally exist together, biotopes can be used to study ecological interactions in a relatively natural setting.

6. Paludarium Style:

Paludarium is an aquarium that combines water and land inside the same environment. These designs can represent habitats including tropical rainforests, jungles, riverbanks, bogs, or even the beach. In a paludarium, part of the aquarium is underwater, and part is above water. Substrate is built up so that some land regions are raised above the waterline, and the tank is only partially filled with water. Unlike other aquarium setups, paludariums are particularly well-suited to keep amphibians.

IV) Techniques of Aquascape:

- In addition to design, freshwater aquascaping also requires specific methods to maintain healthy plants underwater. Plants are often trimmed to obtain the desired shape, and they can be positioned by tying them in place inconspicuously with thread.

- Use aquarium-safe fertilizers, commonly in liquid or tablet form, to help the plants fill out more rapidly.
- It is also necessary to support photosynthesis, by providing light and carbon dioxide.
- Use of animals that consume algae, such as some fish, shrimp, or snails, to clean the algae that collect on the leaves and tank.

References

Amano, Takashi (2009), How to improve your Iwagumi layout, The Aquatic Gardener, vol. 22, number 1, pp. 37–41.

Axelrod, Herbert R., Warren E. Burgess, Neal Pronek, Glen S. Axelrod and David E. Boruchowitz (1998), Aquarium Fishes of the World, Neptune City, N.J.: T.F.H. Publications, p. 718, ISBN 0-7938-0493-0.

https://en.wikipedia.org/wiki/Aquascaping

https://www.youtube.com/watch?v=3zc21uY82FU

Aquascaping Principles And Technique - The Planted Tank. (n.d.). Retrieved from https://www.plantedtank.net/articles/Aquascaping-Principles-and-Technique/27/

FEED AND FEEDING MANAGEMENT FOR FRESHWATER ORNAMENTAL FISHES

Feed is essential for the growth, health and reproduction of fishes. Feed plays a major role in ornamental fish culture which constitutes around 60 to 70% of the recurring cost. Feed and feeding management decides the sustainability, profitability and well-being of an aquaculture system. Further, the feed should be nutritionally balanced, highly digestible and economical for the species cultured. The feed should be fed in such a way to minimize waste, optimize growth, allow for efficient conversion, minimize stress and maintain the fish health.

Nutritional requirement of fishes varies with the species cultured, size, growth stage and feeding habit. Most of the ornamental fish feeds are costly due to its importation from other countries. In this context, it is the need of the hour to formulate low cost ornamental fish feeds. Besides, knowledge on nutritional requirements, feeding behaviour and feeding habits of different species are essential to formulate farm made feeds using locally available good quality feed ingredients.

1) Nutritional requirement of ornamental fishes

The most important components of feed include protein, carbohydrate, lipid, vitamin and minerals. Protein is essential to provide energy and to build up muscle cells and tissues. Lipids and carbohydrates provide energy and also needed for normal growth and development. Likewise, vitamins and minerals are the essential trace elements that regulate the fish health, besides building up and strengthening the skeleton system. In addition, pigments (carotenoids) and probiotics are needed for colour enhancement and disease resistance, respectively.

Knowledge on feed and feeding habit is essential to fulfil the nutritional requirements of different ornamental fish species. Higher amount of protein and lipid is needed for carnivorous fish than omnivorous and herbivorous fish species. Besides, marine fish require more protein and lipid than freshwater fish. Likewise, feed of the fish feeding at the surface will be different from the fish living at the bottom. Generally, ornamental fish require 30-45 % protein, 4-8 % lipid and 30-50 % carbohydrate in their regular diet but it varies with respect to different developmental stages. Accordingly, protein requirements vary with feeding behaviour of different ornamental fish species and can be supplied through various sources of feed ingredients.

Major nutrient requirement of ornamental fishes

Type of major nutrients	Percentage requirement during various developmental stages		Nutrient source
	Earlier/ young	Adult/ broodstock	
Protein	40-45	30-40	Fish meal, shrimp meal, clam meat, squid meal, soybean meal, mustard meal, groundnut meal, wheat or maize gluten
Lipid	4-6	6-8	Fish oil, vegetable oil such as sunflower, linseed, etc.
Carbohydrate	40-45	40-45	Corn flour, rice bran, wheat bran
Vitamin & Mineral	1-2	1-2	Synthetic form

Apart from the major nutrients, live feed should also be provided to the adult or broodstock for better reproductive performance. Likewise, binders such as starch, agar, gelatine, etc. and preservatives such as antimicrobials and antioxidants can also be added to improve the quality and shelf life of feed. The pigmentation pattern and intensity of body colours determine the commercial value of an ornamental fish and hence carotenoids play an important role in the diet of ornamental fishes. In general, commercially available feeds are fortified with carotenoids and in case of farm made feeds; it should be essentially supplemented to enhance the colour of fishes while rearing under indoor culture systems.

2) Fish feed ingredients

Careful selection of feed ingredients is an integral part of feed formulation. The locally available feed ingredient should be cost effective and have the capacity of fulfilling the nutritional requirements of the target species with respect to nutritive value, digestibility and nutrient availability. For example, animal protein sources such as fish meal, squid meal, shrimp meal, etc. can fulfil the protein requirement of carnivorous fish species. Plant protein sources such as soybean meal, mustard meal, groundnut meal, etc. can be utilised for herbivorous and omnivorous species. Also corn flour, wheat flour and rice bran would serve as both energy source as well as binding agent.

On the other hand, commercially available readymade feed can also be purchased from the market if it is not possible to prepare the feed at farm level. Certain facts need to be considered before procuring the commercially available feed such as the quality and cost of feed, nutrient content, feed ingredients used, appropriate size and water stability of the feed.

Locally available feed ingredients

Commercially available feed pellets

3) Types of feed

There are mainly two types of feeds used for ornamental fishes depending upon its moisture content such as

(i). Dry feeds and

(ii). Non-dry (moist/ wet) feeds.

(i). Dry feeds:

The moisture content of dry feed varies between 6-10 %. The different forms of dry feeds are

a) ***Mash meal:*** It is a simple mixture of finely powdered dry ingredients which can be fed for young fish larvae such as fry.

b) ***Pellets:*** The dry feed which is made into a defined shape by mechanical means is termed as pellets which can be made by using hand operated or electric pelletizer or at feed mill.

Preparation of mash meal

Preparation of pellet feed

(ii). Non-dry feeds:

There are two types of non-dry feeds such as

a) ***Moist feeds:*** The moisture content of moist feeds varies between 18 to 40 %.

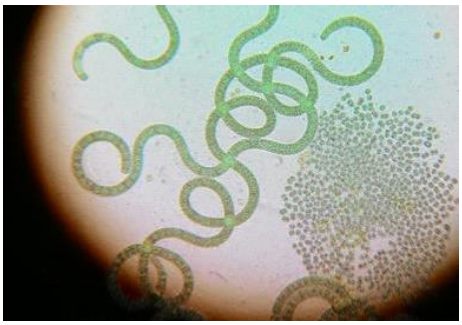
b) ***Wet or paste feeds:*** The wet feeds are made from wet feed ingredients such as trash fish, shrimps, beef heart, etc. or live feed with 45-70 % moisture. The wet

feeds are mainly used for feeding the young ones, carnivorous fishes and brooders.

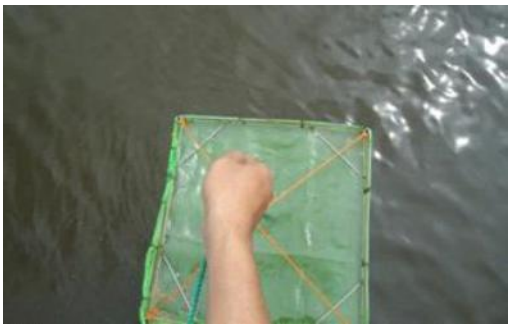
Apart from these feeds, live feeds play a major role in nutrition of ornamental fishes. Live feeds contain all the essential nutrients which enhance the growth, survival and breeding efficiency of the fish along with pigments for colour development. Various types of live feeds include infusoria (protozoans), copepods, cladocerans, rotifers, artemia nauplii, tubifex, chironomid larvae, earthworm, etc. Different fish species prefer different type of live feeds at various stages according to the size of the live feed organism as well the mouth size of the fish.

4) Feeding method, rate and frequency

The use of supplementary feeding is essential to obtain high production and good profit. On the other hand, overfeeding increases the cost of production and also deteriorates the water quality. Hence the feed should be provided by following proper feeding method, feeding rate and frequency. Proper feeding method ensures sufficient amount of feed to the entire stock of fishes. Different types of feeding methods include hand feeding, tray feeding and demand feeding. Hand and tray feeding methods are suitable to feed all the fishes in small sized ponds or tanks and also provides information regarding the amount of feed consumed in order to adjust the feed ration. On the other hand, automatic demand feeders are useful to feed the fish in larger culture systems without much wastage.



Live feed



Check tray

To avoid over or under feeding, it is very important to follow the correct feeding rate at appropriate time of the day. Feeding rate, time and frequency depends on the stage and body weight of fish and also depends upon the optimum environmental conditions like temperature, dissolved oxygen, etc. It is essential to estimate correct biomass of fish for calculating the feeding rate. Fish grows faster during initial days and need to be fed at

frequent intervals to support their metabolic activity and overall growth. Generally, feeding can be done at the rate of 5-10 % body weight per day during early stages up to fry stage and 2-5 % body weight per day during fingerling to grow out stage. The feeding frequency should be 3-4 times a day during initial stages and twice a day during grow out or brooder stage. Accordingly, feed should be provided at the time when fish can consume it and stay stress free during digestion process. It is advisable to feed the fish after sunrise at fixed time daily and avoid feeding during late evening or night hours.

5) Storage of fish feed

Proper storage method is very much essential to maintain the nutritional quality of fish feed. Feed has to be stored properly under hygienic conditions in order to avoid any kind of infestation and spoilage. Dry feeds can be stored at room temperature in a moisture free environment for a longer period of time. The moist feeds are highly vulnerable to infestations due to their high moisture content if not stored properly at low temperature. Therefore, the wet feeds need to be utilised fresh or within the shortest possible time after preparation to prevent spoilage. The moist feed should be stored under refrigeration only for a short period.

Storage of dry feed

6) References

Anonymous, 2009. Fish Feed Management. *In:* Good Aquaculture Practices Series 1. Aquaculture Fisheries Division. Agriculture, Fisheries and Conservation Department, Hong Kong. Pp. 32.

Kaur, V.I., 2016. Feeds and Feed management for Ornamental Fish Production. *In:* Best Management Practices for Freshwater Ornamental Fish Production. National Fisheries Development Board, Hyderabad. Pp. 75-92.

Mohanta, K.N. and Subramanian, S., 2011. Nutrition of Common Freshwater Ornamental Fishes. Technical Bulletin No: 27, ICAR Research Complex for Goa (Indian Council of Agricultural Research), Old Goa - 403 402, Goa, India. Pp. 55.

Sivaramakrishnan, T., Saravanan, K., Anuraj, A., Kiruba Sankar, R. and Dam Roy, S., 2015. Feed Management Practices in Freshwater Carp Culture. ICAR-Central Island Agricultural Research Institute, Port Blair. Pp. 33.

Syamala, K., Khandagale, P. A. and Dias, J., 2014. Feed Management in Cage Culture. *In:* Training manual on Cage Culture of Marine Finfish and Shellfish in Open Sea. Central Marine Fisheries Research Institute, Kochi, Pp. 35-43.

COMMON DISEASES OF FRESHWATER ORNAMENTAL FISHES AND ITS MANAGEMENT

Health management of aquarium fish is gaining more importance in ornamental fish sector due to the financial investments involved in it. Awareness and knowledge on fish health management is the need of the hour to sustain the industry without major economic loss. Diseases are associated with the complex interactions of host, pathogen and environment. Further, the diseases are categorized into two major types such as infectious and non-infectious diseases. Infectious diseases spread from one animal to another and caused by any of the pathogenic organisms such as virus, bacteria, fungi and parasites. Non-infectious diseases are confined to a particular individual animal and may be caused due to environmental stress and nutritional factors.

(I). INFECTIOUS DISEASES

1) Viral diseases

S. No.	Name of the disease	Cause	Clinical signs	Treatment
1.	Koi Herpes Virus Disease (KHVD)	Koi Herpes Virus	• Gill infection with red and white patches. • Sunken eyes. • Pale patches or blisters on the skin.	• No effective treatment is available for viral diseases except few vaccines. • Follow the better management practices. • Separate the affected fish. • Avoid unnecessary stress. • Maintain good water quality. • Provide good quality feed.
2.	Lymphocystis disease	Iridovirus	• Cauliflower like nodular white swellings on body surface and fins.	
3.	Spring Viraemia of Carp Virus (SVCV)	Rhabdovirus	• Haemorrhages in the skin and gills. • Dark skin. • Swollen belly. • Exophthalmia. • Protrusion and inflammation of the vent.	
4.	Herpesvirus disease or Carp pox	Herpesvirus	• Ulcerated lesions. • Presence of plaques on the skin surface.	

2) Bacterial diseases

S. No.	Name of the disease	Cause	Clinical signs	Treatment
1.	Ulcer or Aeromoniasis	*Aeromonas* sp.	• Skin lesion with blood. • Shallow open sores. • Eroded fins and mouth.	• Disinfection of pond with $KMnO_4$ @ 5mg/l.
2.	Fin and tail rot	*Aeromonas* sp. and *Pseudomonas* sp.	• Whitish margin of fins. • Putrefaction of fins. • Reddened areas at base of fins.	• Fish feed mixed with antibiotics terramycin @ 100 mg/ kg or sulphadiazine @ 100 mg/ kg.
3.	Columnaris disease	*Flavobacterium columnare*	• Grayish patches over head and dorsal surface. • Grayish discolouration in outer margin of fins.	• Dip treatment in 500 ppm KMnO4 for 2 min.
4.	Mycobacteriosis	*Myobacterium fortuitum*	• Anorexia • Emaciation • Loss of equilibrium • Exophthalmia • Dropsy • Grey-white nodules on internal organs	• Bath treatment with antibiotics such as • Oxytetracycline @ 50 mg/ l for 15 minutes. • Nifurpirinol @ 66 mg/ l for 15 minutes.
5.	Dropsy	*Aeromonas hydrophila*	• Distended abdomen. • Scale protrusion. • Mild ulceration.	• Dip in 5 mg/l $KMnO_4$ for 2 min. • Disinfection of pond with $KMnO_4$ @ 1mg/l.
6.	Bacterial gill disease	*Myxobacteria* sp.	• Necrotic gill tissues. • Fusion of gill filaments.	• Bath treatment of fishes with alkyl benzalkonium chloride @ 2 mg/l for 1 hour.

3) Fungal diseases

S. No.	Name of the disease	Cause	Clinical signs	Treatment
1.	Cotton wool disease or Saprolegniasis	*Saprolegnia parasitica*	• Cotton wool like outgrowth over injury site and haemorrhage.	• Bath treatment in NaCl @ 3-4%. • KMnO4 bath treatment @ 160 mg/l for 5 days. • Long term bath in 3 ppm methylene blue.
2.	Gill rot	*Branchiomyces demigrans* and *Branchiomyces sanguinis*	• Gill necrosis. • Discolouration & disintegration of gill tissues.	• Bath treatment in NaCl @ 3-4% for 5-10 min. • KMnO4 bath treatment @ 5 mg/l for 5-10 min.

4) Parasitic diseases

S. No.	Name of the disease	Cause	Clinical signs	Treatment
Protozoan parasites				
1.	White spot disease or Ichthyophthiriasis	*Ichthyophthirius multifilis*	• Erratic swimming. • Parasites visible as white spots on skin, gills and fins.	• Bath treatment in malachite green oxalate at 0.15-0.20 mg/l for 4-6 hours. • Bath treatment can also be given in sodium chloride solution for 7 days or more.
2.	Trichodiniasis	*Trichodina* sp.	• Darkening of skin. • Excessive mucus production. • Pale gills.	• Bath treatment in formalin at 15-25 mg/l concentration. • Bath treatment in $KMnO_4$ solution for 7 days or more.

3.	Oodinasis (Velvet disease)	*Oodinium* sp.	• Clamped fins. • Skin shows gray patches which look like dust giving velvet appearance to skin. • The fish may show signs of irritation.	• Bath treatment in malachite green or formalin.
Monogenetic trematodes				
1.	Gill fluke and skin fluke infestation	*Dactylogyrus* sp. (infecting gills) and *Gyrodactylus* sp. (infecting skin)	• Fishes grasp air. • Faded gills. • Gills covered with thick mucus layer. • Body covered with bluish grey mucus layer.	• Permanent bath treatment in dipterex @ 0.25-0.50 mg/l. • Formalin bath treatment @ 100 mg/l.
Crustacean parasites				
1.	Lernaeasis or Anchor worm infestation	*Lernaea* sp.	• Emaciation. • Inflammation and necrosis at the site of attachment. • Small hemorrhagic spots.	• Permanent bath treatment in Dipterex at 0.25-0.50 mg/l. • Bath treatment in NaCl @ 0.8- 1.1% fo 3 min.
2.	Argulosis or Fish lice infestation	*Agulus* sp.	• Haemmorhagic ulcerative lesions around bite wounds. • Visible as a small button like structure on body surface.	• Prolonged bath treatment in Trichlorphon @ 0.2 mg/l for 24 hr. • Prolonged dip treatment in 5% salt. • Bath treatment in 10-20 mg/L of KMNO4 for 30 minutes alternatively for 3 days.

(II). NON-INFECTIOUS DISEASES

S. No.	Name of the disease	Cause	Clinical signs	Treatment
Nutritional deficiency diseases				
1.	Scoliosis and Lordosis (Skeletal deformation)	Deficiency of the essential amino acid namely tryptophan and vitamin C deficiency.	• Scoliosis is the lateral curvature of the spinal cord and lordosis is the vertical curvature of the spinal cord.	• By supplementing required quantities of tryptophan and vitamin C in fish diet.
2.	Pin head disease	Deficiencies in protein, carbohydrate and lipids.	• Poor & stunted growth. • Sluggish movements.	• Administer nutritionally balanced feeds and proper feeding management.
3.	Constipation	Imbalanced or poor quality diet.	• Appearance of a long thread like structure attached to vent. • Fish becomes sluggish. • Swelling of belly.	• Feeding with Daphnia helps as they act as mild laxative. • Salt treatment.
Environmental factors				
1.	Brown blood disease	Presence of excessive nitrite in water (>0.1 mg/L).	• Darker gills. • Excessive pumping of gills. • Piping at the surface of water.	• Flushing of gills under increased flow of water.
2.	Gas bubble disease	Super saturation with either oxygen or nitrogen in water.	• Gas emboli in fins, opercula, eye or gills.	• Agitate water. • Increase water temperature.

The most important approach to control the disease is to manage the culture unit by following better management practices to reduce predisposing conditions of the disease. This can be achieved by optimum stocking density, preventing the introduction of pathogens, maintenance of good water quality, avoiding stress and through the provision of adequate nutrition.

References

Das, M.K. and Das, R.K., 1997. Fish and prawn diseases in India – Diagnosis and control. Inland Fisheries Society of India, Barrackpore, West Bengal, India. Pp. 139.

Magada, S. and Mercy, T.V.A., 2016. Health management in ornamental fish farming. *In:* Best Management Practices for Freshwater Ornamental Fish Production. National Fisheries Development Board, Hyderabad. Pp. 93-106.

Mishra, B.K., Swain, P., Sahoo, P.K., Das, B.K. and Sarangi, N., 2007. Disease Management in Freshwater Pisciculture. Agrotech Publishing Academy, Udaipur, Rajasthan. Pp. 288.

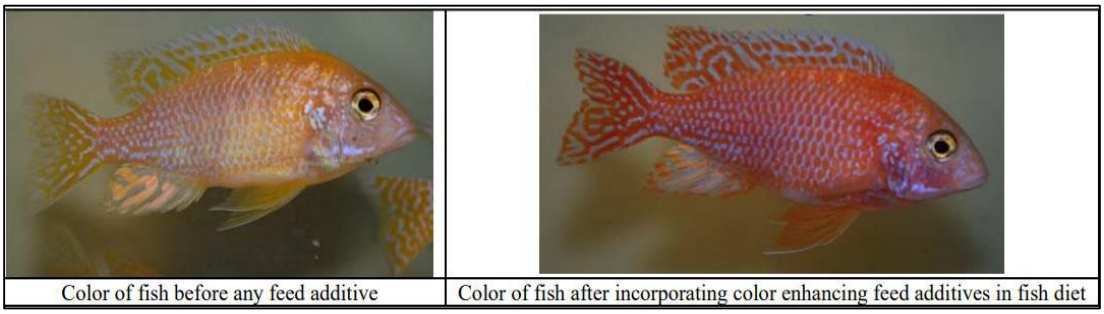
Read, P., Landos, M., Rowland, S.J. & Mifsud, C., 2007. Diagnosis, treatment and prevention of the diseases of the Australian freshwater fish Silver Perch (*Bidyanus bidyanus*). Fisheries Research and Development Corporation. Australian Government. Pp. 81.

VALUE ADDITION IN ORNAMENTAL FISH CULTURE

Aquariculture, the culture of living jewels in the confined auatic system has emerged as the second largest hobby and one of the most favourite commercial business in the world. The ever increasing demand for the ornamental fishes has led to the global trade of them where India is trying to make a significant contribution through value addition and popularization of indigeneous varieties. The aquarium fishes get high value because of its coloration routine, graceful behaviour, peculiar body morphology, and endemicity. But one of the greatest challenge faced by the industry is to replicate the natural colour in the captive environment. So in this regard, the colour enhancement of fish by using eco- friendly feed as well as fabrication of ornamental fish tanks, cultivation of ornamental plants, toys and other decorative for tanks are equally important as the development of breeding techniques to make this in the industry a success.

1. Value addition by color Enhancement

The aesthetic value decides the demand of the fish and therefore the market value of them. Skin coloration is an important factor in this regard. Colour enhancement in fish helps to increase the quality, cost and thus the market value of ornamental fishes. This is possible by administration of pigment enriched eco-friendly feed. The constant intake and adequate level of carotenoids in the feed are essential to optimize the coloration as the biosynthesis of carotenoids is not happens in the fish. Carotenoid pigments give red, orange and yellow coloration. Both synthetic and natural carotenoids can be used for this purpose. Much cheaper sources of carotenoids are plant-based sources which include Alfa-alfa (*Medicago sativa*), Carrot (*Daucus carota*), Marigold flower (*Tagetes erecta*), China rose (*Hibiscus rosa sinensis*), etc. In animal-based sources, astaxanthin is the predominant carotenoid rich in crustacean discards. Dried shrimp meal, red crab meal, krill meal are commercially available as fish feed. However high ash content, chitin digestibility issue limit its rate of inclusion in the feed. Some of the microalgal sources are also available commercially like *Hematococcus fluvialis*, *Dunaliella salina*, *Arthospira maxima,* etc. Examples of commercially available carotenoids are Lucanthin Pink (contain 10% astaxanthin) and Carophyll Red (contain 10% Anthaxanthin). Along with coloration, carotenoids also have functions like it act like a 1) Vitamin A precursor 2) Antioxidant 3) Growth enhancer, etc. Synthetic carotenoids have some disadvantages like residue problem, deteriorating effect on the environment and they are costly. Further research is needed to make improved feed for better coloration.



Color of fish before any feed additive | Color of fish after incorporating color enhancing feed additives in fish diet

Source: Role of feed additives in pigmentation of ornamental fishes. International Journal of Fisheries and Aquatic Studies 2017; 5(2): 684-686

2. Value addition by transgenesis

The possibility of easier genetic manipulation in fish has led to the success of devolvement of genetically modified organism by transgenesis. It helps to bring out new color variants of ornamental fish to increase the aesthetic value and demand by the market. Even though it has some disadvantages, further improvements can definitely bring novel color variants. Such value-added aquarium fishes hare already been commercialized such as 'GloFish.' This brand fish is patented and trademarked, available in the market in bright red, green, orange-yellow, blue, and purple fluorescent colors. Recently other variants also developed with six attractive fluorescent color combinations, including Starfire red, cosmic blue, electric green, galactic purple, sunburst orange, and moonrise pink. The other goals of transenesis include the intensification of growth and food conservation, increase tolerance to environmental variables like temperature and salinity and development of disease resistant forms.

3. Value addition by Painting or Dyeing or tattooing

Painted fishes are artificially colored fishes to increase the appeal to the customers. The artificial coloring or juicing is possible by injecting the fish with bight fluorescent color dye, dipping the fish into a dye solution, or by feeding the fish with food containing desired dye. This is done to develop exotic colors in fish which is not possible by line breeding. The coloring is not permanent; usually, last for six to nine months. Blueberry or strawberry Oscar which is available in the market is an example of dyed fish. Tattooed

fishes with different patterns with different colors are also available in the market. Tattooing is done with a low-intensity laser with a dye. Administration of some of the hormone also showed to increase the coloration in fish.

Conclusion

India is having a great potential in the ornamental fish trade as we have high value indigenous ornamental fish resources. But the trade is largely confined to exotic varieties even if there is a huge market potential is there for native varieties. So the use of native species can be boosted up to increase India's contribution to the global trade along with the improvements in value addition to rectifying the disadvantages of some methods. This will help to increase the market value and demand of fishes thus leads to an established ornamental trade industry in India.

References

Kaur, R. and Shah, T. K., 2017. Role of feed additives in pigmentation of ornamental fishes, *International Journal of Fisheries and Aquatic Studies*., 5(2): 684-686.

Sinha, A. and Prabhakar S. K., 2006. Colour Enhancement in Ornamental Fishes through Use of Natural Carotenoids in Artificial Feed, *The Sixth Indian Fisheries Forum Proceedings*. 43-48.

Rasal, K. D., Chakrapani, V., Patra, S. K., Ninawe, A. S., Sundaray, J. K., Jayasankar, P. and Barman, H. K., 2016. Status of Transgenic Fish Production with Emphasis on Development of

Food Fishes and Novel Color Varieties of Ornamental Fish: Implication and Future Perspectives, *Journal of Fisheries Sciences.com*., 10(3): 52-65**10(**