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SUBJECT: AQUACULTURE TECHNOLOGY

PAPER VI

AQUARIUM MANAGEMENT AND ORNAMENTAL FISH CULTURE

E-CONTENT

Unit-I

PRESENT STATUS OF AQUARIUM TRADE IN WORLD

1.Introduction: Ornamental fish trade is a multibillion-dollar industry in which approximately more than 125 countries involved the trade. The global Ornamental fish trade is estimated to be more than US$ 15 billion and more than 2 billion live ornamental fishes are traded

[1]. The 99% of the global market is confined to hobbyist and less than 1% is used for public aquaria and research institute. Developing countries are the major producers and suppliers in the world supplying more than 60% of the ornamental fish.

Over 2,500 species are involved in the global ornamental fish industry, of which over 60% are of freshwater origin and the rest are marine.

2. Overview of global exports: Global fish markets records were established in 1976 with just 28 countries were known to be exporting ornamental fishes, later reaching 105 in 2004; presently more than 125 countries are involved this trade.

The global exports market was rose steadily from 2000 valued at US$177.7 million and reached a peak value of US$364.9 million in 2011.

The Export value for the global ornamental fish industry in 2016 (Fig.1) stood at US$337.70

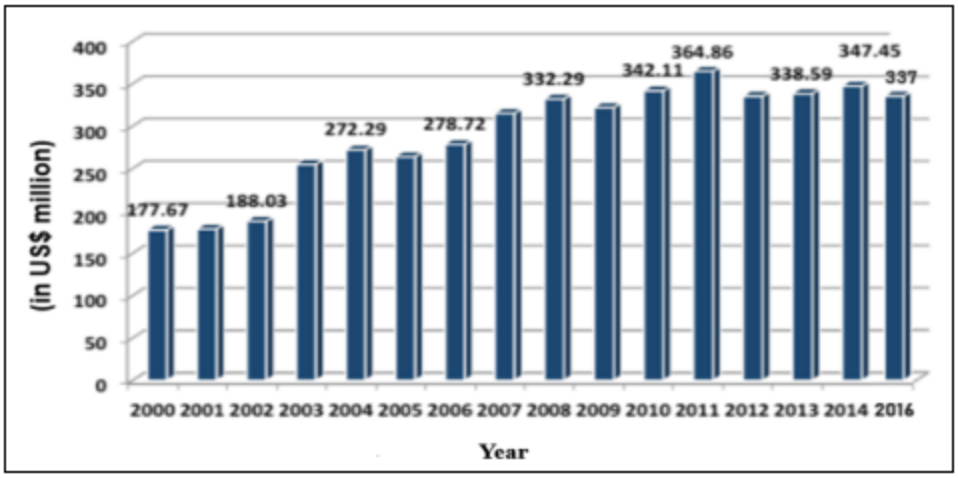


Fig 1: Global exports of ornamental fish, 2000 – 2016 (in US$ million)

Global exports of ornamental fish, 2000 – 2016 (in US$ million)

2.1 Region wise export market share in the world 2014

Asian Countries are the major source of ornamental fish in the

world and the export value in 2014 was US$197.7 million and contributed to 57% of the total exports. Europe, South America, North America, Africa, Oceania, Middle East are the other major regions exporting ornamental fishes

2.2 Top 10 exporting countries in the world 2016

Singapore has been the ornamental fish capital of the world with an export value is US$42.97 million, contributing to 12.7% of the total exports (5). Till today it remains the main trading hub in Asia, with more than 30% of the fish exported having been sourced from other countries. The second position was occupied by the Spain with exports worth US$39.56 million, followed by Japan US$33.10 million, Burma US$32.05 million, Indonesia US$24.64 million, Czech Republic US$19.89 million, Malaysia US$14.09 million, Netherlands US$13.16 million, Sri Lanka US$12.61 million and Colombia US$10.68 million. (Fig.3) [5] .

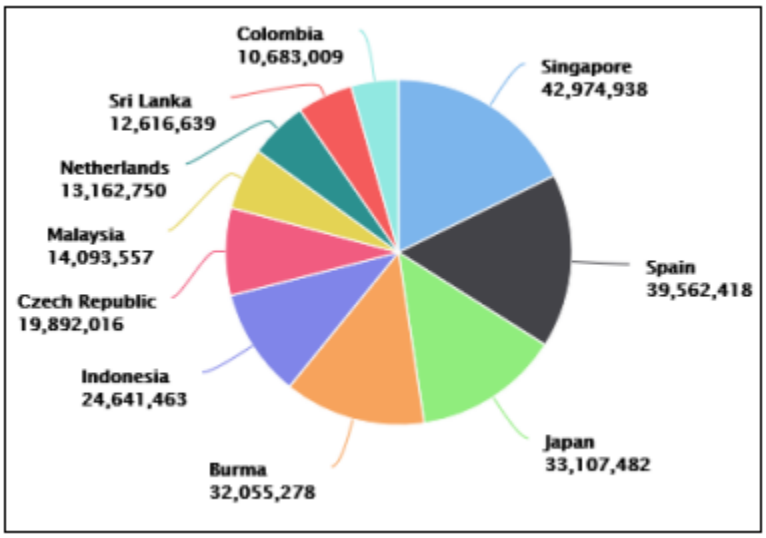


Fig 3: Top 10 Exporting Countries in the world 2016 (in US$ million)

3. Overview of global imports

The global import of ornamental fishes began with a list of only 32 countries in 1976, later their numbers increased significantly and reached 130 in 2001; presently now more than 150 countries are involved this trade (4). Global import market rose steadily from 2000 with a value of US$177.7 million and reached a peak value of US$402.1 million in 2008. The import value for the global ornamental fish industry stood at US$287 million in 2016.

DESIGN AND CONSTRUCTION OF FRESH WATER AQUARIUM

Ans. Design and construction of freshwater aquarium

Introduction

Ornamental fish tank is otherwise called an aquarium. An aquarium is a set up in which ornamental fishes of aesthetic value are displayed for recreation.

Different types of ornamental fish tanks

Aquarium can be made of materials like glass, concrete, wood, fiberglass acrylic sheet etc., depending on its location, cost and durability. Glass tank They are either all glass tanks or metal framed ones. In the metal (steel or iron) framed tanks glass panels are held in place with putty (battery compound). On the other hand in all

glass tanks, glass walls are fitted together edge-to-edge using silicone rubber adhesive. Nowadays, all-glass tanks have completely vanished due to the popularity of metal-framed tanks, which are known for their slim appearance and suitability for keeping marine fishes also. Shape of aquarium tanks The shape of the aquarium tank may be circular, square, rectangular, oval, hexagonal or octagonal. However, rectangular tanks are preferred as they provide sufficient area for free swimming of the fishes.

Materials required for construction of tank

- Silicon gel
- Squeezing gun
- Glass panes with required size

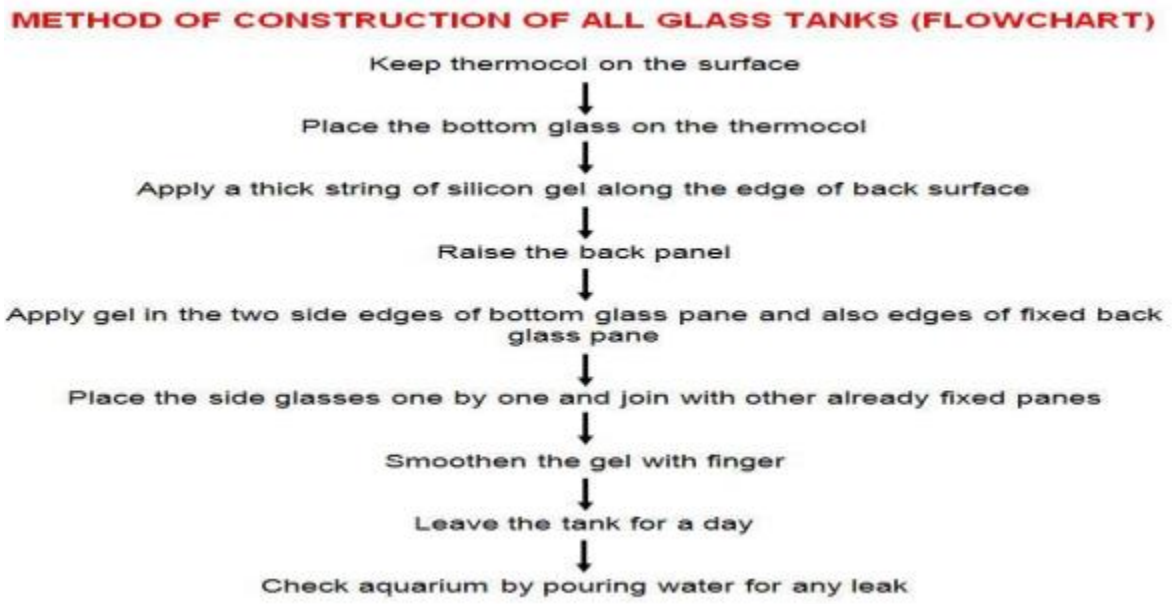
Construction of all glass aquarium tank

These are constructed with only glass sheets. Rectangular all glass tanks are made with a glass wall thickness of 5 – 10 mm. In all glass tanks, the cut glass walls are fitted together with synthetic rubbery sealent called silicone gum. Prior to fabrication of the tank, sidewalls of the tank are arranged so as to have the desired shape. The glass walls are tied with a rope in order to keep the correct shape of the tank. Then the bottom sheet of the tank is kept flat below the arranged sidewalls so as to get the desired and correct shape of the tank. A cut thermocol sheet is kept at the bottom to rest the temporarily tied glass sheets. Now the silicone sealent is evenly applied all along the inner vertical and horizontal cut ends with the help of a hand applicator. Care must be taken to see that the joining ends of the glass pieces are free of oil, moisture or stains. A good sealant compound binds the glass walls in 10 to 20 minutes. However, a curing time of about 10 hrs is required to keep the set tank in position and water should be poured only after 24 hours.

Seating the tank

Soon after curing, the tank is kept on a firm wooden or slotted iron stand. The base of the stand should be even and smooth, as irregular placing of the stands would break the tank bottom. A uniform sized thermocol is also used in between the tank and stand surface to safeguard the tank from pressure.

Method of construction of all glass tanks



MARINE AQUARIUM

Marine Aquarium is an aquarium in which marine plants and animals are kept Marine fish keeping in difference from freshwater counterpart because of the fundamental differences in the constitution of salt water and the resulting differences in the adaptation of its inhabitants.

- The first salt water tanks Used Venetian glasss jars where Romans kept anemones outdoors
- In 1846, Anna, Thynne maintained stony' corals and sea weed in aquarium.
- He was the Creator of the first balanced marine aquarium in London
- The most commonly kept marine fish are Percula clown fish, Sergeant Major damsel fish, small water puffer fish and scats, jewellery blennies, and blue damsels.
- Marine aquariums are equipped with large compressors.

- Marine aquariums are typically classified into three types based on their inhabitants via

1. Aquarium fish for housing fish only.

2. Salt water aquarium for housing fish with live rock (Natural filtration)

3 Ring Coral reefs

- Marine aquariums are divided into 2 types based on temperature.
    - **1 Tropical marine aquarium**
    - This is the most common type of aquarium
    - It houses marine animals from tropical climates
    - The temperature to be maintained is between 24 and 28°c.

Eg; Tropical reef tanks , fish-only- tanks. Live stocks for these aquariums are acquired through Commercial means.

2. Temperature (cold water) marine aquarium.

- *It holds the fish of temperature climate
- Temperature is to be maintained at 24^0 c
- Colourful species ornate clown fish, blennies and sea anemones are some of
- the inhabitants.
- Temperature fish species have specific diet requirements
- Any Marine Aquarium needs the following 7 aspects/arrangements:

I .Live rock : It is composed of lime stone and decomposing coral skeleton covered with benefice algal Coralline & tiny vertebrates & bacteria.

- Live rock, acts as buffer to maintain pH at 8.0-83 in the aquarium Live rock has acid-neutralizing capacity.
- The micro fauna found on live rock are detrivores and herbivores & they eat algae & fish waste.
- Live rock provides a natural attractive shelter of fish.

2. Filtration: Marine aquarium needs a complex filtration requirements compared to most aquariums **.**

- Wet and dry filters and protein skimmers are used to remove organic compounds before their deg- radation.
- Sump is an external container fitted under the aquarium for filtration and maintenance of equipment.
- Sump keeps the healthy by increasing surface area for gaseous exchange.

3.Lighting: Regular cyclical lighting is used in aquariums to stimulate day and night. Lighting provides security and enables rest to the inhabitants.

- High output lighting is required for many invertebrates such as corals and anemones to survive.
- Various light sources like fluorescent. UHO compact fluorescent, LED and metal halide types are needed. Each type of lighting has its own ad- vantages and disadvantages.
- While selecting a lighting for marine aquarium, three factors are to be considered viz: wattage, colour and temperature.

4. Temperature: Marine aquarium temperature should mimic the natural environment of the inhabitants.

- Aquarium heater is necessary to maintain water temperature.
- If temperatures are greater than the desired temperature especially cold water systems, a device 'Chiller' is used to reduce the temperature.

5 Water testing (Water quality monitoring):

- Water quality monitoring ismandatory for successful aquarum keeping.Salinity should be maintained between 28 and 35 ppt
- PH should be maintained between 8.1 and 8. 3. Ammonia & Nitrite must always be Zero. Nitrate should be 10 ppm Phosphate should be <0 .3 ppm .
- Alkalnity may range from 125-200 ppm. Copper concentration never be more than 0.15 ppm

6 Acclimation : Acclimation is a process that performed while adding a new marine life inhabitants) to an aquarium Acclimation is mandatory for invertebrates like sea anemones and corals which lack osmo regulation.

7 Water Exchange: Water exchange is used to maintain calcium carbonate, alkalinity and magnesium which are rapidly depleted in a reef aquarium. Water change helps to remove the toxic substances and keeps the environment healthy.

Setting-up of a salt water aquarium:

For setting up a marine aquarium the following equipment and live materials are required

1.Glass tank of 74 litre (24 gallon) capacity

2.Aquarium stand

3. Cover or Hood

4. Background paper

5.Heater

6. LED lights

7. Power head

8. Protein skimmer

9. Ground fault circuit interrupter

10. Power strip/Surge protector
11. Hose pipe

12. Buckets, towels, gloves

13. Substrate (sand/gravel)

14. Live rocks

15. Corals & decorative items
16. Hydrometer

17. Water test kits

18. Healthy salt water fish

19. Good quality sea water (artificial sea water)

Installation of aquarium equipment: The empty aquarium tank is cleaned inside with soft cloth and dipped in warm freshwater to remove the dust/ dirt. Live sand (or gravel) is poured on the bottom of aquarium in 2-3 inches thickness. Live sand has bacteria and other invertebrates in it which help to naturally filter the water and make the aquarium a more hospitable environment for fish Live sand adds a natural look to the aquarium. A bowl is kept on the live sand bed and the premixed salt water is poured into the bowl. Gradually the water overflows from the bowl and the aquarium tank gets filled with water. The tank is filled $1/3^{rd}$ and checked for any leaks.

Physical and behavioural signs before buying fish for marine aquarium

1. Damaged fins

2. Cloudy or bulging eyes

3. Mucus on the body

4. An emaciated or bloated body

5. Faded colouration

6. Twitching or trembling

7. Erratic swimming

8. Rapid respiration .

Acclimatisation of fish- first a container is placed below the tank for acclimation. Acclimation container should be larger to hold the fish comfortably. Airline tubing is placed between the acclimation container and main tank. The acclimation container is filled with shipping water. A towel over the acclimation container is draped to keep the fish calm. The fish is released into the acclimation container and the water flow is started from the aquarium tank to acclimation container initially 2-3 drops of water from tank to container.

Marine aquarium maintenance:

Salt water aquarium needs regular maintenance to keep the fish and other marine life happy and healthy. Carrying out the maintenance will be supporting life in aquarium to continue its functioning effectively for a long term and it will make the tank look nice. There are five tips to help the routine maintenance of tanks.

1. Aquarium tank should be placed near a sink and drain.

2 . Submerged equipment must be accessible.

3. The tools such as algae magnet scraper, tongs, siphon hose, nets, brushes of different sizes are readily available on hand

4. Hood/cover should be lighter and easily detachable to promote easy handling from the top of the tank for water exchange. scrapping of algae, rearranging rocks, removing uneaten food and dragging corals.

AQUARIUM ACCESSORIES

To keep aquarium tank looking beautiful and clean it needs regular maintenance. To perform the maintenance tasks, different types of equipment are used, as listed below.

1.Aerator(Air pump);Air pump simply provides continuous turbulence through air bubbles in the aquarium water that helps in diffusion of oxygen from atmosphere into the aquarium water. This aeration may be decorative equipment. Air pumpis also necessary for running the filtration system.

2**. Filters;** Filters remove the accumulated metabolites generated by the fish in the aquarium. This process of removal of waste is called filtration. Through filtration, a stable and healthy environment is maintained in the aquarium. These filters are of three types depending upon their filtration processes: Mechanical filtration removes debris, detritus, uneaten food, dead plant matter and other suspended solid particles. Chemical filtration removes chemicals and heavy metal traces. This type of filtration is useful for dealing temporary problems Biological filtration converts obnoxious gases in to non- toxic substances through bacterial action.

Filter media: Different materials are used in the filters. Filter media is the gut of filter. They perform one or more of the water cleaning functions such as mechanical filtration, chemical filtration and biological filtration.

Different Types Of Filters

Internal filters

a). Under-gravel filter: It is most popular filter. It is simple, cheap and occupies less space and easy to install.

b). Foam filter: It is simple cylindri- cal box with holes both on the top cover and in the base. It contains thick layer of foam and an airlift pump tube. This filter is simple, easy to install and maintain. When foam gets dirty, it is rinsed in clean running water and again placed in the box.

c**). Sponge filter**: It is an internal form of biological filtration. These are inexpensive and simple to maintain. Sponge filters are the best choice for aquariums where a gentle flow of water is required (breeding tanks)

d). Box filter: It is a small box filled with carbon and filter floss. This unit is kept inside the aquarium and powered by an air pump. Box filters are designed for both mechanical and chemical filtration. These filters are best choice for the tanks raising fry and fish breeding purpose

External filter

a). Trickle filter: It consists of a series of trays with holes in the bottom. A part is filled with filter media. It can be fixed above or below the aquarium. It is extremely efficient filter, easy to clean but its trickling noise may be annoying. It performs mechanical filtration.

b). Power filter: It is quite suitable for large aquaria which are heavily stocked and re- quire high turnover of water. It can be fitted inside or outside the tank. It performs both biological and mechanical filtration. The fil- tering material needs regular cleaning.

c). Fluidized bed filter: This filter performs purely as biological filtration. Fluidized bed filters are columns of sand held in suspension by a flow of water from the tank. These filters are d…

3. DECORS(Interior designing accessories)

1.Gravel**:** Gravel of appropriate type can create a pleasant habitat for fish. Most important function of gravel is to provide home for beneficial bacteria. Gravel bed improves the quality of water. Gravel bed provides aesthetic appearance. It also provide safe home for fishes laying eggs. Gravel bed is a store house of infusorians, which is a good food for fry.

2.Artificial plants

3.Live plants

4.Decorative / ornaments: These enhance the overall presentation and also help for hiding. These include substrate, sand, gravel, bogwood, marbles, terracotta flower pot, artificial rock, rocks, aquatic plants (real / fake) and fun furnishing pirate chests which open and close when connected to an air stone
3. Lights Aquarium lights play a key role amoralin maintaining water quality and promoting stress free environment. Lights are used to illuminate tank. Lighting replicate natural environment. It promotes plant growth .

4.Feeding equipment

Aquarium fish feeders are electric or electronic devices that are designed to feed aquarium fish at regular intervals. They are often used to feed fish when the aquarist is on vacation or is too busy to maintain a regular feeding schedule.

Fish feeders are usually clamped to the wall of the tank just over the water. Most designs consist of a hopper which is loaded with a variety of dry food, a timer which rotates the hopper at regular intervals (dispensing food in the process), and a method of setting the interval between feeding and the amount of food dispensed. Some designs have individual small hoppers. Whilst this limits the absolute number of feeds, it does allow for more accurate dosing,

and delivery of mixed, (both flake and pellet), foodstuffs, which are often important for community tanks.

Most feeders can dispense flake, pellet, or freeze dried food

5.Heaters: It keeps theaquarium temperature stable and within the safe range

6. pump;Air pump simply provides continuous turbulence through air bubbles in the aquarium water that helps in diffusion of oxygen from atmosphere into the aquarium water. This aeration may be decorative equipment. Air pumpis also necessary for running the filtration system.

7.Lights. Aquarium lights play a key role amoralin maintaining water quality and promoting stress free environment. Lights are used to illuminate tank. Lighting replicate natural environment. It promotes plant growth

Unit-II

Setting of Freshwater Aquarium.

An aquarium is a fish tank containing ornamental fishes, plants and decorations for recreation.

- A Suitable Site is selected in the house, office, hotel or institution.
- in the house
- The aquarium should be installed near a window so that diffuse light Should pass thorough the tank.
- This will give clear Vision of the fish and plants.
- The tank should be placed on a stand of good look.
- A tank of convenient Size is made or purchased.
- The tank should have a removable roof with provision for fitting fluorescent light.
- The light favours photosynthesis of plants.
- It helps the fish to trace the feed.
- It also enhances growth of the fish.

- Lighting is essential for for 8 hours
- The frame of the tank is painted
- The bottom of the tank is spread with small stones, fine gravel and sand.
- These are washed many times in water and spread on the floor.
- It should have a thickness of 3 to5 cm.
- It should have slope slightly towards the front for better vision.
- The tank is provided with an aerator operated by electric current.
- It supplies air which diffuses through a porous stone called diffuser.
- The aerator oxygenates the water.
- The cover is fitted with a fluorescent light.
- The light facilitates clear vision of fishes and plants of the aquarium.
- It also enhance photosynthesis of plants.
- Direct sunlight should not be allowed as it favours algal growth.
- A thermometer is fixed on the aquarium tank to assess the temperature.
- The aquarium fishes require on optimum temperature which range from 22^0C to 26^0C.
- It is measured by the thermometer.
- The aquarium tank is fitted with an electric heater to raise the water temperature Whenever the water temperature goes down.
- The aquarium tank must be fitted with a thermostat.
- When the temperature of the fish tank goes down, the thermostat switches `on` the heaters.
- When the temperature goes up, the thermostat switches off" the heater.
- The small stones, gravel and Sand placed at the bottom from a Compost.
- The aquarium plants provide Shade and Shelter for the fish.
- They also release oxygen during photosynthesis.
- In addition, they form food for herbivorous fishes.
- They also beautify the aquarium.
- A variety of aquarium plants are available.
- The common aquarium plants are:

Vallisnesia, Hydilla, Echinodorus

Cryptocoryne ,Potamogeton, Aponogeton

Najas,Pistia ,Sagittaria,Ceratophyllum

- Before planting, the plants are washed several times in water and disinfected with potassium aluminium Sulphate (0.1% solution).
- The roots are trimmed.
- They are planted to the back and sides.
- A few floating plants may also be added.
- Rainwater and well Water are Suitable for aquarium chlorinated tap water is avoided.
- The fish are introduced into the tank after a week.
- Non - aggressive fishes are introduced.
- Aggressive fishes chase and kill other Species.
- A tank a containing many species of fishes is a Community.
- The home aquarium is a Community tank.
- Aggressive fiches, such as fighters, are kept in separate tanks.
- These tanks called aggressive tanks.
- The fishes are disinfected with 2.1% potassium permanganate solution before introducing into the tank.
- The number of fish is determined by the Surface area of the tank.
- 1 cm long fish may need Surface 75cm² of the Surface area.
- Marine fish needs 300cm².
- The fish are fed with two feed two times in a day. Only the required amount of feed should be given.
- The feed may be placed in a feeding ring fixed on the Surface of water.
- The cup device is for holding Tubifex.
- The fish should be given live feed and artificial feed alternately.
- The live feed includes.

  Tubifex, Cyclops, Daphnia, Rotifers, Artemia, nauplii, chinonomid larvae, Mosquito larvae, etc

- Artificial feed is prepared by mixing dried and powdered prawn with egg.
  - A paste is made. the paste is made into pellets, dried and stored.
  - Over feeding is avoided.

- The Siphon consists of a glass tube as long as the depth of the fish tank and a rubber tube.
- When the water level goes down, additional water is poured.
- The water is changed when the tank water becomes turbid.
- The pH of the water should be 7 to 7.2.
- Infected fishes should be removed immediately for treatment.
- Scavenger animals like Snails are introduced to consume debris.

Water quality management in Freshwater Aquarium

Fish obtain the basic necessities from the water in which they live. The most characteristic feature of an aquarium is the quality of the water.

Water is mainly obtained from rain, river, well, canal and reservoirs.

Due to continuous metabolic activities by the growing fish, toxic waste such as carbon dioxide, ammonia and hydrogen sulphide accumulate in the system and Pollute the water and its quality.

The physico-chemical characteristics of water such as light, pH, hardness, temperature, dissolved oxy- gen, chlorine and carbon dioxide are known to play an important role in the breeding and production of various ornamental fishes.

The pH of Water

pH is a measure of the acidity or alkalinity of water. For normal fish keeping purposes the pH range is narrow i.e. 6.6-7.5. Acidic water is usually soft and alkaline water is hard due to the amount of dissolved minerals.

The aquarium pH is not constant and may vary from day to night due to photosynthesis.

Some ornamental fishes may spawn only in slightly acidic and soft water. Inorganic acids such as hydrochloric or phosphoric acid are added to lower the pH of the water.

The optimum pH for the growth of ornamental fishes is neutral or slightly alkaline i.e. 7-8.

Ornamental fishes preferring slightly acidic pH (6-7) include rosy barb, tiger barb, tetra, angel and danio. On the otherhand, certain fishes like cichlids, koi and gourami prefer invariably alkaline pH. The pH of water can be determined by chemically formulated pH paper or by a digital pH meter.

Hardness

Water hardness is a measure of the amount of dis- solved lime and other minerals.

The hardness could be categorized in to hard water or soft water. Waters with less than 50 ppm (calcium carbonate) hardness are said to be soft waters and waters with more than 50 ppm hardness are hard waters.

A hardness range of 100-300 ppm is found to be suitable for optimal growth of majority of ornamental fishes.

Softening can also be done by passing the water through a porous mass of a chemical called 'Zeolite (sodium aluminium-silicate) which gives up its sodium in exchange for an equal amount of lime and magnesium in water

By the addition of sodium carbonate, any soluble

calcium or magnesium salts present in the water can be precipitated as insoluble $CaCO_3$, and $MgCO_3$.

Salinity

Fishes from brackish water may thrive better in aquarium water to which some natural sea-salt has been added.

Water that has been standing in copper pipes may be toxic to fishes.

Heavily chlorinated water should be strongly aerated to disperse the chlorine before the fishes are introduced.

Dechlorinating additives are also used by some aquarists.

Oxygen

The dissolved oxygen content of the ornamental fish tank water is due to either diffusion of atmospheric air at the air-water interface or by the photosynthetic processes of aquatic plants.

Oxygen level of water could be enhanced by adequate aeration, sprinkling of water or by the installation of surface agitators.

The solubility of oxygen largely depends on the water temperature.

Carbon dioxide

Ornamental fishes are also known to avoid dissolved carbon dioxide content above 5ppm.

Free carbon dioxide at a concentration of more than 15 ppm is also detrimental to ornamental fishes.

However, the fishes could tolerate carbon dioxide content to the level of 60 mg/l provided the dissolved oxygen content of the water is sufficiently high.

The amount of carbon dioxide increases in the tank during night and decreases during day time.

Phenolphthalein indicator can be used to identify the presence of free carbon dioxide.

Chlorine

Chlorine in low quantities (as low as 0.1 mg per i ter) may kill the fishes. Chlorine content can be removed by dechlorination, either by heating or by exposing wa ter to open sunlight for full day

Ammonia

Free ammonia at more than 1 mg/l is known to be toxic to many species of ornamental fishes. Ammonia.com tent of the water is mainly due to the release of

metabolic by products and by the decomposition of organic matter including feed remains and faecal matter.

Fishes exposed to sub lethal concentration of ammonia in water containing unionized ammonia levels varying between 0.4 and 2.0 mg/l for 24 to 72 hours may be lethal.

Nitrites

Biological filter can reduce ammonia, nitrites and nitrate to non-toxic levels.

very small amount of ammonia and nitrites is very toxic to fishes.

Although some fishes may be tolerant to certain levels of nitrites, their immunity or resistance to disease or stress may be seriously impaired,

Hydrogen Sulphide

Unionized hydrogen sulphide is toxic to fishes. When anaerobic condition develops in the bottom of tanks, sulphate gets reduced to hydrogen sulphide.

Hydrogen sulphide immediately reacts with oxygen and produce sulphate ion.

Water change is advisable to reduce the concentration of hydrogen sulphide.

Temperature

In order to keep the tropical fishes alive, temperature of the aquarium water must be maintained at a constant temperature. Tropical aquarium does well at temperatures of 23° to 28° C (730 to 82° F).

Management of Marine aquarium

Marine aquarium maintenance:

Salt water aquarium needs regular maintenance to keep the fish and other marine life happy and healthy. Carrying out the maintenance will be supporting life in aquarium to continue its functioning effectively for a long term and it will make the tank look nice. There are five tips to help the routine maintenance of tanks.

1. Aquarium tank should be placed near a sink and drain.

2 . Submerged equipment must be accessible.

3. The tools such as algae magnet scraper, tongs, siphon hose, nets, brushes of different sizes are readily available on hand

4. Hood/cover should be lighter and easily detachable to promote easy handling from the top of the tank for water exchange. scrapping of algae, rearranging rocks, removing uneaten food and dragging corals.

5. The tank is cleaned more frequently to avoid build up of coralline and other forms of algae.

A maintenance schedule is prepared according to the tank size, water volume, species housed and their activity. Some tasks need daily maintenance, otherwise weekly/biweekly/monthly

Daily: The lights are turned on and off in a constant pattern. The swimming behaviour of fish is observed to ensure that all are alive, healthy and uninjured. The fish and other invertebrates are fed twice a day in small amounts. Any uneaten food is removed Water temperature, salinity and specific gravity are verified and adjusted Water level is observed to top up with clean dechlorinated freshwater for compensating the evaporation. Tank connections of drips and leaks are checked. It is ensured that all equipments (Heater,UV, power heads) are functioning properly. The protein skimmer cup is emptied as needed.

Once in a week. Water tests for critical parameters such as specific gravity, pH, ammonia, nitrite, nitrate and alkalinity are carried out. The aquarium cover, tank edges, power cords and other surfaces exposed to salt spray are wiped out. Algal mass on aquarium glass is removed with algal scraper / magnet Evaporated water is replaced with an equal volume of purified freshwater to keep the salinity stable. The inside neck of protein skimmer is cleaned with the help of a wipe to eliminate dirt, sticky substances that are built up. The filter socks, foam blocks, sponge sleeves, banded filter pads and other mechanical filter media are thoroughly rinsed with clean tap water to eliminate trapped particulate wastes. A 10% water exchange is done to reduce nitrate level.

Monthly; The outside of the aquarium is cleaned to remove calcium deposits on tank cover, light fixture and cover glass with a dampened cloth immersed in white vinegar, Replace the carbon in filter with fresh good quality one. The salinity is observed and added sea salt if necessary to maintain salinity. The filter is thoroughly checked Air stones are replaced. The assembly of the protein skimmer is removed and thoroughly cleaned.

Once in every 3 months: Thorough examination of all aquarium equipments including lighting, heating, filtration, aeration pumps tubing, etc. is required

Once in 6 months/ one year; The bulbs and tubes in the lighting system are replaced if necessary. The hose pipes are changed. Water is replaced @ 25% of the tank volume to maintain proper water quality. Corals and other decorations are cleaned as needed.

Common mistakes encontered in maintenance of salt water aquarium:

1. Improper water exchange.

2. Not utilising a deionization unit.

3. Over feeding the aquarium fish.

4. Inadequate cleaning protocols

5. Live stock incompatability.

6. Equipment's are not cleaned properly.

7. Timely replacement of light is not done

8. Water tests are not done on weekly basis.

9. Salinity adjustment is not done property

10. Dissolved oxygen levels are not tested frequently

Do's and don'ts for marine aquarium

Do's

- Buy larger Aquariums, which are more stable and easier to maintain.

- Check the health of the fish and other invertebrate every day.
- Select proper compatible species.
- Observe the signs of illness or any abnormal behaviour
- Feed small amounts of food regularly.
- Feed a varied diet which satisfies all the inhabitants.
- Keep an eye on algal growth and remove it periodically.
- Ensure sufficient circulation in the tank
- Ensure the filters functioning regularly.
- Use timer to maintain the photo period according to the natural environment of the inhabitants.
- Replace the activated carbon for every 2 months.
- Keep all the water parameters in optimum range by regular water test.
- Monitor the protein skimmer functioning on weekly basis. Use two small heaters in aquarium tank instead of a single powerful heater.
- Cycle the tank before introducing the fish.

Don'ts:

- Don't over feed the fish & don't overstock the aquarium.
- Don't release fish without cycling the aquarium water.
- Don't use tap water directly without treating and testing.
- Don't add fish to the aquarium tank without removal of chlorine or chloramines.

Don't use any sprays, air fresheners in the room where aquarium is placed.

Packing And Transport Of Fishes

Packing & transport of fish;

The success of ornamental fish business also depends on the ability to meet customers' needs. High quality fish is always a critical factor. Most of the ornamental fish are destined for both domestic or export markets. The fish must not only be pleasing to look, but also robust enough to withstand the long journey during transportation. Careful handling of ornamental fish right from harvesting is a

must. The amount of stress caused during harvesting, holding and transport affect the health of fish and suns Stress weakens the immune system of the fish Proper handling of fish and maintaining good water quality in packing optimize the fish health to reduce the post shipment mortality, DOA (Death on Arrival) from exporter to importer Collection of fish, conditioning packing and transport are important aspects to be considered

The most important reasons for mortality of fish during transportation/shipment are;

1. Improper handling of fish while collection & packing

2. Improper conditioning of fish

3 Improper acclimatization prior to transportation

4. Insufficient oxygen in the transport medium

5. Toxicity due to accumulated wastes

The transport distance may vary from a few kilometres to thousand kilometers or more depending upon its destination points such as local area, interstate or overseas Generally fish could be transported either in open syntex tanks (local areas) or packed in LDPE (low density polyethylene) bags (for long distance)

Conditioning:

Key factors involved for packing of fish are mainly conditioning of fish prior to packing, duration of transport number of fish to be packed, species to be packed, size of the packing box, means of transport, etc. To reduce stress, fish are fed with vitamin 'C' supplemented diets for two weeks prior to harvest. Harvesting of fish should be conducted in a quick and efficient manner. The harvesting method is different for different species. The netting material used for catching fish should be soft and mesh size should be selected according to the size of fish. Monofilament nets are used for small fish collection and knotless nets are used for bigger fish.

Most important factor in moving fish from a pond to holding facility is the source of water used in the transport container Sc damaged & dead ones from the holding facility are removed and disposed off safely. Grading should be done manually with utmost care Fish are kept in holding facility or conditioning tank for 1-2 days

The conditioning tank water is treated with common salt @3 gm/litre and 20% water needs to be exchanged daily. After 2 days. fish are examined for any external parasites or any signs of distress After 2 days graded fish are transferred into glass tanks provided with adequate aeration Glass tank water is also treated with methylene blue @ 0.0035 ppm and common salt (0.1 pp) to avoid infections. Fish are kept for 2 days in glass tanks.

Before transport fish are starved for 1-2 days to make their gut empty. Small fish are starved for 12-24 hours, while the bigger fish are starved for 48 hours. Herbivorous fish needs more days for starving. Mollies may require longer period of starving (not to feed for 3-4 days). Starving should be undertaken in glass tanks only. During starving, the metabolic rate of fish becomes slow there by reducing oxygen consumption. It also reduces ammonia and carbon dioxide which allows higher packing densities.

Packing:

LDPE (low density poly ethylene) bag of 250 microns thickness are ideal for fish packing. The shape of the bag is also important for domestic market, the bags that are sealed straight at corners are used. For international trade curved sealing is best For small fish the bags with straight corners are not good, as the fish will congregate at the comers. Therefore, the comers could be tied with rubber band. The bag size is selected for packing as per the number of fish to be packed. For domestic trade, packing bag size is 5"x 12", 12" x 20" and 18" x 24" For international trade usually the bag sizes of 3"x 9" to 13" to 26" are used. Fish packing bags are filled with 1/3rd water and 2/3rd pure oxygen. Packing density depends on species tolerance to stress, size of fish, transport time, health status of fish, temperature and concentration of chemicals and additives.

Sanitizers & additives:

The level of the physical activity of transported fish must be kept to the minimum. During transport, ammonia accumulates due to excretion by the fish under packing. To avoid ammonia problem, add cleaned zeolite rings 15-20 g/litre. Additives (permitted levels) in packing bags such as, Eugenol (5 mg/litre). Tricaine methane sulfonate (MS-222 @ 20 mg/litre), Barbital sodium, etc are used for successful transport.

The purpose of additives are to lower the metabolic rate of fish, reduce the oxygen consumption and controlling the excitability of the fish.

After starving, fish can be pre packed into bags to acclimatise fish packing. The packing bags are kept for acclimatization in air-conditioned rooms at 22-33C for 4 hours before final packing This enables the fish to acclimatize to the packing conditions such as confinement, crowding and low water temperature. The details of species, number and average size shall be indicated on the bag with a marker pen Pre treated water is filled up in poly bags for final packing.

It must be ensured that the temperature of water being filed in the bags is

same that of pre-packed bags (after acclimatization period). The bag filled with water is again inserted in another bag of same dimensions. Keeping a news paper in between the two bags provides additional safety against water leakage and also reduce stress to fish from excess light. Finally, the bag is filled with pure oxygen and sealed by twisting the top of the bag and folded over and tied with rubber band (for domestic trade) or metal clips are used to fasten the top of the bag (for international trade).

Aggressive fish like betta and other fish with fragile finnage such as angel, pearl gourami are packed individually to prevent them from attacking each other Individual packing is practiced for high priced fish like arowana, discus as a safety measure to avoid mortality Poly-bags stocked with fish are kept in polystyrene styrofoam boxes (insulated) for transportation Advantage of insulated boxes is to keep the temperature constant during transport.

Bags are not stacked upon each other Bags are kept inside the box in a single row. Once the bags are kept in insulated boxes, the box is covered with news paper before closing the box. Finally, the styrofoam boxes are kept in corrugated card board box for extra protection Boxes are sealed with

packing tape properly. The boxes are now ready for transportation. The boxes are never kept under sun heat during transportation and also during waiting period. They should be kept under some shade.

Freshwater Ornamental fishes.\

Gold Fish

Kingdom;Animalia

Phylum;Chordata

Class: Actinopterygii

Order ; Cypriniformes

Family;Cyprinidae

Goldfish (Carassius auratus) are small ornamental freshwater fish that are commonly kept as pets.

Goldfish were one of the earliest breeds of fish to be domesticated and are still one of the most commonly kept fish in aquariums and outdoor water gardens.

There are different body shapes, fin and eye configurations. Goldfish may also change their colour by varying the spectrum of light under which they are kept.

Goldfish produce pigment in response to light. Cells called chromatophores produce pigments that reflect light and give coloration.

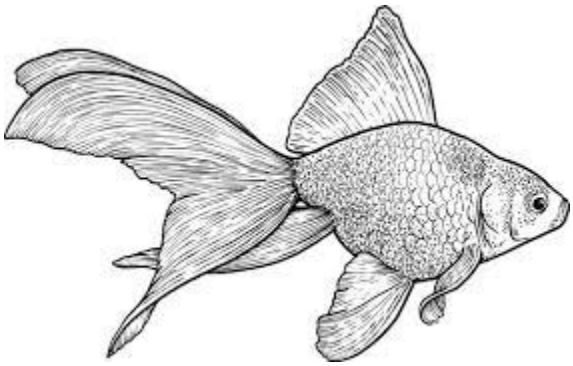
Goldfish cannot tolerate rapid changes in temperature. The sudden shift in temperature could kill them.

Like most fish, goldfish are opportunistic feeders.

They are omnivorous.

Supplement food include shelled peas, green leafy vegetables and live food such as Daphnia, brine shrimp and bloodworms.

Artificial plants made of plastic are often more durable but might irritate or harm a fish if it comes in con- tact with the plants.



Sword Tail

Phylum;Chordata

Class;pisces

Order; Teleostei

Family;Poecilidae

It is an ornamental fish.

It is a freshwater fish.

It can grow to a length of 14 cm.

pH: 7 to 8 .

The lower lobe of the caudal fin is elongated inthe male.

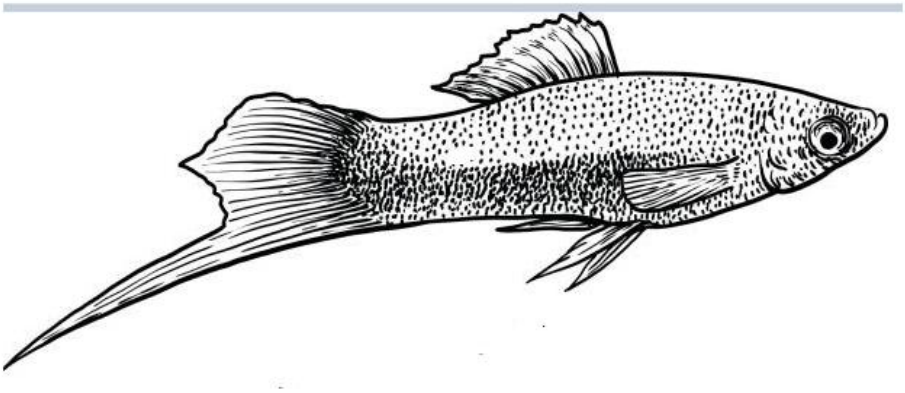
The anal fin of the male is sword-like and hence the name sword tail.

The name 'sword tail' is not derived from the elongated tail fin. It is a misnomer.

The colour patterns are red, green and black.

Omnivore.

Live bearer,giving birth to youngones.



Zebra Fish (Danio rerio)

Phylum; Chordata

Class ;Pisces

Order; Teleostei

It is an ornamental fish. It is a freshwater fish.

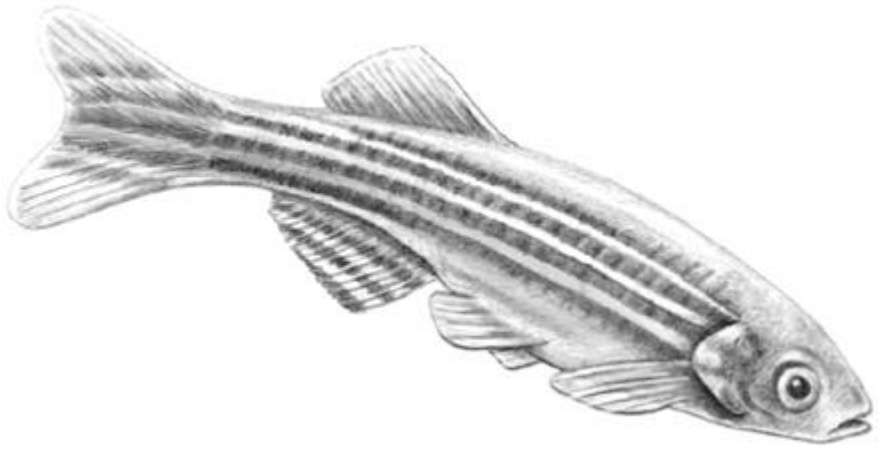
It is native of streams of Himalayas. It commonly inhabits streams, canals, ditches, ponds and paddy field It has five horizontal blue stripes on the side of body similar to zebra horse.

. Males are torpedo-shaped and have gold stripes between the blue stripes.

Fig.19.14: Zebra fish. . Females have a larger whitish belly and have silver stripes instead of gold.

It grows to 3.8 cm. . It lives for 5 years.

. It lays eggs.



Parental care in ornamental fishes

Comparatively few fishes reveal a sense of parental care. Most fishes eat their eggs as soon as they have been deposited and the larvae as soon as they hatched out. However some fishes show parental care. Parental care falls into three categories: They are

1 Substrate or open brooders

2 Secretive cave brooders (also known as guarding speleophils),

3. Mouth brooders (ovophile mouth brooding and larvophile mouth brooding).

1. Open or Substrate Brooders;Open or substrate brooding fishes lay their eggs on open places such open rocks, leaves or logs and guard them. Cichlids such as Pterophyllum, Symphysodon spp and Anomalochromis thomasi comes under this category.

Fig 27.1: Male and female Jewel cichlid guarding their eggs

In biparental substrate brooding cichlids, the male and female usually engage in different roles to protect their eggs and raise them in to fry. The male parent patrols the pair's territory and repels intruders. The females attend the brood by fanning water over the eggs and remove infertile eggs.

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2. Secretive Cave Brooders

Secretive cave brooding cichlids lay their eggs in caves, crevices, holes or discarded mollusc shells. Ex- amples include Pelvicachromis spp., Archocentrus spp and Apistogramma spp.

Free-swimming fry and parents of both open and cave spawning cichlids communicate with each other. Frequently this communication is based on body movements,such as shaking and pelvic fin flicking

3. Mouth Brooders

Mouth brooders (mostly cichlids) incubate their eggs in their buccal cavity. Compared with other cichlids, these species produce fewer but bigger eggs. The eggs are protected from the environment by the parents. But they do not provide any nutrients to the developing eggs. Thus this condition is analogous to, though not identical with, ovovivi parity. Eg. Megalochromis and Tilapia. Depending on whether the male or female parent is brooding their eggs mouth brooding is of 3 types. They are maternal mouth brooding, paternal mouth brooding, biparental mouth brooding.

1. Maternal Mouth Brooders

Vast majority of mouth brooding cichlids are maternal mouth brooders, that is the female broods the young The females carry their eggs in their mouth for 14-18 days During this period, the female takes no food. Hatching occurs in mouth and after 3-4 days of hatching, only the young ones are allowed to swim out. But at the sight of any danger they return to the mouth. Eg. Haplochromines and some of the tilapians, such as Oreochromis mossambicus and Oreochromis niloticus.

2. Paternal Mouth Brooders

They are species where the male looks after the eggs Paternal mouth brooders include the arowana, the mouthbrooding betta Betta pugnax and sea catfish Ariopsis felis. Among cichlids, paternal mouthbrooding is relatively rare, but is found in the black-chin tilapia Sarotherodon melanotheron.

Among the fresh water sunfishes (Centrarchidae) the male scoops out a shallow basin like cavity at the bottom of the aquarium. They carefully remove all pebbles and lines it with snout, after the eggs have been deposited. They keep the nest clear of sediment. Fish guard them carefully until the young fish are able to swim freely.

3. Biparental Mouth Brooding

It occurs where both parents take some of the eggs. This is relatively rare, but is found among the cichlid genera Asprotilapia and Xenotilapia, and a single catfish, Phyllonemus typus.

Care of Young Fishes in the Aquarium

Young fishes obtain nourishment from its attached yolk -sac until they swim freely. So provide no food until that time. First foods can be proprietary liquid or powdered foods meant for young ones. Green water, microworms and grindal worms can be provided. The food is brine shrimp. As the fish grows the size and amount of the food should be increased. Aeration should be provided in order to keep the food moving. Remove weak and malformed young ones.

Fertilization and Development of Eggs

Fertilization

Fertilization is the union of egg and sperm and the subsequent fusion of the nuclei of both sex cells called **amphimixis.**

In oviparous fishes, fertilization is external occur ring in water. In viviparous fishes fertilization is internal occurring inside the body of the female.

Embryonic Development

Development of an individual begins immediately af ter fertilization of egg by sperm. The process of develop- ment can be divided into three periods.

They are

1. Early embryonic

2. Transitional embryonic or larval and

3. Post embryonic.

1. Early Embryonic Development

The early embryonic period starts when the egg is fertilized by a sperm. The process ends when the embryo has attained the stage of generalized organ system. This phase of the development include cleavage, gastrulation, organogenesis and hatching.

Cleavage

It is the division of the fertilized egg (zygote) in tosuccessively smaller cells called blastomeres. The cleav- age is said to be meroblastic. Since the egg is telolecithal the cleavage is restricted to a small disc of cytoplasm at the animal pole. This results in the formation of blasto- derm. The blastomeres accumulate on the top end of the yolk and is called morula.

Blastula

The central cells of blastoderm divide to form a num- ber of free blastomeres which become arranged on the top of the yolk as a layer. This layer is called periblast. The

space between the blastoderm and the periblast is the blas- tocoel. The embryo is called blastula. The blastoderm gives rise to the embryo. The periblast serves to digest the yolk and supply it to the developing embryo.

Gastrulation

Gastrulation is a process by which the three germi nal layers (ectoderm, endoderm and mesoderm jare formed. The gastrulation is accomplished by

1. Epiboly

2. Involution

Organogenesis and Hatching

After the completion of gastrulation various organs of the body are generally formed. The body at this time is more or less cylindrical and basically bilaterally symmetrical. Head and pharyngeal region project from the yolk mass anteriorly. The trunk lies over the yolk. The tail projects posteriorly.

2.Transitional or Larval Development

Developmental stages prior to the adult stage following hatching or birth are termed larval. The young ones at this stage are called fry. The period of larval life range from a few moments to several years. The larval development is sometimes divisible into prolarvae and post lar- vae. Prolarvae are with yolk sac and commonly called sac fry. In some species, when the yolk sac disappears the little fish is a miniature adult. This is called alevin or an advanced fry.

The post larva undergoes a metamorphosis to lose larval structures and gain adult features.

3. Post Embryonic Development(Juvenile to Adult)

Termination of embryonic development is followed by a period of growth in size. This is followed by matura- tion of the gonads. The females usually attain the largest size. The males usually mature earliest. The period required to reach the

adult condition may be short 4-10 weeks (Eg. Guppy) or long 6 to 12 years varying with temperature and other factors.

Egg Development of Gold Fish

The eggs resemble tiny transparent bubbles. Fertile ones are pale yellow, infertile ones are opaque white. Re- move infertile eggs immediately, as they get covered with fungus within a day.

Once eggs are fertilized, pigmented eyes, small spots and a beating heart take shape after two to three days. On the fifth to seventh day, larval fish with yolk sacs on their bellies burst out thereafter and cling to plants and the tank sides, resting most of the time.

A few days after, they break free for good.colouring starts after a month or so

Hatching and Larval Rearing in Freshwater Ornamental Fishes

Fishes are monogamous. fish are egg layers. Fishes forms pairing before spawning: pairing ge takes a year. The best way to secure a pair is to raise a group of fry together and allow them to pair naturally. Fishes pair up and start swimming side by side and defending their area of the tank from other fish. The male fish in the breeding pair attacks other males. Once the breeding pair is identified, the pair is introduced into a big tank (spawning tank). Feeding with live feeds such as Daphnia, brine shrimp and meaty foods will induce spawning. Fully matured fishes have bulged belly and more aggressive in nature.

Spawning tank setup:

Aquarium tank with 18 inches height and 100 litre capacity is

ideal for spawning. Sponge filter is Arranged above 6 mm from bottom; elevation of filter prevents fry being trapped fishes do best

in warmer waters Spawning tank temperature should be set between 27-29 C Vertical surfaces like slate or glass are

arranged slantly in the tank as the fishes usually choose these for laying eggs pH of 6.6-6.8 is idea in the tank water.

Parental spawning ;

Usually 2-3 days before spawning the pair select a place in the tank and begin to clean the spawning using their mouth to bee and scrub the leaf surface or slate. Cleaning process continues for 24 hours. Selected pair should be transfered to separate tank to avoid aggression from other tank mates. The female fish passes over the site and release eggs. Eggs are adhesive in nature Eggs are round and measure 1.5-3 mm. The female lays eggs on broad leaves or the stunning rods or on slate. Male fish makes alternative passes and release spermatozoa cells over the eggs and fertilize the eggs. Eggs are small and translucent Unfertilized eggs are white in colour Nearly 1200 eggs are laid if the pair is mature and in good condition.

Caning of eggs and young ones:

Once the spawning is over there are two options

Leave the eggs with parents. Parents guard the eggs until they hatch out. If parent fish got stressed they will eat away the eggs spawn. The spawners will eat away the eggs in first few spawns. Otherwise parental care persists up to 8^{th} week in captivity.

After fertilization the slate or glass with eggs are transferred into a 20 litre tank

An air stone is arranged underneath the slate to provide circulation. After introducing the eggs in a separate tank, methylene blue is added to avoid fungal infections. Angel eggs are sensitive to light. They need darkness for better hatching Water should exchanged every day in the hatching tank. Dead eggs should be removed from the tank to prevent the spread of fungus to live eggs. After 48 hours the fertilized eggs showing wriggling tails of hatchlings.

Eggs hatchout within 60-72 hours. The hatchlings are in tadpole shape with yolk sac The yolk sac will start shrinking on 5 day and very soon hatchlings will become free swimming .The post larvae begin to forage for their own food from 7 day onwards. Newly hatched brine shrimp nauplii are the starter food to the post larvae

Post larvae should be fed 3-4 times a day with live food. Finely crushed flake foods are given as supplement in addition to ne live feed. Dry food is Introduced twice a day to fry of 5-7 weeks old. They attain marketable size at 8 weeks age. If the eggs hatch with parents, they will spawn again after 2-3 weeks .The first fry will use the eggs as food.

Unit-IV

Commercial production Gouramies

Commercial Production

For the commercial production of Trichogaster Trichopterus, several steps must first be followed in order to synchronize spawning to have large numbers of fry of the same age for stocking.

Step 1. Sexing - Male gouramis can be distinguished by their longer dorsal fins which extend back to the caudal fin. In many cases they are also more brightly coloured than the females. The females will have a shorter dorsal fin and should show some plumpness in the abdomen area. Brood stock should be selected based on size, colour and apparent egg development in the females based on the plumpness of the female.

Step 2. Male and female brood stock are then placed in separate tanks for conditioning at a rate of one fish per ten litres (3 gal) with a ten percent water exchange per day to insure adequate water quality and provided with high quality feeds at least three times a day. Fish should be fed to satiation with caution taken to remove any uneaten feed from the tank. It is advisable to give a variety of feeds to the brood stock fish. This would include a complete commercial diet that contains at least 32% protein with a pellet or grind size no larger than about 1.0 mm.

Step 3. After two weeks of conditioning the broodstock should be ready to spawn. Males are placed into the spawning tanks early in the morning so they acclimate and establish a territory. Ten gallon aquaria work well for Trichogaster sp. but use a larger or smaller container depending upon the size or genus offish you are spawning. The hatchery should be dimly lit with as little foot traffic as possible to avoid disturbing the pairs. In many cases males will begin construction of a bubble nest in the first two to three hours. With the Trichogaster sp. it is not necessary to

add a floating substrate to facilitate construction of the bubble nest such as a floating ring, the bottom of a styrofoam cup or floating plants

Step 4. Spawning will take place over a period from one to four days. It is sometimes difficult to distinguish the eggs from the nest itself. The eggs are about the same size as the bubbles that make up the nest but have a darker golden or brownish tint to them. After spawning has taken place, it is advisable to remove the female in order to avoid injury due to the males aggression. The male will then care for the nest and fry once they are hatched.

Step 5. The eggs will hatch in about 24 hours at 27o C (80o F) and remain in the nest another two to three days while the yolk sack is being absorbed. The fry are free swimming on about day four or five post spawn and are five to six millimeters in length. When the fry exhibit a distinct change in behavior swimming throughout the water column, they are ready to start actively feeding

Step 6. The fry, in this stage of development are very delicate and should be moved with great care. Fry transfers should take place in the morning to avoid extreme differences in temperature and pH as well as avoiding photic shock. The fry tank water should be siphoned down using a large screened end on the siphon hose with a mesh size of 100 microns until there is 2-4 cm of water left in the tank.

Step 7. Once the fry are ready to feed it is important to provide them with infusoria, rotifers or small Daphnia sp. The change to free swimming feeds is usually done by transferring the fry to a nursery pond or tank that has been prepared no more than ten days in advance. The fertilizer is applied at a rate of one millilitre per fifty litres of water site.

If the desired bloom is not achieved, the recently developed microencapsulated feeds and artificial plankton feeds can substitute for most if not all live feeds currently used on most commercial farms. Simply take the artificial feed add it to water and blend until all of the powder has been wetted. Spray this solution over the surface of the tank three to four times a day.

Step 8. Newly stocked fry should be fed to satiation 2-3 times a day with a commercial swim up diet and newly hatched Artemia from stocking until day 10

when the amount of artemia can be reduced at about ten percent a day until the fish are feeding exclusively on the commercial diet.

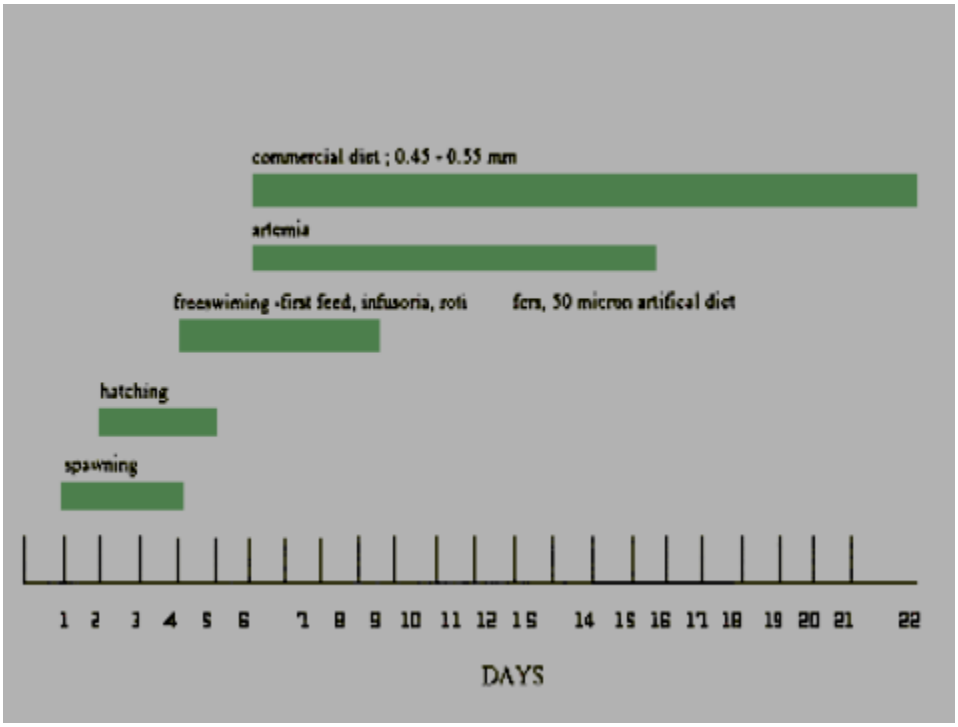


Figure 8. Diagram of feeding schedule for Trichogaster trichopterus.

Commercial production of barbs

Commercial Production

Brood stock Conditioning

Tiger barbs that are going to be used as brood stock (e.g., 20 to 30 millimetres or 0.8 to 1.2 inches body length) are first collected from a production pond or tank and sorted with size graders.

The fish are then separated by sex using a glass-top sorting table. Sexually mature females are identified by a full round abdominal region, and sexually mature males are identified by bright red colours on the fin rays.

Fish that have undesirable colour, poorly defined bar or black band patterns, or deformities are discarded.

The selected brood stock are then placed by sex into separate conditioning tanks. The conditioning tanks can be circular, square, or rectangular, but the rectangular tanks are more efficient for removing and selecting brood stock.

The conditioning tank should be provided aeration and water exchange at a rate of 20% per day.

Separation of the sexes elicits a synchronization of spawning that results in a large number of fry at the same time.

The separated fish are conditioned by a diet of frozen blood and/or tubifex worms, Artemia, a high quality flake or a prepared paste at least two or three times per day to satiation for a period of two weeks.

Conditioning the sexes in separate tanks is an important step in the production process.

Lack of proper conditioning will result in greatly reduced numbers of successful synchronized spawnings.

It cannot be overemphasized that during conditioning of the brood stock good water quality should be maintained as the conditioning diets can lead to fouling of the water. In addition, subtle changes in water quality can reportedly influence spawning of tiger barbs.

Spawning experiments where water from tanks in which males were kept during the conditioning process resulted in an overall reduction in the incidence of ovulation of females relative to controls in the spawning tanks .

Spawning

Tiger barbs and related species are generally easy to breed, requiring only minor but important manipulations in brood stock conditioning, water quality, and spawning substrate.

The hatcheries often hold several hundred spawning tanks that are utilized at a single time to produce large numbers of fish of similar size per trial

The process for spawning the tiger barbs after conditioning is as follows:

Step 1. Stocking the spawning tank Single pairs of broodstock fish are placed into 40-liter (10-gallon) glass aquaria with little or no aeration.

A stiff bottle brush that is used as a spawning substrate is placed in each spawning tank in the late afternoon of the same day that spawning pairs are introduced to the tanks.

Other spawning substrate materials, such as rayon knitted yarn are also used by commercial producers.

The stiff spawning brush functions as the substrate on which the sticky eggs are laid, prevents the brood stock from eating the spawned eggs, and is easily cleaned between spawning.

Step 2 . The following morning: The morning after stocking, check each aquarium for eggs and be careful to note which pairs of fish might currently be spawning so that you do not disturb them.

Step3. After spawning: Egg-filled brushes are removed from the spawning tanks and placed in other tanks for incubation and larval rearing. The broodstock are returned to the conditioning tanks for further conditioning or holding. Fish that are exhibiting spawning behavior and others that have not yet spawned are allowed to remain in their spawning tanks for an additional day.

Paired fish are allowed only two days to spawn, after which they are removed from the spawning tanks.

The hatchery is then cleaned and prepared to receive another batch of conditioned brood stock.

After the egg-filled brushes and brood stock have been removed, the spawning tanks may be immediately restocked for another spawning run

. If conditioned brood stock are available, a simple hatchery of 40 to 50 10-gallon tanks can produce roughly 10,000 tiger barb larvae per week.

Larval Rearing

Larval culture is characterized by the introduction of various feed types during the development of the larvae. Feeds customarily used can vary in size, quality, and quantity during the course of the rearing process.

The procedure for rearing tiger barb larvae is as follows:

Step 1. Preparation of the incubation and rearing tank: The size of the incubation and larval rearing tank is determined by the potential number of Commercial Production of Tiger Barbs.

Various types of brushes used as spawning substrates in commercial tiger barb production.

Spawning tank with bottle brush used as a substrate. Spawning tanks used for commercial production of tiger barbs.

Commercial Production of Tiger Barbs fry, and the volume of brushes it can hold underwater. larval rearing cycle.

Step 2. Hatching: Spawning brushes containing the sticky eggs from the spawning tanks are placed into the tanks prepared to hold the hatched larvae.

The eggs should hatch in three days if a temperature of 25°C to 27°C (78°F to 80°F) is maintained.

The newly hatched fry are non swimming for two days and obtain nutrition from the yolk sac, so the fry do not require feeding at this time.

Three days after hatching the yolk sac is usually absorbed and disappears.

Step 3. First feeding:

When fry are approximately 4.0 mm (0.16 in) in body length at three or four days after hatching and/or free swimming, feed should be introduced.

It should be noted that the hatching of larvae may vary, resulting in the presence of larvae at different stages of development.

Initial feeding must begin when the first larvae with a fully absorbed yolk sac are observed.

Newly hatched brine shrimp, Artemia sp., approximately 500 m (0.02 inches) in size is introduced as the first feed and used exclusively for the next two days.

Step 4. Feeding protocol:

Overfeeding with brine shrimp and/or high protein larval feeds can quickly pollute the feeding regimen used for the larval culture of tiger barbs. Commercial Production of Tiger Barbs.

Adjust the feeding rate according to the amount of debris on the tank bottom and observe water quality.

Feeding more often with smaller rations can lessen the risk of elevated ammonia levels that can easily kill fry.

After feeding brine shrimp exclusively for two days, prepared commercial fry feed should be introduced.

Fish should be slowly weaned onto new feeds by alternating small amounts of prepared feeds with brine shrimp nauplii over the course of a day.

When weaning fish to a new feed, daily introduce 10% of the new food while reducing the same percentage of the first feed until 100% of the new food is accepted.

Fish are sometimes reluctant to accept new feeds but slowly weaning off one and onto a new feed can reduce the amount of wasted feed in a tank.

It is important to remember that excess feed can rapidly lower water quality. The feed weaning process can be completed in three to five days.

Step 5. Harvesting and moving fry: Once fry have been actively feeding for two to three days, they can be stocked into a growout pond or tank.

Grow out ponds or tanks should be prepared and stocked no later than 1 0 days after being filled with water to avoid problems that would develop with aquatic weeds and/or establishment of predatory aquatic insects.

Fry transfer should take place during the morning and care must be taken to avoid extreme differences in temperature, pH and light intensity. Fry can be removed

from the rearing tank by siphoning with tygon tubing that has at least a 3/8-inch inside diameter.

Fry are siphoned into a bucket that has a 100 m screened section that has been cut into the wall of the bucket about three to four inches from the top of the bucket.

This allows the fry to be collected into a reservoir of water in the bucket and excess water to drain out without harming the collected fry. The bucket containing the fry can then be taken to the pond or tank where they can be acclimated before stocking

Mass production of Ornamental fishes

Mass production of Ornamental fishes

- Ornamental fish production for the aquarium industry is a multimillion dollar industry in the United States. Annual sales from Florida alone are estimated at over 175 million dollars in retail value.
- Because the vast majority of fish varieties sold originate from tropical regions of the world, in the United States, the majority of production is limited to South Florida. The Florida industry dates back to the early 1930s, but its major expansion has occurred in the last 20 years.
- Farms in Florida now produce over 700 varieties of ornamental fish and ship them to wholesalers and retail pet shops around the world. In a survey conducted by the Florida Department of Agriculture, the farm gate value of this crop was reported to be $33.7 million in 1989.
- Besides the production on Florida farms, there are minor operations in warm water springs in the Western U.S. and numerous "backyard" operations throughout the country. In the Far East, production centers are found in Thailand, Singapore, Indonesia, Hong Kong and Malaysia.
- In addition, there are hundreds of species which are only available as wild-caught specimens, either because no one has found a way to produce them on farms, or economics prohibit production; except for a handful of species, all marine ornamental fish are caught from the world's tropical oceans.

- Major centers for wild-caught freshwater fish are the Amazon river basin, the Congo river basin and the major rivers of Southeast Asia. With modern advances in air transportation, fish from other areas of the world are becoming more available to the industry as well.
- Production Ornamental fish are produced primarily in outdoor, earthen ponds. In Florida these ponds are almost all water-table ponds in sandy loams. In extreme south Florida, ponds are dug into the coral bedrock. Relative to other aquaculture ponds, tropical fish ponds are very small, averaging 25'x75', with a maximum depth of about 6'.
- The water level in the pond is dependent on the existing hydrology, and during times of drought (springtime), they must be supplemented with well water in many areas.
- The water quality of a given site is dependent on the soil type, which can vary abruptly in Florida. Classically, ponds in areas with high organic matter are acidic, and their total alkalinity and hardness may be low.
- But in Florida, typical pond water has a total alkalinity in excess of 100 parts per million (ppm) and a pH of 8--9. Ornamental fish comprise two broad categories: live-bearers and egg-layers.
- Live-bearers include guppies, mollies, platies and swordtails. Egg-layers include almost everything else; the major groups are barbs, tetras, gouramis, danios and cichlids.
- Live-bearers are grown almost exclusively in outdoor pools. The pool is pumped dry, hydrated lime is added as a sterilant, and an organic fertilizer such as cottonseed meal is added to start the pool.
- Once the pH has stabilized below 9 (lime sterilizes the pond by raising the pH to extremely high levels), the breeding fish are added to the pool. Stocking rates for breeding ponds vary greatly, from as few as 50 fish to as many as 1000. Selection of brood fish is extremely important, since genetic variation within a strain of fish can be great.
- Only the best specimens should be stocked in the breeding pool. Live-bearing fish are harvested almost exclusively with baited traps.
- The traps are placed along the edges of the pond early in the morning. Fish are often sorted and graded on the pond bank.

- Fish destined for market or stocking another pond are placed in buckets, while others are returned to the pond or discarded.
- Most live-bearers are hybrids or color variations, and many are discarded because their coloration, finnage or quality do not conform to the desired type.
- The number of discarded fish can exceed half the total production from a pond, especially in more exaggerated varieties, such as high-fins or lyre-tails. In addition, most live-bearers have extreme sexual dimorphism, i.e., males and females don't look the same, and buyers demand an almost equal male-female ratio in a given shipment.
- In most pond populations, the number of sexually mature males will lag behind the number of females, therefore, excess females are discarded because no males can be found to ship with them.
- Competition from the Far East is probably at its highest in the live-bearer section of the industry. Production techniques for egg-layers would encompass an entire book on fish reproduction.
- Major divisions of this group include mouth brooders, bubble nest builders, substrate spawners and egg scatterers.
- Some of these fish are spawned in ponds, similarly to live-bearers, but the majority require a hatchery for commercial production.
- Some species, most notably members of the cichlid family, will mate for life, and therefore, pairs of breeders are maintained in individual tanks where they spawn continuously for as long as five years..
- Grow-out time in the pond also varies considerably with the species being produced.
- Some species have a market for small individuals, and the farmer may harvest the pond after only two to three months of grow-out. When fish grow much slower or there is no market for small individuals, grow-out can take an entire year. Again, the extreme diversity of the industry prohibits gross generalizations in this area.

Multiplication of Aquarium plants

There are three types of multiplication of Aquarium plants.

1.Asexual Propagation:

2.Artificial Propagation:

3.Seed Propagation:

Many common plant species will reproduce on their own in a healthy aquarium. However it is often harder to obtain ideal conditions in the aquarium for all types of aquatic plants to readily propagate. Some aquarium plants will reproduce freely without assistance, while others will do better with some help.

There are a several types of plant propagation.

Reproduction is either by sexual or asexual means. Sexual propagation involves flowers and seed formation. Asexual propagation in plants, also called vegetative propagation, is without seed but through runners, offsets, and plantlets. Plant propagation techniques done with cuttings or rhizome dividing is artificial propagation.

Aquatic plants tend to favor asexual (vegetative propagation) or artificial propagation. Only a few depend on seed as their main method of plant propagation. In general, propagating aquarium plants is much easier when separating a part of the original plant and re-planting it, than by trying to grow new plants from seeds.

1.Asexual Propagation:

Most aquarium plants reproduce asexually, meaning that the offspring are genetically identical to the parent plant. This is also known as vegetative propagation. There are three different ways for aquarium plants to reproduce this way:

- **Runners (slips):** One way is for them to produce runners, which grow out from the base of the parent plant and then produce what are called "slips" at the end of the runners. These slips can eventually anchor themselves in the substrate and survive on their own. Sometimes the runners that are between the parent plant and the slips break away from the slips, and sometimes they just continue to grow and produce more slips. Usually, it is best to separate a slip and plant it on its own

once it is about a quarter the size of the parent plant.

- **Offsets:** Another asexual way that plants reproduce that is very similar to producing runners is producing offsets. Offsets also grow off of the main plant, but they grow extremely close to it and do not wander like runners do. These offsets can be removed from the parent plant and planted elsewhere in the aquarium.

- **Adventitious plantlets:** The last asexual way of reproduction is when small plantlets form on the parent plant, called adventitious plantlets. These can grow on any part of the plant, i.e. nodes, roots, leaves, or stems. After it has grown for a while, naturally its attachment to the parent plant will die off and it will be removed, however in aquariums you should remove them once they are about 3-4 cm and replant them yourself to ensure survival.

2.Artificial Propagation:

It is also often quite easy to artificially propagate many aquarium plants by simply cutting part of it off and replanting it (stem plants are the easiest to do this with); or by dividing the rhizome in two and replanting the two pieces (ferns and mosses can be propagated this way).

- **Cuttings:** The best place to take cuttings is from the top stems, however you can also take cuttings from side shoots and the middle stems as well, they are just not usually as strong as those from the top stems.
  To take a cutting, cut part of the plant off just above a node and remove any leaves around nodes that are directly above this. This is the area where the new roots will grow. Then plant the cutting into the substrate so that the nodes where you removed the leaves is just covered.

- **Rhizome dividing:** Plants that have rhizomes can also be artificially propagated by dividing the rhizome in two. You can do this by removing the plant from the substrate and carefully cutting the rhizome, being careful that both pieces have at least one good shoot growing from them. Then re-plant each piece of the parent plant.

3.Seed Propagation:

Propagating plants by way of seeds is often difficult to do, however it can be done. If you are trying to reproduce plants that propagate sexually, you should have

at least two of those plants, and they should be able to produce flowers above the water surface.

- **Parent plants:** Provide a low enough water level that the plants can easily grow strong aerial stems above water. After flowers have been produced, you must then transfer pollen from the stamen to the stigmas using a watercolor brush, cotton swab, or your finger depending on how large the flowers are.

- **Seedlings:** Seeds should be produced if pollination is successful and you'll want to plant them as quickly as possible. First, plant the seeds in damp soil rather than soil immersed in water. Once they start to grow above the soil, add a small amount of water. As the plants grow, continually add just enough water to keep them submerged in water.

Unit-V

Habitat of Marine ornamental fishes

Marine ornamental fish are widely collected from the coral reef habitats throughout the Indo- Pacific region. The marine aquarium trade has developed into a vibrant multimillion-dollar industry offering livelihood prospects to people who depend on the coral reef ecosystems.

They are found in a variety of habitats from boulder-strewn mountain torrents to small pools in dry zone streams. There are more than 12 species reported today of which Danio malabaricus (Pearl Danio), D. albolineata and Brachydanio rerio (zebra fish) are common in the hobbyist market.

Essential fish habitat includes coral reefs, kelp forests, bays, wetlands, rivers, and **even** areas of the deep ocean that are necessary for fish reproduction, growth, feeding, and shelter. Marine fish could not survive without these vital, healthy habitats.

Most marine life is found in coastal habitats, even though the shelf area occupies only seven percent of the total ocean area. Open ocean habitats are found in the deep ocean beyond the edge of the continental shelf. Alternatively, marine habitats can be divided into pelagic and demersal habitats

The marine habitats can be divided into deep ocean floors (benthic), mid-water oceanic (bathypelagic), surface oceanic (pelagic), rocky coast, sandy coast, muddy shores, bays, estuaries, and others. Also, for example, rocky coastal shores in tropical and temperate regions will have different fish faunas, even when such habitats occur along the same coastline.

Major marine ornamental fish resources in India

India possesses rich resources of marine ornamental fishes such as the lagoons and coral reefs of Lakshadweep and Minicoy islands, Andaman and Nicobar Islands, Gulf of Kutch, Coast of Kerala, Gulf of Mannar and Palk Bay.

Prominent among them are Loaches, Eels, Barbs, Catfish, and Goby. On the other hand, the Western Ghats of India is one of the 34 'Biodiversity Hotspot' Areas of the World. Among the total freshwater fishes reported from the Western Ghats, 40 are of ornamental value of which 37 species are endemic to the Western Ghats.

Marine fisheries resources in India:

The warm, fertile inshore waters of India are among the most productive fishing grounds in the world, yielding shrimps, sardines, mackerels, Bombay ducks, carangids, croakers, soles, and a variety of other marine fish. Marine products are a major component of India's overseas trade.

In India, Kerala, Tamil Nadu and West Bengal mainly practice ornamental fish farming in India. The ornamental species are categorized into indigenous and exotic. Availability of a vast number of native species has contributed significantly to the development of ornamental fish industry in the country.

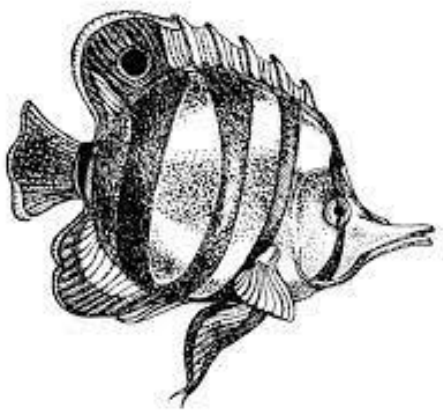
Marine ornamental fish are widely collected from the coral reef habitats throughout the Indo Pacific region. The marine aquarium trade has developed into a vibrant multimillion-dollar industry offering livelihood prospects to people who depend on the coral reef ecosystems.

Potential marine ornamental fish species resources are Clown Fish, Damsel Fish, Moorish Idol, Lion Fish, Parrot Fishes, Box Fishes or Trunk Fishes, Marine Angels, Butterfly Fish, Cleaner Wrasse, Cardinal Fishes, Sergeant Fishes/ Unicon Fish, Rabbit Fish, Squirrel Fish, Scorpion Fish, Blennies, Sand-smelt Fish and Seahorse.

Indian ornamental fish trade mostly deals with freshwater fish (90%) of which 98% are cultured and 2% are captured from wild. The remaining 10% are marine fishes of which 98% are captured and 2% culture. Majority of the Ornamental Fish Breeders in India breed exotic fishes and very few breed indigenous, marine and brackish water fish. Goldfish has the highest preference among hobbyists and hence its breeding dominates the Indian Ornamental Fish Sector.

Marine ornamental fishes

Butterfly fish (Chelmon rostratus)



Butterfly fish are generally small sized marine fish. Many species of butter fly fish have black stripes across their eyes and eye like spots on the body. The butterfly fish is well known for its brightly coloured body and elaborate markings. Today butterfly fish is considered to be an endangered animal. Butter- fly fishes are coral

reef fishes. Butterfly fish live near the coral reefs which serve as hiding place from predators and it is the main source of food

Distribution and habitat: There are 120 species of butterfly fish Butterfly fish are found throughout the Indian, Pacific and Atlantic Ocean. It lives in tropical and sub tropical waters primarily around coral reefs.

Behaviour: These fish are diurnal. Young ones appear in large schools. Adults are fairly solitary or stay with their mating partner. They hide themselves in crevices located in the coral to escape from predators. The spots & stripes tend to help them to escape from their predators.

Water quality conditions: Butterfly fish need close supervision and difficult to groom. Minimum 500 litre tank is needed. Water Temperature between 22-25°C is suitable and Carbonate hardness of 143-214 ppm is preferred, pH of 8.2-8.4 may be a suitable range for this fish.

Butterfly fishes are brightly coloured often yellow or white with darker contrasting markings that may conceal the eye Their colouration makes them as popular aquarium fish. Body is oval, laterally compressed, snout is pointed: face is flat. Mouth is small at the end of pointed snout. Ctenoid scales on the body extend on to the soft rayed potion of the dorsal and anal fins Eye spots are found on their Banks and dark bands are seen across their eyes. Dorsal fin is uninterrupted Tail fin may be rounded or truncated but never forked. It grows up to 4.7-8.7 inches in length in wild.

Food & feeding habits; Butterfly fish species feed on plankton, sea anemones, small crustaceans corals, zooplankton, crustaceans and molluscs in captive conditions, butterfly fishes can be fed with a varied diet of vitamin enriched marine fish, crustacean, mollusc flesh and mysid shrimp.

Sexual dimorphism: Sexually monomorphic. Occasionally males are found to be larger. Females show swollen stomach a couple of days prior to spawning.

Breeding:

Butterfly breeding is easy. Butterfly fish are pelagic spawners. Butterfly fish can be bred in captivity. For captive breeding aquarium should be loaded with water.

Water hardness is moderate and acidic water is suitable for rearing fry and finger lings. pH should be maintained between 7.0 and 7.8. Female release many buoyant eggs into the water floating with the currents until hatching.

The fry go through a "Tholichthys stage" where in the post larval fish is covered in large with bony plates extending from the head. Whenever they mature the larvae lose their bony plates. White eggs rise to the surface of the water and lay themselves on floating plants. After 24 hours the eggs turn dark and start sinking. These eggs are hatched out within 7 days, hatch lings are released.

Parrot fish

Kingdom;Animalia

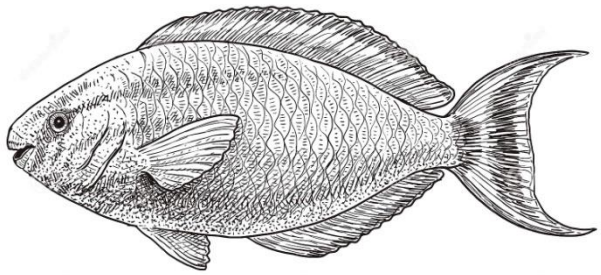
Phylum;Chordata

Superclass;Osteichthyes

Class;Actinopterygii

Order;Perciformies

Family;Scaridae



They are abundant on shallow reefs of the Red sea, Atlantic, Indian and Pacific oceans.

Parrot fish are named for their dentition. Their numerous teeth are arranged in a tightly packed mosaic on the external surface of the jaw bones, forming a parrot like beak.

This is used to rasp algae from coral and other rocky substrates (a process called bioerosion).

Many species are also brightly colored in shades of blue, green, red and yellow.

They are considered to be herbivores, parrot fish eat a wide variety of organisms that live on coral reefs.

Their bodies are deep, with large, thick cycloid scales.

The pectoral fins are large and the tail fins are homocercal.

They use pectorals for locomotion and the tail is only used when speed is required.

Life Cycle

Parrot fish of most tropical species form large schools grouped by size. If the dominant male of a school is re- moved, one of the females will change gender and adopt the dominant male role.

Parrot fish are pelagic Spawners.

Parrot fish has a beak similar to that of a parrot.

It is a marine ornamental fish.

It lives in the coral reefs.

It is brightly coloured like a parrot

It has numerous teeth on the jaws.

They are herbivores.

They feed on the algae of coral reefs and rocks.

They voraciously rasp the algae from the corals and rocks by a process called bioerosion.

The ingested coral rock is ground by pharyngeal teeth.

The digested coral materials are excreted as sand creating small islands.

The body covered by cycloid scales.

The pectoral fins are large.

The tail fin is homocercal

They can change their colour by a process called polychromatism.

They live in colonies.

Each colony has a dominant male and female.

When the dominant male dies, one of the females changes its sex into male.

They are pelagic spawners

Anemone fish/Clown fish

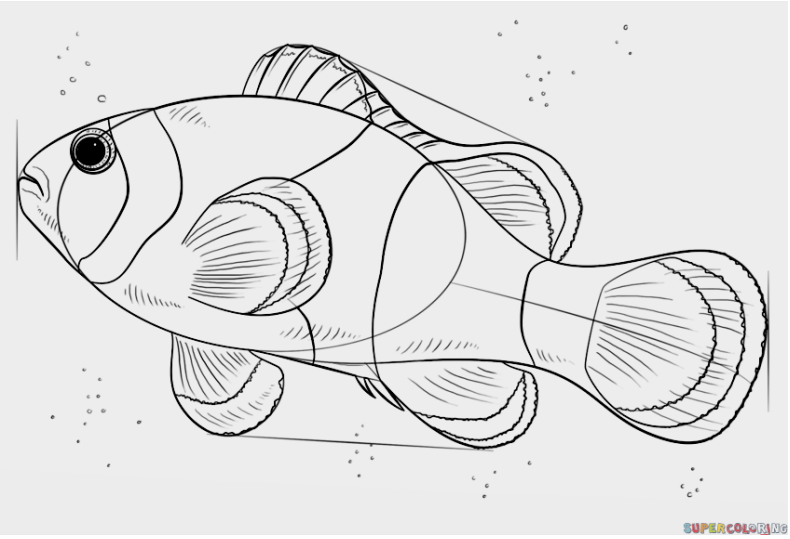
Kingdom ; Animalia

Phylum; Chordata

Class;Actinopterygii

Order; Perciformes

Family; Pomacentridae



Anemone fish is small, brightly coloured marine ornamental fish living among the tentacles of sea anemone.

It is also called clown fish as it is very actively 'clowning' around sea anemone.

It is brightly coloured with three white bands around the body.

It is small in size-2 to 5 inches.

It is a warm water fish living in coral reefs.

It is aggressive.

It leads a symbiotic life with sea anemone.

The mucous coat of clown fish protects it from the sting of sea anemone.

It is omnivorous.

Clown fish are sequential hermaphrodites.

It lives in a colony. The colony consists of a mating couple and their offspring. All offspring are males.

It is a territorial fish. It defends its anemone from other clown fish.

It is an aggressive fish.

All eggs hatch into males only.

On sexual maturity, one male changes into female. When the female dies, one dominant male changes into female. So the colony has only one female.

Female lays eggs in rock nests.

Male fertilizes and guards the eggs.

The eggs are hatched into males in 6 to 10 days.

They can live for 3 to 5 years in the aquarium and for 10 years in the wild.

Breeding of marine ornamental fishes

Breeding of clown fish: Clown fish are spawned in tropical warm waters throughout the year. Clown fish can breed under captive conditions.

Tank setup for breeding: A 250-500 litre tank is ideal for breeding. Breeding tank with a layer of coral sand at the bottom few live rocks, bright lighting arrangement and with good filtration system is necessary. Clown fish can spawn with host anemone in the wild but in captive breeding sea anemone is not required.

Water quality parameters for breeding: Water quality plays a key role for successful breeding. Water temperature from 26°C 30°C, dissolved oxygen from 4.8-6.3 ml/litre, pH range of 8.0-8.4 and salinity between 32-35 ppt are ideal. Water movement in ensured in the tank.

Spawning: Few days before spawning the male fish shows some behavioural changes such as extending his anal, dorsal and pelvic fins and involved in preparing the nest. First, male fish locates a spot on a bare rock under the sea anemone's tentacles. The bear rock is initially cleaned by the male with his mouth later assisted by the female. Before releasing the eggs, the female fish - gently brushes the surface of the nest and releases the eggs. Female lays the eggs a number of times Female is closely followed by male who fertilizes the eggs as and when female releases them. Spawning activity is completed between 30 minutes to 2 hours. The number of eggs released may vary from 100- 1,000 depending upon the size and age of the female. Each egg measures 3-4 mm in diameter.

Hatching: The male fish mouths and fans the eggs throughout the incubation period and also guard the eggs against predators. The eggs hatch out within 6-7 days after sunset and the hatchlings emerge from each egg and measures about 3-4 mm in length and they require 14 hours light. Photoperiod of 14 hours is maintained for larval rearing, by using 20 W fluorescent bulbs in larval rearing tanks. A 30% of water exchange every day yields good results. Rotifers form good live feed for larvae to get best survival. The hatchlings sink to the bottom, Later, they swim to the surface water due to phototaxis. The larva spends a week days along with the plankton. After 8-12 days of hatching, the juvenile clown fish settles to the bottom and search for the host sea anemone. after metamorphosis of larvae into juvenile fish are fed with artemia 3 times/ day. One month old juvenile fish. fed with mashed

fish meal and pellets. A repeated interaction with the host anemone stimulates the fish to produce its protective mucous coating. Young clown fish may become strong.

Breeding in blue ring fishes :

It can breed in captivity in aquariums but the survival of larvae is very poor. In wild, these fish are egg scatterers. The mature male and female will form harems. They breed year round. Each harem consists of a male defending several females in a small area. These fish spawn in pairs. Pairs congregate at edge of the reef at sunset. The pair are engaged in a courtship display where the male and female swim in a brisk head to tail circling motion. Spawning normally begins with the onset of dusk and is triggered by the decrease in light. Each pair will spawn and ascend into water column. They swim together in an arc up to 7-10 feet above the substrate. The female expels the pelagic eggs at the summit followed by spraying of milt by male.

Spawning takes place between only one male and one female at a time, but males possibly mate with more than one female within the group. Fertilisation is external in the sea water. Eggs hatch out within 15-24 hours. The eggs hatch out during sunset on the day after courtship ritual of parents and swim with the plankton for a month, before (metamorphosis) developing into juveniles. The blue ringed fishes are considered protogyrous hermaphrodites i. e., in the beginning of life all are females. As the development advances the larger fish become males. During development, drastic changes occur in the colouration patterns of juveniles to adults. The juveniles start out with alternating vertical blue and white stripes on a black background. As the juveniles grow up into mature adults, the vertical blue and white stripes disappear, the caudal fin whitens and the body colour or background becomes a dark orange to brown. Horizontal blue lines also appear and run from the back of the head/pelvic fin area to the caudal and dorsal fins.

Short Answer Questions:

Unit-I

Aquarium filters

Aquarium Filters

Your aquarium filter helps increase the quality of the water in your fish tank. Most think of mechanical filtration when it comes to aquarium filters but as you will soon see, there are some other filter types that you need to know about.

Mechanical, Biological & Chemical Aquarium Filters

There are three types of aquarium filtration:

Mechanical Filtration

Biological Filtration

Chemical Filtration

Mechanical Aquarium Filtration

Mechanical filtration removes the free floating particles from the aquarium water.

Biological Aquarium Filtration

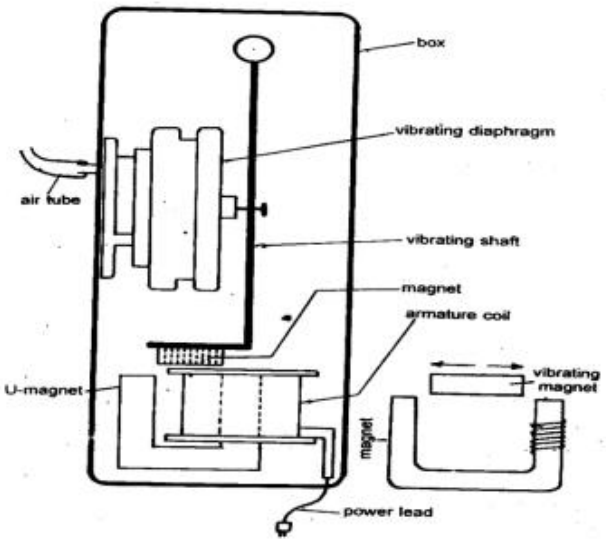
Biological filtration is the most important aquarium filtration type because it deals with the growing of the good bacteria in your aquarium filter. The good bacteria is the bacteria that converts ammonia to nitrite and then converts nitrite into nitrate. This establishment of bacteria is essential to your success with keeping tropical fish.

Chemical Aquarium Filtration

Chemical filtration involves removing the dissolved wastes from the aquarium water. Often times this is accomplished through the use of activated carbon in the aquarium filter. Activated carbon can also help to reduce odors. Many people dislike using carbon in their tanks due to the fact that the carbon is useful for only a short period and then must be replaced. If it doesn't disappointing loss of their fish. Using zeolite during the cycling process in your aquarium filter can help prevent

this from happening but it has the side effect of lengthening the time it takes to complete the aquarium nitrogen cycle.

Aerators



Aerator is an air-pumping device which is electrically operated. The device consists of a vibratory air pump – a tiny rubber diaphragm. When alternating current (A.C) passes a shaft bearing a magnet vibrates briskly under a magnetic field effect.

As the shaft is attached to the diaphragm, the latter is allowed to vibrate up and down like a piston, producing a forceful stream of air.

The air flow is then directed into the bed of the aquarium tank using plastic air tubing (thin pipe).

At the opening, a diffuser (air stone) may be used to produce tiny bubbles of air. The aerator is a very useful handy device for small home aquarium. They are cheap, long lasting and need little maintenance.

However, there are a number of drawbacks too. First, they produce an unpleasant, rather loud, humming sound.

Second, they are ineffective in large and deep tank. It must be noted that an aerator does not generate fresh air.

On the contrary, it only pumps out into the tubing the air of the surrounding. An aerator is likely to drive any fumes, chemical vapours and so forth along with the air into the aquarium tank which may prove harmful to fish.

It should therefore not be operated if any such situation exists in the room.

Apart from its role in aeration of tank water, aerator has a role of air-lifting of water for filtration.

In Under gravel filter, an aerator is used to confine the rising stream of air-bubbles into a narrow vertical tube (the uplift pipe) to bring about air-lifting of water and any suspended particles in it.

Power air-pump

To produce aeration in large and deep aquarium or a battery of aquaria, such as those installed in public aquaria, more powerful electric motor driven piston-pumps or rotary pumps are used.

They are more efficient due to high output and noiseless running. However, they are expensive and need care and maintenance more frequently.

Spray bar

The outlet of power filter is fitted with a spray bar to enhance aeration of water as the filtered water is returned to the aquarium tank.

The spray bar is a perforated tube which produces a rain of small droplets of water falling on the surface of tank water.

The agitation of water produced at the surface by falling water drops helps in better oxygen diffusion at air-water interface.

Water quality requirements

The quality requirement of water in the aquarium **depends on the types of the fishes being kept there**. The tap water is probably the safest source of aquarium water for majority of tropical fish. However pH, dissolved oxygen, hardness, ammonia, chlorine, temperature, salinity etc.

Fish obtain their basic necessities from the water in which they live. The most characteristic feature of any aquarium system is therefore the quality of the water it contains. Aquarium should be filled with clear portable water. The quality requirement of water in the aquarium depends on the types of the fishes being kept there. The tap water is probably the safest source of aquarium water for majority of tropical fish. However pH, dissolved oxygen, hardness, ammonia, chlorine, temperature, salinity etc. plays important role in management of aquarium.

This water must be obtained from some source, pre-treated to make it suitable for the fish, delivered to the fish in sufficient quantities and maintained in good condition. Finally, it must be disposed of.

The water supplied to an aquarium is not pure, but contains dissolved and particulate materials, some are necessary for the well-being of the fish and others are harmful.

Unit-II

Under gravel filters

Under gravel filters are commonly found with beginner's aquarium kits and the under gravel filter has been around for a long time.

Under gravel aquarium filters can provide good mechanical filtration because it forces the water down through the aquarium gravel where particles are trapped.

You can then use an aquarium vacuum to clean the detritus.

Biological filtration occurs in the gravel because of the slow flow of water through it.

The water is then pushed up through the uplift tubes in the back of the tank where chemical filtration takes place with the activated carbon in the top of the tubes.

The problem with this type of aquarium filter stems from the fact that it can be difficult to thoroughly vacuum the gravel and harmful gas pockets can form under the gravel plates thereby harming your tropical fish.

There's a lot of controversy surrounding the use of under gravel filtration. Check out The Under gravel Filter Controversy for more on this subject.

Many long time fish keepers still use the under gravel filter and swear by it.

If you do use an under gravel filter try to regularly vacuum your gravel to prevent the harmful gasses from forming.

Quarantine measures

Understanding the concept and importance of a quarantine tank should be the first step to fish-keeping. Many aquarists are not aware of the significance of the quarantine tank and keeping every new fish in it before the main tank. If you know the concept of a quarantine tank, you can easily avoid most of the uncertainties or conflicts coming on the way of fish-keeping.

A quarantine tank is useful for both- the new fish from the shop and the sick fish from your own tank. Also, whether you have a freshwater fish or marine water fish, quarantine is an essential process for both.

FOR NEW FISH

So now that you are planning to get a new fish for your display tank, it’s time to prepare the quarantine tank first. Take out your container or tank and fill half of it with pure drinking water and the rest with the mature water from your display tank. Now add filter and filter media into the tank and run it for at least 45 minutes before adding a new fish.

Maintain the temperature as per the fish's specific requirement or else around 24 to 25-degree centigrade, which is optimum for most of the species. Once the temperature is maintained, you can add the newly bought fish for a certain period to quarantine in this temporary home.

For Sick Fish

If one of your fish in the display tank gets sick or injured and you want to treat it, transfer it into the quarantine tank (in this case, hospital tank). First of all, add fresh and pure water to the tank, place the filter and water heater and maintain the desired temperature. The temperature should be similar to that of the display tank to avoid sick fish coming under stress. Now add your unwell fish and provide the required medications.

If you are not sure about the medicines, take help from the experts. However, to boost immunity, you can simply give medicated fish feed. At this time, anti-protozoan flakes and Deworm flakes work wonders in improving the condition of the sick fish.

Adding bacterial additives will be a good decision to help your new fish become accustomed to the new environment. You can also go for a seeded sponge or biofiltration in the quarantine period. It will promote the nitrogen cycle and ensure a healthy environment inside the tank.

quarantine period

Ideally, the quarantine period ranges from 2 to 6 weeks. However, for how many weeks the fish needs to remain in the quarantine tank will depend upon its symptoms, activity, and behavior. If the fish seems bubbly and lively, two weeks of quarantine is enough, or else you can extend it accordingly.

Ensure that you are maintaining the feeding and medication schedule in this period, just like you do in your main tank. In this way, the fish will bend to the new routine as well as the new environment. Once your new fish is adjusted, everything becomes easy and manageable.

Temperature acclimation

Acclimation is the process where you introduce a fish, coral, or invertebrate to new water conditions without causing shock that would harm the animal.

If you remove a fish from a tank where the water is maintained at 75 degrees, and place it in a tank with 80 degree water, the fish could die from shock. However, if you gradually introduce warmer water – by "floating the bag" for freshwater, or drip *acclimation*, which we'll discuss shortly – the fish will not suffer, and will be matched to the conditions of the new tank.

There are many variations to the acclimation method, but the goal is the same: slowly introduce the animal to water conditions from the new system. For freshwater community fish, you can simply place the store bag, still sealed, in your tank and let it float. Depending on the temperature difference, it should take 15-30 minutes for the bag's temperature to equal your tank's water temperature. Once this is done, the fish can be added to your tank, but don't pour the bag's contents into your tank; pour the bag through a net into a sink, then put the netted fish in the tank.

The Floating Bag Method only acclimates for water temperature. With sensitive freshwater fish, and all saltwater animals, you have to consider the other parameters that affect them. Things like pH, kH, salinity (for saltwater and brackish fish), nitrates, levels of trace elements like iodine and magnesium, these are all water parameters that can affect the health of your newly acclimated fish. It seems intimidating, at first, to think that you can match all these water parameters perfectly for your fish. But it's not difficult at all, if you follow our instructions for the Drip Acclimation Method.

Drip acclimation requires two items: a length of air hose tubing, and a container to hold your new fish (for the sake of brevity, we'll talk about acclimating fish, though this also applies to invertebrates and corals).

Place your new fish and the water from the bag into your container. Anything about a gallon in size is good; if it's a big fish, bigger than six inches, use a five gallon bucket. Don't "fill the container with fish" – make sure there's room for it to be comfortable, so it can at least turn around. You want enough water in the container so that it covers the fish's fin, and a bit more. For example, anything damsel/dotty back/blenny sized would need less than 2 inches of water; a big yellow tang might need five or six inches.

Take the air hose tubing, and clip one end into your tank. If you have a cleaning magnet, this makes a great clamp. Place the container with fish next to the tank, then start a siphon by sucking briefly on the air hose. You should get a nice stream of water into your container. This, however, is too fast; it needs to be a drip. Tie a pretzel-knot in the air hose line, and slowly pull it tight. You're waiting for the stream to change to a fast drip. Don't let it drip too slow, or the water will cool too rapidly.
The rate of the drip should cause the water level to double in about fifteen minutes. When this happens, pause the drip and pour out half of the water. Now your container holds 50% old and 50% new water! Continue the drip. Each time you do this, you're reducing the old water by 50% – next time it's 25% old water, then 12.5%, etc – so after five times, you have reduced the "old" water in the container to less than 10%. At this point, verify the water is the same by comparing salinity using a hydrometer (skip this, obviously for freshwater), net your new fish and introduce him to his home.

Objects and selection of fishes in aquarium

An aquarium is a fish tank containing ornamental fish, plants, and decorations for recreation.

Objects Used In The Aquarium

Fish tank, cover glass, hood, gravel, heater, thermometer, filter, filter medium, aerator, air stone,

Decoration materials: aquarium plants, plastic plants, rocks, wood, branches.

Fish selection in the aquarium

Small and social fish are ideal. Small fish in groups of two males and six females are very suitable. Fish species are easy to breed.

- The maximum size of the fish should not exceed 3".
- The quality of the water should be good.
- Fish species should be omnivorous.
- Fish species should be attractive and fascinating.

Water quality management

The following are the most important physical and chemical parameters of water to consider before keeping fish in an Aquarium: pH:

pH pH is the logarithmic expression of the reciprocal value of the hydrogen ion concentration. It is a scale of measure (1- 14) of how a substance is acidic or alkaline. Water pH plays an important role in physiological activities of fish, decomposition of uneaten food and dead organisms. pH of fish blood is 7. 4 and the optimum tolerance range for fish is 6.5 to 8.5. Fish will be under stress if the pH of the water is beyond the tolerance range. pH of the aquarium water is changed during morning and evening due to algal growth and live plants. The pH changes can adversely affect fish health especially the delicate gill membranes followed by skin.

Temperature: Fishes are cold blooded i.e., the body temperature changes according to the environment. Temperature is the most important and deciding environmental factor in determining feeding efficiency, growth rate and metabolism. Fish growth is reduced and mortalities may occur beyond extremities of the tolerance range of temperatures.

A temperature range of 20°C to 24°C is suggested for general maintenance in captive condition. The optimum temperature for tropical aquarium fish is 28°C to 32°C. If the temperature falls below 28°C the fish loses its activeness leading to poor growth. In aquarium, higher temperature increases the rate of metabolism of fish and oxygen demand.

Dissolved oxygen: Dissolved oxygen levels are always kept to saturation point by keeping mechanical means i.e., through diffuser (air stone) on the bottom of the aquarium to agitate the water as much as possible to eliminate CO2 and NH3 and enrich the water with oxygen.

Dissolved oxygen is not only for respiratory requirement of fish but also for oxidation of toxic gases (ammonia & nitrite). For maintaining optimum levels of dissolved oxygen in the aquarium, detritus, uneaten food and decaying materials are removed before decomposition and mechanical means of aeration in the tank is arranged. Dissolved oxygen problems arises due to over feeding high stocking density, algal blooms, etc.

Alkalinity: Alkalinity is a measure of bases i.e., carbonates and bicarbonates of water. Alkalinity is the capacity of water to neutralize acids. Alkalinity is also a very important water parameter for nitrification process in bio filters. Optimum range of alkalinity for aquarium fishes is 75 to 120 ppm. High alkalinity leads to fluctuations in pH which results in poor growth, as the fish is under stress.
Hardness: Water hardness is a measure of dissolved mineral salts mainly calcium and magnesium. Calcium and magnesium ions of water are essential for bone formation, blood clotting and other metabolic activities of fish. Calcium is the most important divalent salt essential for osmoregulation and helps to reduce the loss of salts like sodium and potassium. Hardness between 60 and 100 ppm is ideal for aquarium fish. Hardness of aquarium water should be tested frequently.

Ammonia: Ammonia is a toxic gas build up in the aquarium or any aquatic environment due to the uneaten food, excreta of fish and decomposition of organic waste. Majority of ammonia excreted by fish through gills and some is excreted through urine and feces. The amount of ammonia excreted by fish varies with the amount of feed used in aquarium.

The optimum ranges of different water parameters in an aquarium are as follows:

S No	Name of the parameter	Optimum Range
1.	Water temperature.	28°C - 32°C
2.	pH.	7.0 - 8.0
3.	Dissolved oxygen.	5 - 8 ppm
4.	Alkalinity.	75 - 120 ppm
5.	Water hardness.	60 - 100 ppm
6.	Ammonia.	<0.1ppm
7.	Nitrite	<0.1ppm

Good sanitation will lead to good water quality. Maintaining good water quality is the most important consideration in aquarium. Fish keeping involves proper

feeding, provide good filtration, usage of quality gravel or sand, artificial decors and lighting (photoperiod).

Steps to be taken for management of water quality:

1. Source of water should be tested before use.

2.Aquarium tank water should be conditioned before introducing the fish.

3. Water parameters should be checked periodically with reliable quality test kits.

4. Adequate aeration is arranged.

5. Proper selection of species is very essential.

6. Water filters should be cleaned and serviced regularly.

7. Disinfect the tank and equipments regularly.

8. Avoid over stocking and over feeding.

Packing and transport of live fish

Packing And Transport Of Fish

There comes the time when you carry out your plan to have your own aquarium and fish, you are already in the shop and buy future residents of a beautiful water tank and now your are faced with a challenge – how to transport them safely home? You will also have to face a similar task when moving. Transporting the fish is a very important issue, because mistakes can result in health problems or may even endanger their lives.

Fish transport in a plastic bag

You are certainly familiar with the sight of fish being transported in a plastic bag. But don’t let looks fool you! It can’t be a standard grocery store bag. Using it for

transporting living organisms could be disastrous, because you have no guarantee that it is leakproof. What's more, there is also uncertainty as to what kind of plastic it is made of, so it is possible that in contact with water, the plastic will start to release toxins and poison the fish. This is why pet shop owners offer special bags. They are made of safe materials and have rounded edges, which protects the fish from getting stuck in sharp corners.

During transport the fish need oxygen, so the bag should be filled with water to 1/3 of its height. This will provide the aquarium inhabitants with the necessary air. Remember that the bag with the fish should be transported in a stable upright position. It is best to place it in a box (the darkness reduces the stress of the transported animals). The time of year when you make the purchase is also important. In winter you should ensure thermal insulation in the form of a Styrofoam container. You can also use special heat-insulating boxes intended for transporting food.

What happens next? When you get home, don't put the fish in the aquarium right away. The change of the temperature and water environment can be a shock to them. Therefore, place the bag in the aquarium and wait until the water in the bag equals the temperature in which they will eventually stay. Then add some aquarium water to the bag and wait a quarter of an hour, then repeat this procedure and move the fish to their home with a net after another 15 minutes. Note! Do not pour water from the transport bag into the aquarium as it is heavily contaminated with metabolites that the stressed fish produced during transport.

Unit-III

Live bearers

The fishes giving birth to young ones are called livebearers.

Eg: Swordtails, Guppies,Mollies, Platys, Sharks, Split fins, Half beaks, Sea horses,Pipe fishes

The livebearers are of two types namely,

- Ovoviviparous .
- Viviparous

Ovoviviparous fishes retain the eggs inside their body, eggs are hatched inside the body and young ones are born. The eggs do not receive any nutrition from the mother.

Eg. Guppies,Mollies

Viviparous fishes keep the embryo inside the body, supply nutrition through placenta-like tissue and the young ones are born.

Eg : Split fins, Half beaks, Sea horse, Pipe fish

In sea horse and pipe fish, the eggs are layed by females; but the males pick up the eggs and keep them in a brood pouch. They supply O_2, and nutrition through a placenta-like organ. The eggs are hatched inside the pouch and the young ones are born.

Live-bearers exhibit copulation and courtship behaviour.

They have Copulatory organs. Swordtail has gonopodium-pointed long anal fin.

The young ones are precaucious-active immediately after birth.

The young ones can swim actively and hide immediately after birth.

So livebearers produce less number of young ones-20 to 40 in a season.

They exhibit sexual dimorphism. Males are brightly coloured.

Female can store sperm for several months.

They are calm and not aggressive.

They prefer hardwater.

They live in groups. A school has one male and several females.

Gestation period is about 4 weeks.

Maturation in ornamental fishes

The ability to reproduce for the first time is called sexual maturity. Several factors influence the time of maturity. These factors include species difference, age and size as well as individual physiology. In general, species of small maximum size and short life span mature at younger age than do kinds of large maximum size. Some fishes are sexually mature at birth. Males of the reef-perch (Micrometrus aurora) and of the dwarf perch (M.minimus) spawn shortly after birth. Although the females of these species receive sperm soon after they are born they do not bear young until a year later. Guppies (Lebistes) mature at an age less than a year and a length of an inch or less although they are not born in an adult stage. Many fishes mature at the age of 1 year.

Age at maturity is controlled both by intrinsic and extrinsic factors. Internal factors include the pituitary gonadal interactions, individual physiology, hormones, etc. External factors include presence of opposite sex, current, tide, stage of the moon and the presence of spawning facilities.

The term "maturation" can be defined as the **cyclic, morphological changes that the male and female gonads undergo to attain full growth and ripeness**. "Spawning" refers to the release of male and female gametes from the body of fish to the exterior environment where fertilization takes place.

The maturation and spawning of the fish **can be improved through the nutritional quality of the brood stock diet,** as respected by many researchers. There is a need to control the cost of feed that is used in ornamental fish farming, which can help in the large-scale adoption of the formulated diet for brood stock management.

24-hour light conditions had almost a total suppression of early sexual maturation in both males and females and an increased growth rate compared to the fish in natural light conditions.

Breeding habits

Fish have developed many different ways for gaining nearness of sperm and egg to each other in order to facilitate and insure their union. For external fertilization, proximity of two individuals of the opposite sex for spawning is the most common means employed Actual pairing and some form of holding (amplexes) is sometimes used as a special development of proximity. In pairing some fishes come side by side in actual contact and simultaneously emit eggs and sperm. In other instances the male twist his body around female in a semicircle.

Eg. Gourami

For internal fertilization, several devices have evolved in fishes. Most common among them is the placement of sperm by the male into the reproductive tract of the female in the process of intromission. For this, the important adaptation includes the modification of anal fin into gonopodium (Poecillidae).

Release of the sex products at the right time by both sexes guarantee the proximity of eggs and sperms. This is brought about in many fishes by definite courtship behavior pattern. In this sound emission and pheromone play an important role. The male may swim circles around the female or prod, bunt, rub, fan, herd her or do anything to signify that "now is the time". Fishes showing strongest courtship appear to have produced smaller number of eggs. In fishes, the males are very active courters assume the task of caring for the eggs.

Aquarium fishes will breed in captivity only when all the aquarium conditions such as temperature, light, quality of water are in ideal conditions.

Most fishes do not breed continuously. The following clues will help one to identify the actual breeding pair:

1.The sides of the fish fill out and females, packed with eggs, become especially plump.

2. Coloring become more intense.

3. Males may display to the female with rigid out stretched fins.

4. They tend to become more active in exploring possible spawning sites. Phases breeding:

There are three phases in fish breeding. They are the pre-spawning activity, actual spawning activity and the caring eggs and youngones.

Cichlids

Cichlids are rather deep-bodied and have one nostril (rather than the usual two) on each side of the head.

The lateral line is discontinuous, and there are three or more anal spines. They generally have rounded tails and, though sizable for aquarium fish, usually do not grow longer than about 30 cm (12 inches).

Most cichlid movements are either threats or flirting.

Telling the difference between the two is fairly difficult. Shimmying or shaking of the fins and tail are usually signs of flirtation. I've also seen circular chasing and nipping or kissing (where the two fish grab each other's mouths) prior to mating.

Cichlids are **useful for studying the process of how new species evolve** because 2,000 unique species have evolved in the last 10 million years.

Few other animals offer the opportunity for scientists to study speciation in this way. But cichlids are not only important for understanding how species emerge.

Cichlids are found in almost every possible body of freshwater within their geographic range, including **rivers, lakes, swamps, and even ditches and puddles**.

They are not found at high elevations and generally require water warmer than about 68 degrees Fahrenheit (20 degrees Centigrade).

Secondary sexual characters

The characters developing during sexual maturity, distinguishing male from female and are not directly connected to reproductive system are called secondary sex characters.

They develop during breeding season. They help in courtship and mating.

They create sexual dimorphism.

They are not directly involved in reproduction. They are assisting reproduction.

They are accessory to primary sex organs such as

testis, ovary,etc.

Ornamental fishes provide the following secondary

sex characters:

1. Size difference

2. Shape difference

3. Bright colouration

4. Enlarged fins

5. Modified fins

6. Breeding tubercles

7. Hooks

Males are smaller in size. Females are larger in size. Eg. Gold fish.

Males have normal belly, females are pot-bellied. Eg. Gold fish.

Males are brightly coloured. Females are dull coloured. Eg. Guppies, Mollies.

Males develop nuptial tubercles (pearl organs).

The lower tail fin is extended to form a gonopodium. Eg. Swordtail.

• Males develop a spiny retractile knob called frontal clasper on the head.

Eg. Chimaeras

Development of eggs

Egg morphology

When it comes to the morphology of eggs, there was no lipid droplets found and the egg yolk was red colored. Fertilized eggs were found to be sticky demersal egg and the diameter of eggs were ranging between 0.91–0.93 mm (mean 0.92 ± 0.01 mm, *n*=10).

Egg development processes

Two hours after the fertilization, eggs were in the 32-cell stage and then reached the 64-cell stage after 2 hours and 30 minutes. Three hours later, eggs were in the morula stage and subsequently reached the blastula stage after 3 hours and 30 minutes. After 4 hours, a blastula covered the yolk, and the early gastrula stage was begun.

The sphere was closed after five hours of fertilization, and then the embryo started to form. The head part of the embryo started to develop after 6 hours and 30 minutes of fertilization. After 7 hours, optic vesicles were formed in the head of the embryo and Kupper's vesicles were found.

Auditory vesicles and 13–17 myomeres were formed after 8 hours and 30 minutes of fertilization, while Kupper's vesicles disappeared.

After 11 hours, there were 20–25 myomeres, and the tail was separated. Subsequently, 11 hours and 30 minutes later, more myomeres (26–28) were found and membrane fins were formed. More myomeres, approximately 30–32, were found after 13 hours and 30 minutes, and a heartbeat was detected while the tail was getting narrow and elongated.

The embryo began to move after 14 hours and 30 minutes of fertilization, and blood circulation through the yolk was observed. In this period, myomeres were increased to 35–38.

After 15 hours of fertilization, right before the hatching, the number of hearts beating was 70–75 per minute. Sixteen hours later, the upper head was directed at the front end of the egg membrane and started to hatch.

1) Prelarvae stage

Right after their hatching, the whole length of the larvae was between 2.76 and 3.05; the mouth and anus were closed, and all fins were membranous. Melanophores were precipitated on the yolk, and the numbers of myomeres were 35–38 in this period. After two days of hatching, the whole length of the early larvae was 3.21–3.80 mm.

2) Postlarvae stage

On day 5, the whole length of postlarvae was ranging between 3.57 and 4.20 mm, the membranous ventral and anal fins were separated, and five softrays were formed on the caudal fin. The head itself was approximately 69% of the total body proportion, which seems relatively big considering the body size.

3) Juvenile stage

On day 45, the whole length of fries was 11.9–14.1 mm (mean 12.5 1.60 mm), and melanophores were precipitated on the middle of the dorsal fin as well as the gill cover, while these were precipitated like a horizontal stripe on the end of the anal fin.

Unit-IV

Commercial production of angel fish

One of the most popular tropical fish kept in the aquariums is the Angelfish. Angelfish belongs to the Cichlidae family and especially the species Pterophyllum scalare were found in the Amazone river and in the coastal rivers of Guinea.

Angelfish form monogamous pairs. Eggs are generally laid on a vertical surface: a piece of wood, a flat leaf, or even the aquarium glass. Breeders often provide an artificial spawning site such as a piece of slate, a ceramic cone, or a vertical piece of plastic pipe.

Breeding angelfish is a rewarding experience that can have its challges, especially if you're not familiar with the species or if you're a beginner aquarist.

Generally, angelfish are relatively easy to breed if you ensure that all necessary conditions are met, and you have a cooperative breeding pair.

In some cases, your angel fish pair may be fussy about everything and you may need to get everything just right for them to be willing to breed.
If it's your first time breeding angelfish, you may encounter difficulties not only with the breeding process itself, but also with caring for angelfish babies.

In this comprehensive guide on how to breed angelfish, I will present you the particularities of breeding angelfish, preparing you ahead of time for the issues you may encounter.

Areas of importance in angelfish breeding include:

1. Setting up a breeding tank;
2. Ensuring water conditions optimal for breeding;
3. Determining the gender of angelfish and finding a breeding pair;
4. Feeding angelfish;
5. Hatching the eggs;
6. Caring for the fry.

Mass production of Ornamental fishes

Ornamental fish production for the aquarium industry is a multimillion dollar industry in the United States. Annual sales from Florida alone are estimated at over 175 million dollars in retail value.

- In addition, there are hundreds of species which are only available as wild-caught specimens, either because no one has found a way to produce them on farms, or economics prohibit production; except for a handful of species, all marine ornamental fish are caught from the world's tropical oceans.
- Major centres for wild-caught freshwater fish are the Amazon river basin, the Congo river basin and the major rivers of Southeast Asia. With modern advances in air transportation, fish from other areas of the world are becoming more available to the industry as well.
- Production Ornamental fish are produced primarily in outdoor, earthen ponds. In Florida these ponds are almost all water-table ponds in sandy

loams. In extreme south Florida, ponds are dug into the coral bedrock. Relative to other aquaculture ponds, tropical fish ponds are very small, averaging 25'x75', with a maximum depth of about 6'.

- Most live-bearers are hybrids or color variations, and many are discarded because their coloration, finnage or quality do not conform to the desired type.
- The number of discarded fish can exceed half the total production from a pond, especially in more exaggerated varieties, such as high-fins or lyre-tails. In addition, most live-bearers have extreme sexual dimorphism, i.e., males and females don't look the same, and buyers demand an almost equal male-female ratio in a given shipment.
- In most pond populations, the number of sexually mature males will lag behind the number of females, therefore, excess females are discarded because no males can be found to ship with them.

Asexual Propagation

Most aquarium plants reproduce asexually, meaning that the offspring are genetically identical to the parent plant. This is also known as vegetative propagation. There are three different ways for aquarium plants to reproduce this way:

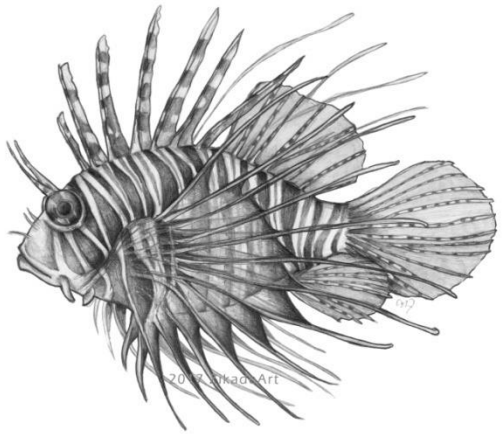
- **Runners (slips):** One way is for them to produce runners, which grow out from the base of the parent plant and then produce what are called "slips" at the end of the runners. These slips can eventually anchor themselves in the substrate and survive on their own. Sometimes the runners that are between the parent plant and the slips break away from the slips, and sometimes they just continue to grow and produce more slips. Usually, it is best to separate a slip and plant it on its own once it is about a quarter the size of the parent plant.

- **Offsets:** Another asexual way that plants reproduce that is very similar to producing runners is producing offsets. Offsets also grow off of the main plant, but they grow extremely close to it and do not wander like runners do. These offsets can be removed from the parent plant and planted elsewhere in the aquarium.

- **Adventitious plantlets:** The last asexual way of reproduction is when small plantlets form on the parent plant, called adventitious plantlets. These can grow on any part of the plant, i.e. nodes, roots, leaves, or stems. After it has grown for a while, naturally its attachment to the parent plant will die off and it will be removed, however in aquariums you should remove them once they are about 3-4 cm and replant them yourself to ensure survival.

Unit-V

Lion fish



Lion fish (Pterios volitaris)

They are commonly called as radial fire fish, clear fin lion fish, clear fin Turkey fish, tail bar lion fish or white fin lion fish. Lion fish are found in the Indo Pacific. Habit and habitat: Radiate fish are found both inshore and offshore rocky reefs at a depth of 82 ft. Juveniles are sometimes found in tide pools.

They are well known for their ornate beauty, venomous spines and unique tentacles. Long non-venomous rays are present on the pectoral fins.

There are stiff, dagger like dorsal, pelvic and anal fin spines which deliver the painful punch of the venom Body is covered with delicate skin (cuticle) which can be periodically shaded off. It has red, white and black vertical stripes over the body

with large fan like structure from pectoral fins and quill-like dorsal fins. This can be easily recognized with white stripes decorated tail

These are carnivores and require a diet that is very rich in meaty foods. It prefers mysis, brine shrimp small fish, clams, squids, shrimp and scallops

Behaviour: They are semi-aggressive in nature. Radiate fish are nocturnal in the wild. In aquarium also, they like to hide inside the caves

Breeding habit: They spawn year round in warm waters. Female can spawn very often at 3-4 days interval Female produces 2 egg sacs every 4 days. Each egg sac contains 15,000 eggs. The male use their spines & fins in visual display to attract the female (mate).

Life cycle: The eggs hatch out within 24-36 hours. Juveniles move in groups consisting of nearly 40 individuals. The larva leads free swimming life for 25-30 days and search for a hideout at the sea floor. After hatching, the larva is free swimming and it feeds on ciliates and zooplankton for 4 days.

Major marine ornamental fish resources in India

India possesses rich resources of marine ornamental fishes such as the lagoons and coral reefs of Lakshadweep and Minicoy islands, Andaman and Nicobar Islands, Gulf of Kutch, Coast of Kerala, Gulf of Mannar and Palk Bay.

Prominent among them are Loaches, Eels, Barbs, Catfish, and Goby. On the other hand, the Western Ghats of India is one of the 34 'Biodiversity Hotspot' Areas of the World. Among the total freshwater fishes reported from the Western Ghats, 40 are of ornamental value of which 37 species are endemic to the Western Ghats.

Marine fisheries resources in India:

The warm, fertile inshore waters of India are among the most productive fishing grounds in the world, yielding shrimps, sardines, mackerels, Bombay ducks, carangids, croakers, soles, and a variety of other marine fish. Marine products are a major component of India's overseas trade.

In India, Kerala, Tamil Nadu and West Bengal mainly practice ornamental fish farming in India. The ornamental species are categorized into indigenous and

exotic. Availability of a vast number of native species has contributed significantly to the development of ornamental fish industry in the country.

Marine ornamental fish are widely collected from the coral reef habitats throughout the Indo Pacific region. The marine aquarium trade has developed into a vibrant multimillion-dollar industry offering livelihood prospects to people who depend on the coral reef ecosystems.

Potential marine ornamental fish species resources are Clown Fish, Damsel Fish, Moorish Idol, Lion Fish, Parrot Fishes, Box Fishes or Trunk Fishes, Marine Angels, Butterfly Fish, Cleaner Wrasse, Cardinal Fishes, Sergeant Fishes/ Unicon Fish, Rabbit Fish, Squirrel Fish, Scorpion Fish, Blennies, Sand-smelt Fish and Seahorse.

Indian ornamental fish trade mostly deals with freshwater fish (90%) of which 98% are cultured and 2% are captured from wild. The remaining 10% are marine fishes of which 98% are captured and 2% culture. Majority of the Ornamental Fish Breeders in India breed exotic fishes and very few breed indigenous, marine and brackish water fish. Goldfish has the highest preference among hobbyists and hence its breeding dominates the Indian Ornamental Fish Sector.

Breeding in clown fish

Breeding of clown fish: Clown fish are spawned in tropical warm waters throughout the year. Clown fish can breed under captive conditions.

Tank setup for breeding: A 250-500 litre tank is ideal for breeding. Breeding tank with a layer of coral sand at the bottom few live rocks, bright lighting arrangement and with good filtration system is necessary. Clown fish can spawn with host anemone in the wild but in captive breeding sea anemone is not required.

Water quality parameters for breeding: Water quality plays a key role for successful breeding. Water temperature from 26°C 30°C, dissolved oxygen from 4.8-6.3 ml/litre, pH range of 8.0-8.4 and salinity between 32-35 ppt are ideal. Water movement in ensured in the tank.

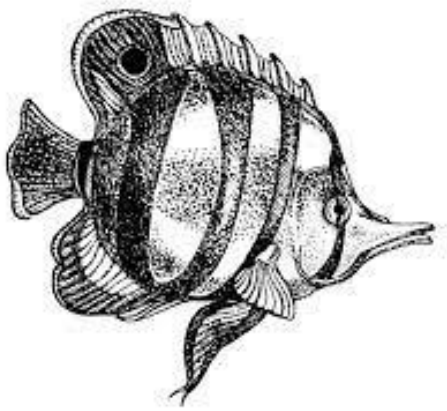
Spawning: Few days before spawning the male fish shows some behavioural changes such as extending his anal, dorsal and pelvic fins and involved in preparing the nest. First, male fish locates a spot on a bare rock under the sea anemone's

tentacles. The bear rock is initially cleaned by the male with his mouth later assisted by the female. Before releasing the eggs, the female fish - gently brushes the surface of the nest and releases the eggs. Female lays the eggs a number of times Female is closely followed by male who fertilizes the eggs as and when female releases them. Spawning activity is completed between 30 minutes to 2 hours. The number of eggs released may vary from 100- 1,000 depending upon the size and age of the female. Each egg measures 3-4 mm in diameter.

Hatching: The male fish mouths and fans the eggs throughout the incubation period and also guard the eggs against predators. The eggs hatch out within 6-7 days after sunset and the hatchlings emerge from each egg and measures about 3-4 mm in length and they require 14 hours light. Photoperiod of 14 hours is maintained for larval rearing, by using 20 W fluorescent bulbs in larval rearing tanks. A 30% of water exchange every day yields good results. Rotifers form good live feed for larvae to get best survival. The hatchlings sink to the bottom, Later, they swim to the surface water due to phototaxis. The larva spends a week days along with the plankton. After 8-12 days of hatching, the juvenile clown fish settles to the bottom and search for the host sea anemone. after metamorphosis of larvae into juvenile fish are fed with artemia 3 times/ day. One month old juvenile fish. fed with mashed fish meal and pellets. A repeated interaction with the host anemone stimulates the fish to produce its protective mucous coating. Young clown fish may become strong.

Butterfly Fish

Butterfly fish (Chelmon rostratus)



Butterfly fish are generally small sized marine fish. Many species of butter fly fish have black stripes across their eyes and eye like spots on the body. The butterfly fish is well known for its brightly coloured body and elaborate markings. Today butterfly fish is considered to be an endangered animal. Butter- fly fishes are coral reef fishes. Butterfly fish live near the coral reefs which serve as hiding place from predators and it is the main source of food

Distribution and habitat: There are 120 species of butterfly fish Butterfly fish are found throughout the Indian, Pacific and Atlantic Ocean. It lives in tropical and sub tropical waters primarily around coral reefs.

Behaviour: These fish are diurnal. Young ones appear in large schools. Adults are fairly solitary or stay with their mating partner. They hide themselves in crevices located in the coral to escape from predators. The spots & stripes tend to help them to escape from their predators.

Water quality conditions: Butterfly fish need close supervision and difficult to groom. Minimum 500 litre tank is needed. Water Temperature between 22-25°C is

suitable and Carbonate hardness of 143-214 ppm is preferred, pH of 8.2-8.4 may be a suitable range for this fish.

Butterfly fishes are brightly coloured often yellow or white with darker contrasting markings that may conceal the eye Their colouration makes them as popular aquarium fish. Body is oval, laterally compressed, snout is pointed: face is flat. Mouth is small at the end of pointed snout. Ctenoid scales on the body extend on to the soft rayed potion of the dorsal and anal fins Eye spots are found on their Banks and dark bands are seen across their eyes. Dorsal fin is uninterrupted Tail fin may be rounded or truncated but never forked. It grows up to 4.7-8.7 inches in length in wild.

Food & feeding habits; Butterfly fish species feed on plankton, sea anemones, small crustaceans corals, zooplankton, crustaceans and molluscs in captive conditions, butterfly fishes can be fed with a varied diet of vitamin enriched marine fish, crustacean, mollusc flesh and mysid shrimp.

Sexual dimorphism: Sexually monomorphic. Occasionally males are found to be larger. Females show swollen stomach a couple of days prior to spawning.

Breeding:

Butterfly breeding is easy. Butterfly fish are pelagic spawners. Butterfly fish can be bred in captivity. For captive breeding aquarium should be loaded with water. Water hardness is moderate and acidic water is suitable for rearing fry and finger lings. pH should be maintained between 7.0 and 7.8. Female release many buoyant eggs into the water floating with the currents until hatching.

The fry go through a "Tholichthys stage" where in the post larval fish is covered in large with bony plates extending from the head. Whenever they mature the larvae lose their bony plates. White eggs rise to the surface of the water and lay themselves on floating plants. After 24 hours the eggs turn dark and start sinking. These eggs are hatched out within 7 days, hatch lings are released.

Collection of live fish

Non availability of tank-acclimatised fishes is a major hurdle in the development of the marine aquarium hobby in India. At present, fishes collected from the coral reefs and shallow waters by divers through hand picking, use of scoop nets and by trap fishing are the sources of marine ornamental fishes . Present study is an endeavor towards the collection and rearing of marine ornamental fishes caught during the trawling operation. Standardisation of the collection procedure, rearing practices and to prepare an inventory of the marine ornamental fishes available in the area is the other objectives of the study.

Materials and Methods.

fish trawl and 45.12 m shrimp trawl are the gears used for the survey of fishery resources. Survey operations of the above vessel each lasting twenty days during the months May, 2003, March, 2004, November, 2004, April, 2005 and November, 2005 in which first author has participated onboard the vessel as cruise leader and resource survey data and ornamental fishes collected during the period from May 2003 to May 2007 were utilized for the present study. Live ornamental fishes caught from the 30-70 m depth zone during the last

2-3 days of each cruise were collected for keeping in the aquarium. Marine ornamental fishes landed live on the deck were immediately collected and transferred to a freshwater tank for freshwater bath to destroy the parasites and other pathogenic organisms likely to be present on them. Fishes were kept in the tank for about 30 seconds to a minute by then they show signs of inactivity. Freshwater treated fishes were then transferred to the collecting tank. A 250 litre capacity square type white colored plastic tank was used as the collection tank. Necessary filtration arrangement and aeration were also made. Immediately after collection, fishes were found to be in stressed condition. Excessive rate of excretion, increased opercular activity and fast swimming were noticed during the above period. Water exchange of 75% of total water in the collection tank was carried out after one hour of collection to avoid pollution of water due to increased rate of excretion. Further, 50% of water exchange was carried out twice in a day. Care was taken to see that the tank was not exposed to direct sunlight to minimize heating up of the water. Specimens were identified up to

species level by using standard references10-13. Identified specimens were taxonomically arranged by following14 to prepare the check list of the species collected during the study. Immediately after reaching the shore live fishes were transported to shore aquarium in 50 liter plastic buckets. Maximum effort has been taken to avoid stress and overcrowding of live fishes. Fishes were stocked in quarantine tank for 21 days after giving a freshwater bath. Four glass tanks of size 5′×2′×2.5′ made of 12 mm toughened glass with silicone sealing were used for stocking the marine ornamental fishes. Under gravel filter system with substrate of coral sand, fitted with a power head of 2000 liter/hour was used for filtration. Fluorescent tubes fitted on the top cover of the tank were used for providing the lighting. 120 mm mesh sized polyethylene nets were used to cover the top of tank. Seawater collected from the open sea was kept in black colored plastic tanks for more than 21 days for conditioning, before filling in the aquarium tanks. 25% water exchange was done at monthly intervals to minimize the nitrate load

fishes caught by trawl net were found to be landed in live condition. An inverse relationship between the percentage of live fishes and the depth of operation was observed during the present study. A similar relationship was observed in the case of haul duration, where lesser haul duration resulted in the increased percentage occurrence of live fishes. Survival of fishes collected onboard mainly depended on the following factors viz. Time taken for collection, Handling of live fishes by the crew, Depth of collection, Haul duration, Type of fish (Species), Stocking density in the collection tank, Water exchange rate Rate of aeration. Sixty six species of marine ornamental fishes belonging to 35 families were collected in live condition and transported to the shore to rear in the marine aquarium tanks. A checklist of the species collected is furnished in Table 1. Species that survived more than one month are considered as potential species for aquarium use. Out of the 66 species, 22 were found to be hardy and comparatively easy to manage in the rearing tanks

Breeding in Damsel fish

Breeding in blue ring fish(Damsel fish) :

It can breed in captivity in aquariums but the survival of larvae is very poor. In wild, these fish are egg scatterers. The mature male and female will form harems. They breed year round. Each harem consists of a male defending several females in a small area. These fish spawn in pairs. Pairs congregate at edge of the reef at sunset. The pair are engaged in a courtship display where the male and female swim in a brisk head to tail circling motion. Spawning normally begins with the onset of dusk and is triggered by the decrease in light. Each pair will spawn and ascend into water column. They swim together in an arc up to 7-10 feet above the substrate. The female expels the pelagic eggs at the summit followed by spraying of milt by male.

Spawning takes place between only one male and one female at a time, but males possibly mate with more than one female within the group. Fertilisation is external in the sea water. Eggs hatch out within 15-24 hours. The eggs hatch out during sunset on the day after courtship ritual of parents and swim with the plankton for a month, before (metamorphosis) developing into juveniles. The blue ringed fishes are considered protogyrous hermaphrodites i. e., in the beginning of life all are females. As the development advances the larger fish become males. During development, drastic changes occur in the colouration patterns of juveniles to adults. The juveniles start out with alternating vertical blue and white stripes on a black background. As the juveniles grow up into mature adults, the vertical blue and white stripes disappear, the caudal fin whitens and the body colour or background becomes a dark orange to brown. Horizontal blue lines also appear and run from the back of the head/pelvic fin area to the caudal and dorsal fins.