NESAMONY MEMORIAL CHRISTIAN COLLEGE, MARTHANDAM

DEPARTMENT OF ZOOLOGY

SEMESTER I

SKILL ENHANCEMENT COURSE-SEC-I

ORNAMENTAL FISH FARMING AND MANAGEMENT

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BOOK FOR FIRST YEAR BSC ZOOLOGY STUDENTS

ZOOLOGY ISN'T JUST A SCIENCE
IT'S A LIFE STYLE

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INTRODUCTION TO ORNAMENTAL FISH KEEPING

The ancient Romans were the first to keep ornamental fishes as pets at home. maintenance of ornamental fish became popular in England and Scotland in the eighteenth century. Tropical aquarium keeping is a peaceful, educational and stress free hobby which cuts right through all artificially created barriers. Creating an artificial biosphere within one's living room where fishes can live happily, and even reproduce themselves seems to hold a delightful fascination of millions of people from all walks of life around the world. It really is amazing how just a few minutes spent watching the aquarium can ease away hours of daily stress. Therefore, everyone is able to enjoy the hobby with complete equality.

Commercial ornamental fish culture on the other hand can not only generate revenue and foreign exchange but can also create employment opportunities for the employed and under employed youths and rural folks.

Technical advances in the commercial ornamental fish production have taken place in the past 40 years. Suitable technologies for the mass production of the egg laying and live bearing fishes have also been developed recently. For proper water quality maintenance, flow – through systems have also been developed. Due to these the world ornamental fish industry has really grown steadily over the years. More and more entrepreneurs have developed enough interest in this area of culture and trade and expanding their interest plants also.

Economists and dealers estimated that the world turnover in the aquarium fish trade has already exceeded 10,000 crore rupees annually. Sixty per cent of the aquarium fish sold throughout the world is produced by Asia, 30 per cent South America and the remaining 10 per cent by the other continents. Asia supplies mostly fish raised on fish farms in Singapore, Hong Hong, Thailand and Philippines, but those supplied South America are largely collected in the world.

Singapore has emerged as very important country in the production of ornamental fish. It is also the major exporter of aquarium fish and plants, as it exported aquarium fish and aquatic plants worth of 2,000 crore rupees in 1990. This industry caters not only the country's demand, but also to the overseas market of corporate buyers. 75% of the global export enters the Canadian, Western European and the U.S markets. While Sri Lanka earns over 100 crore rupees annually from ornamental fish exports, India's earning is less than one crore rupees per year. Freshwater species are in far greater demand in the world market (90 per cent) than sea animals, which continue to be of marginal importance despite the greater interest in their breeding.

As far as India is concerned, rapid development in ornamental fish farming would be a boon to the national economy. Ornamental fish farms including hatcheries have now been put up by some selected business houses to diversify their activities. This trend may continue and more ornamental fish farms may be set up on specific regions selectively for marine ornamental fishes, brackish water ornamental fishes and also freshwater ornamental fishes. This approach would help to identify many more useful ornamental fishes from our natural environments and multiply them suitably, so that India can come up and compete internationally in this trade.

In the first or the second decade of the present century, ornamental fish keeping commenced as a hobby and it became an industry on a large scale in metropolises -like Bombay, Madras and Culcutta. Soon after the establishment of Taraporewala Aquarium in Bombay in1951, the hobby acquired a status of its own in India. In India, most of the large scale commercial ornamental fish traders are mainly confined to the above cities only. Although facilities are available in rural and suburban areas of India, ornamental fish farms have not come up on any significant scale due to lack of awareness and proper technical guidance. This is the right time to identify suitable farmers or entrepreneurs for the technologies of ornamental fish culture and breeding.

IMPORTANCE AND SCOPE OF ORNAMENTAL FISH CULTURE

- ❖ It is a hobby giving pleasure to everyone.
- ❖ It relaxes our mind when feel tired.
- ❖ This hobby is said to reduce blood pressure.
- ❖ Children gain knowledge and skills.
- ❖ It develops attachment with nature and responsibility towards the welfare of other living beings.
- ❖ It creates self-employment opportunities.
- ❖ Aquarium fish can get about 100 times more price than the food fish
- ❖ Ancillary activities such as culture of ornamental fishes, breeding, export, supply of accessory apparatus viz: filters, aerators, plants, feeds etc., also provide indirect employment.

Fish Keeping Industry

- ❖ Fish keeping has been started as a hobby in the beginning. But nowadays it has become apopular industry worldwide.

Ornamental fish farming in World Market

- ❖ The fish keeping hobby is a multi-million-dollar industry, throughout the world. UnitedStates is considered as the largest market in the world, followed by Europe and Japan.
- ❖ In 1994, 56% of US households had pets, and 10.6% owned ornamental freshwater orsaltwater fish, with an average of 8.8 fish per household. In 1993, the retail value of the fish hobby in the United States was $910 million,
- ❖ From 1989 to 1992, almost 79% of all U.S. ornamental fish imports arrived from Southeast Asia and Japan.
- ❖ Singapore, Thailand, Philippines, Hong Kong, and Indonesia were the top five exporting nations.
- ❖ South America was the second largest exporting region, accounting for 14% of the total annual value. Colombia, Brazil and Peru were the major suppliers. The remaining 7% of ornamental fish imports came from other regions of the world.
- ❖ Approximately 201 million fish worth $44 7 million were imported into the United States in 1992. These fish comprised 1,539 different species; 730 freshwater species, and 809saltwater species.

- The freshwater fish accounted for approximately 96% of the total volume and 80% of the total import value. Of the total of all trade, only 32 species had import values over $10,000. These top species were all of freshwater origin and accounted for 58% of thetotal imported value of the fish.
- The top imported species are the guppy, neon tetra, platy, betta, Chinese algae eater andgoldfish.
- In many developing countries, local villagers collect specimens for the aquarium trade astheir prime means of income.

Ornamental fish farming in Indian Market

- India, despite its vast coastal zone and with abundant sources of freshwater, is still far behind as far as ornamental fish trade is concerned. The demand for good quality tropical fish is increasingly high. But the availability of ornamental fishes in the market does not meet the required level.
- More than 100 varieties of indigenous ornamental fish species are known in Indian freshwaters. The indigenous barbs *Puntius sp*. and *Botiasp,* are known for their fancy fin, colour pattern and flashing appearance and they fetch high price in the world market.
- India's contribution to global aquarium trade is worth more than 10 crore rupees annually. Tamil Nadu, with its year round warm climate and sustained live food sources isconduct for ornamental fish breeding. At present, only metropolitan cities like Calcutta, Mumbai and Chennai have emerged as the major ornamental fish breeding centers in the country
- About 150 popular varieties of ornamental fishes such as clown fishes, damsel, marine angel, moorish idol, surgeon fishes, fangs and butterfly fishes are reported from Andaman and Nicobar Islands, Lakshadweep, Gulf of Mannar and Palk bay. The Thoothukudi coastal waters are also rich in ornamental fish due to the coral reefs.
- The Indian marine ornamental fish trade is benefited by wild collection. This is because these fishes cannot be easily bred in captivity.
- India is utilizing the natural ornamental fish sources along her coast, particularly in the Gulf of Kutch, South Cochi, Cape Comorin and Rameswaram. If the valuable ornamental resources are taken up for

proper use, it is possible to increase the present level of export to about 110 crore rupees.

DOMESTIC AND GLOBAL SCENARIO OF ORNAMENTAL FISH TRADE AND EXPORT POTENTIAL

Domestic ornamental fish trade

Domestic ornamental fish trade about Rs.500 crore in India.80% trade from Freshwater and 20% from brackish water& marine water.5000 production units in West Bengal(55%)Tamil Nadu(30%),Kerala(5%) Maharastra and others(7%),North East and Island(3%)

Trends in ornamental fish culture centers in India

West Bengal: Largest ornamental fish producer in India. Alarge number of villages in districts of 24 Pargana, Howrah, Hoogly and Nadia are major centers

Tamil Nadu: is the second largest ornamental fish producerin the country after West Bengal.The village of Kolathur near Chennai is the epic centre of large varieties.The similar trend in Madurai, another major business city in Tamil Nadu.

Kerala: is fast becoming popular ornamental fish culture as many villagers in the districts of Thiruvananthapuram, Ernakulam,Thrissur, Allapuzha and Kottayam.

Mumbai (Maharastra): was known for culture of ornamental fishes about two decade backs but now it is mainly popular for high value fishes specifically Discus only.

A few units of freshwater ornamental fish production are also established in Inland states of Rajasthan and Madhyapradesh.

India possesses rich resources viz., rivers, streams, the lagoons and coralreefs with highly attractive and varied species of ornamental fishes.

Global ornamental fish trade

Aquarium fish keeping is a centuries old popular hobby growing interest in which has resulted in steady expansion in its trade in more than 125 countries, Most of the ornamental fish is sourced from developing countries in the tropical and sub tropicalregions.The international trade in ornamental fish in fact,provides employment opportunities for thousands of rural people in developing countries. As a result of advancements in breeding, transport and aquarium technology more and more species are being added every year.

Over 2500 species are involved in the global ornamental fish industry of which over 50% are of fresh water origin. It has been estimated that about 30 fresh water species dominate the global market such as live bearers neon tetra, angelfish, goldfish, zebradania and discus.The guppy and neon tetra species alone represent more than 25% of the market by volume and more than 14% by value.

The trade at retail level is worth more than US$ 10 billion with an average annual growth of 10% while the entire industry including plants, accessories, aquarium, feed and drugs is estimated to be worth more than US $18.20 billion

Global exports of ornamental fish since 2000 rose steadily from US $177.7 million to a peak of US$ 364.9 million in 2011 then declining slightly to US$ 347.5 million in 2014.A close look at the top ten regions supplying78.6% to the export market in 2014 showed that Asian countries accounted for US$ 197.7 million in exports more than 57% share of the trade. Europe accounted for 27.6% of the total exports, South America shared 7.5% of the total exports, while North American exports were sharing3.98% of the global supply. During the fifteen year period from 2000 to 2014,the import value for ornamental fish rose from US $247.9 million in2000 to an all time high of US $402.1 million in 2008.Thereafter,there was a declining trend until 2013 and then a slight rise to US $299 million in 2014.

Singapore, with exports valued at US $69.32 million was the ornamental fish capital of the world, contributing close to 20% of the total supply. Till today it remains the main trading hub in Asia.

Japan(US $41.34.7 million) was in second place, holding a stable share in the market due to its niche on koi carp.The third position was occupied by the Czech Republic (US $32.0 million) followed by Thailand(US $23.31 million),Malasia (US $22.62 million),Indonesia,(US $21.54 million) Isreal (US $19.04 million),Brazil(US $18.52 million), Srilanka (US $13.1 million and Colombia(US $12.3 million).

In 2014,the USA was the single largest importer of ornamental fish with14.3%(US $42.9 million) of total imports. This was followed by the UK with US $29.5.million.The other importing countries during the view period were Germany(US $23.4 million),Singapore(US $21.3million) ,Japan(US $19.5 million), China/ Hongkong (US $19.3 million), France(US $16.3 million),the Netherlands(US $13.3 million), Italy(US $9.7 million),Malaysia(US $9.1 million) Canada(US $8.6 million) and Belgium(US $8.3 million).These 12 countries together shared over 74% of the global imports. Problems in supply ,traceability, sustainable management along the supply chain, disease, innovation as well as transportation practices, destructive fishing methods and introduction of exotic species are some of the most important issues with regard to improving access to markets and enhancing value.

IMPORTANT FRESHWATER AND MARINE ORNAMENTAL FISHES

Indigenous and Exotic Species

Indigenous : Originating or occurring naturally in a particular place.
Exotic: It is comes from a different country or culture.

GUPPY (*Poeciliareticulata*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cyprinodontiformes
Family	:	Poecilidae

- ❖ It is an ornamental fish.
- ❖ Common Name: Guppy Fish
- ❖ Attainable Size: 2.5 inches
- ❖ Environment: Fresh and brackish water
- ❖ Origin: South America, Venezuela, Trinidad, Northern Brazil and Ghana.
- ❖ Company: Can be kept in most community aquariums. Don't keep with aggressive fish.
- ❖ Water: pH: 7.0 to 8.5
- ❖ Temperature: 18 to 28°C
- ❖ Aquarium: Best kept with a lot of plants and free swimming space.
- ❖ Feed: Omnivorous
- ❖ Breeding: Live bearer. Females give birth to fry

SWORD TAIL (*Xiphophorushelleri*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cyprinodontiformes
Family	:	Poecilidae

- ❖ It is an ornamental fish.
- ❖ Environment: freshwater fish.
- ❖ Attainable Size: 14 cm.
- ❖ Water: pH: 7 to 8

- ❖ The lower lobe of the caudal fin is elongated in the 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
- ❖ Feed: Omnivore
- ❖ Breeding: Live bearer. (Females give birth to fry)

GOLD FISH (*Carassiusauratus*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cypriniformes
Family	:	Cyprinidae

- ❖ Gold fish is an ornamental fish.
- ❖ Scientific Name: *Carassiusauratus*
- ❖ Common Name: Gold Fish.
- ❖ Attainable Size: 59 cms
- ❖ Origin: Central Asia, China and Japan.
- ❖ Habitat: Fresh water
- ❖ Water pH: 7.5 to 8.5,
- ❖ Temperature: 17 to 28°C
- ❖ Company: Can be kept with other large nonaggressive species if aquarium is large enough to accommodate.
- ❖ Aquarium: As it grows big, it requires a large aquarium. A well planted aquarium is preferred. It is a bottom dweller
- ❖ Feed: Omnivorous, accept dry food, likes to eat small insects and also like vegetable food. Gold fish feeds on a large variety of food.
- ❖ Breeding: Oviparous
- ❖ It is red or red white or black in colour.
- ❖ It can live for 20 years.

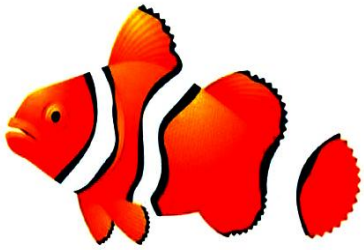
ANGEL FISH (*Pterophyllumscalare*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cichliformes
Family	:	Cichlidae

- ❖ Angel fish is an ornamental fish.
- ❖ It is a freshwater fish.
- ❖ Scientific name: *Pterophillumscalare*
- ❖ Common name: Angel Fish
- ❖ Water: pH: 6.5-6.9,
- ❖ Optimum temperature: 24-28°C.
- ❖ Attainable Size: 6 inches
- ❖ Origin: It originates from South America
- ❖ Feed: Omnivore.
- ❖ Breed: lays eggs (oviparous).
- ❖ A number of varieties are available. They are
- ❖ Silver, Black lace, Black, Half black, Veiltail, Marble, Golden, Pearl scale.

ANEMONE FISH (*Amphiprion ocellaris*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Perciformes
Family	:	Pomacentridae
Sub family	:	Amphiprioninae



- ❖ 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 an 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.
- ❖ On sexual maturity, one male changes into female.
- ❖ When the female dies, one dominant male change into female. So the colony has only one female.
- ❖ Female lays eggs in rock nests. (Oviparous).
- ❖ 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.

BUTTERFLY FISH *(Chelmon rostratus)*

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Perciformes
Family	:	Chaetodontidae

- ❖ They are found mostly on the reefs of the Atlantic, Indian and Pacific oceans.
- ❖ There are approximately 120 species in 10 genera.
- ❖ Butterfly fish looks like smaller versions of angelfish (Pomacanthidae) but unlike these lack preopercle spines at the gill covers
- ❖ Butterfly fishes are fairly small, mostly from 12 to 22 cm in length. The largest species grow up to 30 cm.
- ❖ Many bear shades of black, white, blue, red, orange and yellow. Some species are dull in colour.

ZEBRA FISH (*Daniorerio)*

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cypriniformes
Family	:	Cyprinidae

- ❖ It is an ornamental fish.
- ❖ Habitat**:** freshwater fish.
- ❖ It is native of streams of Himalayas**.** It commonly inhabits streams, canals, ditches, ponds and paddy fields.
- ❖ 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.
- ❖ Females have a larger whitish belly and have silver stripes instead of gold.
- ❖ Attainable Size: 3.8 cm.
- ❖ Lifespan: 5 years.
- ❖ Breed: It lays eggs (oviparous).

KOI (*Cyprinuscarpio*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cypriniformes
Family	:	Cyprinidae

- ❖ Common Name: Koi Carp
- ❖ Attainable Size: 48 inches
- ❖ Environment: Fresh and brackish Water
- ❖ Company: Can be kept with most large nonaggressive species
- ❖ Water: pH: 7.0 -7.5, Temperature: 30 -32°C
- ❖ Aquarium: Requires a very large aquarium with a lot of space to swim on the surface. Areas with plants are appreciated if your aquarium can support both plants and open area.
- ❖ Feed: All kinds of food. Breeding: Females are rounder in spawning condition. Move eggs to a separate aquarium since parents eat them.
- ❖ They have different colours - white, black, red, yellow, blue, cream, etc.

TETRA FISH *(Hyphessobrycon bentosi)*

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Characiformes
Family	:	Characidae

- ❖ Habitat and Distribution: Asia, Pakistan, India, Bangladesh, Myanmar, Thailand and Malaysia.
- ❖ Feeding: Omnivores, meaning that they feed on both living animal and plant foods.
- ❖ Breed: oviparous.
- ❖ Tetra fish have well developed teeth that vary according to the gender.
- ❖ They are fast swimmers, very active and prefer grouping in schools by species.
- ❖ Most have scales with metallic shine.
- ❖ Colours are grouped in stripes, dots or spots. Very rarely they cover the whole body.
- ❖ The shape of the body is not typical for the whole family, and varies significantly from one Gender to another.
- ❖ Their behavior varies from absolutely peaceful to aggressive.
- ❖ Whenever possible they will be supplied with some live food, such as mosquito larvae, water fleas(Daphnia), well-purged and washed tubifex and eventually scraped raw meat, frozen and frozen beef heart with the vegetable grater or boiled chicken liver and stepped on.

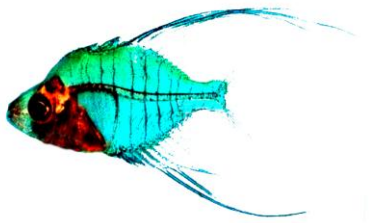
Molly (*Poecilia sphenops*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cyprinodontiformes
Family	:	Poecilidae

- ❖ Molly is an ornamental fish.
- ❖ It belongs to the family of swordtails and guppies.
- ❖ Habitat: Brackish water fish
- ❖ A table spoon of salt is added to the tank for better performance of molly.
- ❖ Feed: Omnivore
- ❖ Life span: 5 years.
- ❖ Breed: Live-bearer giving birth to young ones.

GLASS FISH (*Parambassis ranga*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Family	:	Ambassidae



- ❖ Common name: Indian Glassy Fish, Indian Glassy Perch, Indian X-Ray Fish, Siamese Glassfish, and sometimes as the Malaysian Glassy Fish, the Glass Fish is one of the more fascinating species of aquarium fish.
- ❖ Fish have a laterally compressed body
- ❖ This is a fish whose transparency allows us to see without problems its skeleton and its internal organs.
- ❖ They are often sold injected with fluorescent colours, like blue, yellow, green, purple among others.
- ❖ Size: 3 inches
- ❖ Water pH: 6.5-7.5
- ❖ Optimum Temperature: 68° - 86°
- ❖ Origin: Southern Asia from Pakistan to Malaysia
- ❖ Breed: To induce spawning they need slightly brackish water conditions with elevated temperatures. They may place eggs on plant leaves. Raising the fry is another story all together.

CICHILD (*Pseudotropheuscrabro*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Cichliformes
Family	:	Cichlidae

- ❖ Cichlid, any of more than 1,300 species of fishes of the family Cichlidae (order Perciformes), many of which are popular aquarium fishes.
- ❖ Cichlids are primarily freshwater fishes and are found in tropical America, mainland Africa and Madagascar, India and southern Asia.
- ❖ Depending on the species, cichlids range from vegetarian to carnivorous.
- ❖ The majority of species are African, appearing in great diversity in the major African lakes
- ❖ 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 fishes, usually do not grow longer than about 30 cm (12 inches).

SEAHORSE (*Hippocampus*)

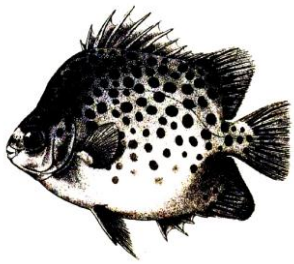
Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Syngnathiformes
Family	:	Syngnathidae

- ❖ The seahorse is a small species of vertebrate that is found in the tropical shallows and temperate waters around the world.
- ❖ The sea horse is also commonly found around coral reefs where there is plenty of food and places for the seahorse to hide.

- Origin: Worldwide
- Diet: Omnivore
- Size: 2.5cm 30cm (0.9in - 12in)
- Habitat: Fresh, Brackish, Salt
- Optimum pH Level: 7.9-8.4
- Lifespan: 2-6 years
- Conservation Status: Endangered

SPOTTED SCAT (*Scatophagus argus*)

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Actinopterygii
Order	:	Perciform
Family	:	Scatophagidae



- The Spotted Scat is an extremely attractive fish with a silvery or bronze case and I covered with spots.
- Feed: Omnivorous species. In the wild they feed on a variety of plant matter along with worms, crustaceans, and insects.
- Lifespan: 20 years.
- With two colour versions of the Spotted Scat, the Red Scat and the Green Scat, this fish has a lot to offer. The Green Scat is the type most commonly seen.
- The Ruby Scat or Red Scat is a red subspecies.
- A few of the other names they are known by include Argus Fish, Common Scat, and Leopard Scar
- These are all big, attractively patterned, and very durable fish. Almost every brackish aquarium will include at least one these types.
- The Spotted Scat is a bit larger brackish fish than either of those other two, typically reaching 6-8 inches (15-20 cm) in the aquarium.
- IUCN Red List: LC - Least Concern

BIOLOGY OF EGG LAYERS AND LIVE BEARERS

- Barbs are the most important group among egg layers and most species of them are known originated from India, fishes from Cyprinidae family also coming under this.
- Egg layers are of two types, egg layers with parental care and without parental care.
- Egg layers without parental care are two types, adhesive eggs and non adhesive egg.
- Egg layers with parental care are again classified as Egg buriers, mouth incubators, nest builders, and egg carriers
- Gold fish (*Carassiusauratus*), Angel (*Pterophyllumscalare*). Siamese fighting fish (*Bettasplendens*) Koi carp (*Cyprinuscarpio*) etc...

CLASSIFICATION

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cyprinodontiformes
Family: cyprinidae
Genus: *Carassius*
species :*auratus*

GOLD FISH

- One of the most traded and most commonly seen aquarium fish.
- It is originated from China
- About 150 breeds of fancy gold fish- Shubunkin, Comet, Fringe tail. Telescope moor, Oranda, Lion head. Veil tail

- ❖ It belongs to cyprinidae family, the scientificall known as *Carassiusauratus.*
- ❖ It is a egg scatter with adhesive eggs.
- ❖ Well suited to a Community aquarium.

BIOLOGY

1. Tubercles on head, operculum, and on pectorals on males.
2. Belly bulging female
3. Genital opening rounded and protruded in female, long, oval in male.
4. Live upto 20 years

REQUIREMENTS IN AN AQUARIUM

- ❖ pH of water:7-8
- ❖ Water hardness:9-19
- ❖ Temperature:27-2°C
- ❖ submerged plants like Hydrilla, are used to provide to attach eggs.

Brood stock development

1. 8-15 month old fish (40-100 gms)
2. Feeding thrice daily, tubifex during morning and evening and
3. Formulated feed in the afternoon.

   Feeding or 10% BW/day

Larval rearing

water temp: 27-28 deg celsius.1 female :2 males ratio,

1. Male and female move in pair, snout of the male will be near the vent of the female- courtship
2. Female releases eggs, fertilised by the milt released by the male
3. Eggs adhesive- egg collectors are used
4. Fertilised eggs transparent, dead eggs opaque.
5. Separate the egg collectors into a different container.
6. Hatching within 3 days.

7. Infusoria, boiled egg yolk, microworms. Daphnia, Tubifex.

GOLDFISH VAREITIES

Black Moor Background

Originally Black Moor Goldfish were always black. Recently other colors and variations of the Moor Goldfish have become available. Purists may insists that Moor gold fish should always be black While some strains have a normal eye, others have a more unusual feature that has developed; a telescopic eye that protrude from the head

Bubble eye Goldfish

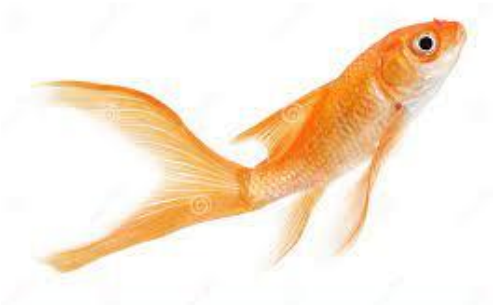
The Bubble Eye Goldfish, otherwise known as sulhogan in lapan, is instantly recognizable small twin tailed fancy variety of goldfish. This goldfish has eyes that are nearly completely surrounded by a fluid filled sac. The bubble eye has an egg shaped body and does not have a dorsal fin Coloration, like most goldfish can be varied, but bubble eye goldfish are typically metallic red/orange

Celestial Eye Background

Celestial Eye Background The fancy Celestion eye goldfish have a pair of characteristic telescope eyes which are turned upwards Celestial gold fish are part of a relatively small group of goldfish without a dorsal fin. They can vary widely

in color, with either metallic of nacreous scales. Due to many issues that the upward oriented eyes, celestial gold fish are best kept in a tank with out celetial eyes. Young Celestials will have normal eyes that protrude slightly sideway and then over a period of 6 months will turn upwards.

Comet Background



Comet gold fish have an elongated body, with equally curved dorsal and ventral contours. Unlike the common goldfish, it is not deep or heavily bodied. While many color option are available the most common colors are;

Red Orange

Lemon Yellow

CLASSIFICATION

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order:Perciformes
Family: cichlidae
Genus: *Pterophyllum*
Species: *scalere*

ANGEL FISH

- The Angel fish coming from the genus *Pterophyllum*
- All *Pterophyllum*species originate from the Amazon Basin. Orinoco Basin and various rivers in the Guiana Shield in tropical South America.

- The three species of *Pterophyllum* are unusually shaped for cichlids being greatly laterally compressed, with round bodies and elongated triangular dorsal and anal fins Angelfish are ambush predators and prey on small fish and macroinvertebrates.

BIOLOGY

- Male and females are not distinguishable
- The life span ranges above five years
- All *Pterophyllum* species form monogamous pairs.
- Eggs are generally laid on a submerged fog or a flattened leaf
- Depending upon aquarium conditions, *P.scalare* reaches sexual maturity at the age of six to 12 months or more

BREEDING

- Angelfish pairs form long-term relationships where each individual will protect the other from threats and potential suitors.
- Upon the death or removal of one of the mated pair, breeders have experienced both the total refusal of the remaining mate to pair up with any other angelfish and successful breeding with subsequent mates.
- When the pair is ready to spawn, they choose an appropriate medium upon which to lay the eggs, and spend one to two days picking off detritus and algae from the surface.
- This medium may be a broad-leaf plant in the aquarium, a flat surface such as a piece of slate placed vertically in the aquarium, a length of pipe, or even the glass sides of the aquarium.
- The female deposits a line of eggs on the spawning substrate, followed by the male, which fertilizes the eggs,
- This process is repeated until a total of 100 to more than 1.200 eggs are laid.

- Depending on the size and health of the female fish. As both parents care for the offspring throughout development, the pair takes turns maintaining a high rate of water circulation around the eggs by swimming very close to the eggs and fanning them with their pectoral fins
- In a few days, the eggs hatch and the fry remain attached to the spawning substrate. During this period, the fry survive by consuming the remains of their yolk sacs. detach and become free-swimming.
- At one week, the fry Successful parents keep close watch on the eggs until then.
- At the free-swimming stage. the fry can be fed newly hatched brine shrimp (*Artemia*spp.) or microworms.
- Brine shrimp are the superior choice for fast growth rates of fry.

CLASSIFICATION

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order:Perciformes
Family: Osphronemidae
Genus: *Betta*
Species: *splendans*

Siamese fighter fish

- The *Betta* is native freshwater fish from Thailand (formerly Siam) and Cambodia (formerly Kampuchea), Wild bettas can often be found in a small pond, river, or drain.
- All the *Betta* species are small fishes, but they vary considerably in size, ranging from under 2.5 cm (1 in) total length in B. chanoides to 12.5 cm (5 in) in the *Akarbetta* (*B. akarensis*).

- A good subject for the study of Selective breeding. *Bettas* are anabantoids, which means they can breath atmospheric air using a unique organ called the labyrinth.
- This accounts for their ability to thrive in low-oxygen water conditions that would kill most other fish, such as rice paddies, slow-moving streams, drainage ditches, and large puddles.

BIOLOGY

- They have a cylindrical form with the anterior part of the body tapering to a, laterally compressed shape
- The pelvic fins are quite long and extended, particularly in the male.
- The dorsal fin inserts behind the midpoint of the back and varies in short to moderate.
- In domesticated male *Bettasplendens*, this fin can be exaggerated into what appears to be a huge sail
- Near the pectoral fin, the anal fin is long, and when displayed, it billows out like a large fan similar to the caudal fin.
- When at rest, both fins hang down by its side, giving the appearance of long, folded drapes.
- As Bettas age, their tails and fins grow longer and heavier, causing the fish to become sluggish.

BREEDING

- As they are fighting fish, they are quite aggressive towards one another.
- To spawn, you must introduce the pair to a courtship, which generally has a length of two weeks.
- Live food is ideal, but frozen food is also a good option.
- The pair should also be carded from each other.
- An ideal spawn tank generally is around 20-30L.
- A heater set at 26-28^{0}C

- At least one or two Indian Almond Leaves (IAL). IAL has anti bacterial properties, and turn the water a dark tea colour. This both helps the male with nesting as it turns the water "stickier" and feels like a more natural environment rather than crystal clear water.
- Hides. Normally used in live plaints, Java moss, Java fern, foxtail, hornwart or frogbit are all good options.

CLASSIFICATION

KINGDOM: Animalia
PHYLUM: Chordata
CLASS: Actinopterygii
ORDER: Perciformes
FAMILY: Cichlidae
SUB FAMILY :Astronotinae
GENUS: *Astronotus*
SPECIES: *Ocellatus*

BIOLOGY

- *Astronotusocellatus* is a species of fish from the cichlid family known under a variety of common names including oscar, tiger oscar, velvet cichlid, or marble cichlid.
- *A .ocellatus* examples have been reported to grow to about 45 cm (18 in) in length and 1.6 kilograms (3.5 lb) in weight
- The wild-caught forms of the species are typically darkly coloured with yellow-ringed spots or ocelli on the caudal peduncle and on the dorsal fin

- These ocelli have been suggested to function to limit fin-nipping by piranah*Serrasalmus spp*.), which co-occur with 4 ocellatus in its natural environment.
- The species is also able to rapidly alter its colouration, a trait which facilitates ritualised territorial and combat behaviours amongst conspecifics.
- Juvenile Oscars have a different colouration from adults, and are striped with white and orange wavy bands and have spotted heads.
- Oscars will often lay claim to an area of the aquarium and will be very aggressive towards other fish encroaching on their newly established territory inside the aquarium or lake.
- The size of the territory varies depending on the size and aggressiveness of the fish based on its surroundings.
- Once the Oscar established a territory, it will vigorously defend it by chasing away other fish.

Varieties

- Include forms with greater intensity and quantities of red marbling across the body, albino, leucistic and xanthistic forms.
- A. ocellatus with marbled patches of red pigmentation are sold as red tiger oscards, while those strains with mainly red colouration of the flanks are frequently sold under the trade name of red Oscars.

BREEDING

- The species is widely regarded as sexual monomorphic.
- Males have been suggested to grow more quickly, and in some naturally occurring strains, males are noted to possess dark blotches on the base of their dorsal fins.

- The species reaches sexual maturity as sexual monomorphic. age, and continues to reproduce for 9-10 years. Frequency and timing of spawning may be related to the occurrence of rain.
- Fecundity-1,000 to 3.000 eggs.
- The females egg tube is oval in shape, not unlike the pointed end of an egg. The males sexual organ is pointed and looks rather like a thorn or spike.
- Oscars prefer to lay their eggs on a flat surface, they will not lay their eggs directly on the substrate. If there is nothing in the tank for them to lay their eggs on, they will clear a patch of gravel/sand until the bottom of the tank is exposed and then they will lay their eggs there.
- The females lay eggs in batches by rubbing her underside on the flat surface and allowing the male to circle around and fertilize them.
- When all of the eggs have been laid, both the female and the male will hover over the eggs and fan them with his pectoral fins.
- The eggs normally take 3 days to hatch. If they are fertilized they should turn a lightish tan colour
- When the eggs hatch, the fry will be totally helpless, they will appear as a wriggling mass attached to the rock..at this stage, they don't need food.
- The fry will have a yolk sac that will feed them for around four days . Once the yolk sac is gone, the fry will then need feeding.
- Newly hatched brine shrimp (0.08 to 0.12 millimeter) can be used as an very reliable starter feed.

CLASSIFICATION

KINGDOM: Animalia
PHYLUM: Chordata
CLASS: Actinopterygii
ORDER: Perciforms
FAMILY: Osphronemidae
GENUS: *Colisa*

SPECIES: *lalia, fasciato*

BIOLOGY

- Gouramis or gouramies are a group of freshwater perciform fishes that comprise the family, Osphronemidae.
- The fish are native to Asia, from Pakistan and India to the Malay Archipelago and north-easterly towards Korea.
- Many gouramies care for their eggs in beautiful nests made from bubbles, while others scatter their eggs to the water or even keep the eggs in the father's mouth!
- sedentary, fairly peaceful species that attains lengths from a few centimetres to more than two feet (60 cm).

BREEDING

- Gourami species are usually comparatively easy to breed in aquariums.
- All Gourami species are egg-layers, and several species are renowned for building very beautiful bubble-nests in which they keep egg and fry
- The bubble nests are very sensitive and can be ruined by water movement,
- Firstly, breeding Gourami will require the set up of a separate breeding aquarium height of six inches and room for 10-20 gallons of water is quite enough.

- Provide thin layer of gravel, do not use any kind of filter producing a strong current.
- A male Gourami will always claim a territory and fiercely defend it. So it preferable to keep the female in separate tank.
- Live plants are advisable and other shelter such as aquarium decorations, such as clay pots, are also very good hiding spaces for a female Gourami.
- It is advisable to wait until the female is evidently gravid before you introduce the male. The diet is important if your want your female Gourami to become gravid, and she should ideally be fed meaty foods such as blood worms and brine shrimp.
- Keep the lighting in the breeding aquarium subdue. The water temperatures should be kept in the 25-28 degrees C range and the pH between 6.6 and 7.6.
- Once the male Gourami has been placed in the breeding aquarium the female will commence her bubble nest building.
- The female and male Gourami will start dancing with each other. Now the male Gourami cups the body of the female Gourami and wiggle close to her.
- Finally the female Gourami will release her eggs and the male will fertilize them. The eggs will be safely placed inside the bubble-nest.
- This behaviour will be repeated a number of times and after several hours the female Gourami will have deposited more than 600 eggs.
- Now make sure to turn off all the filters and siphon the water out up to half.
- Low water pressure and warm temperatures are beneficial to the offspring, and the breeding aquarium should be covered.
- After less than 24 yours the Gourami eggs will hatch and after 3-5 days you can see free swimming fry in the breeding aquarium.
- Feed the Gourami fry newly hatched brine shrimp or liquid fry food.

CLASSIFICATION

KINGDOM: Animalia
PHYLUM: Chordata
CLASS: Actinopterygii
FAMILY: Cyprinidae
ORDER: Cypriniformes
GENUS: *Puntius, Sahyadria, Pethia*..

BIOLOGY

- The species is a tropical freshwater fish most often found in the aquarium trade mainly belonging to the genus *Puntius.*
- The majority of these fish are not large although there are exceptions, such as the Tinfoil Barb which grows quickly and has potential to reach 35cm in aquariums.
- Smaller Barbs (such as Tiger, Rosy, Cherry and Ruby Barbs) aquariums. grow to between 5-10cm.
- Females are slightly larger than the males.
- The males can be distinguished via a reddish nose and red line across the tip of the dorsal fin.
- In the wild these are active shoaling fish and in the aquarium they need to be kept in groups of four for five, which may also help to lessen aggression towards other fish.
- These fish can live for 4-5 years in a home aquarium in which the water quality is well maintained.

BREEDING

- As these fish should be kept in shoals, a tank of at least 45 litres is recommended. However when adult Tinfoil Barbs require a much larger tank of at least 250 litres.
- Barbs are fairly hardy fish and have a preference for water which is in the range of 20-27°C.
- At least once every two weeks a partial water, 25-30%, change is strongly recommended.
- The majority of these fish are omnivorous, happily feeding upon worms, crustaceans, insects and plant matter. The exception is the Tinfoil Barb which prefers a vegetable diet.
- These fish should be fed what they can eat within t a few Barbs are among the easier fish species, particularly the Tiger minutes 1-2 times a day
- Barbs, to breed. Barbs produce large numbers of fry after successful spawning.
- A larger aquarium is required to keep the fry alive especially as the adults will eat them voraciously.
- The male and female fish should be placed into a breeding tank with a spawning mop.
- Aquarium sub start were fibers as a medium to attach their eggs. Male and female ratio of 1:1 and 1:2. Flow of water was given to supply oxygen.
- Once spawning has occurred remove the adults as they will eat the eggs.
- The fry should hatch within three or four days.

INTRODUCTION

Livebearers are ornamental fishes originated from South America.

- They retain eggs inside the body and give birth to live, free- swimming young
- Known as Live-bearing tooth-carps (upper and lower jaw have teeth).
- Common livebearers (Platy, Molly, Swordtail & Guppy) belong to Family Poecilidae
- Halfbeaks, Splitfins, Freshwater stingrays and Four-eyed *Anablepsanableps*) are livebearers from other families. fish
- They are considered as Beginner's fish and kept in a community aquarium
- Creating new varieties of livebearers is a great challenge to hobbyists.

BIOLOGY

- Livebearers are omnivores which cats plant and animal based foods.
- Females (2.5-5 inches) are larger than males (1.5-3 inches).
- Males are more colourful when compared to females.
- Possess gonopodieum (modified anal fin) for depositing sperm into the female.
- Females have rounded body and possess gravid spot (anterior and dorsal to anus).
- Female livebearers can store the male’s perm for a period of months and can have several broods even if they have mated just once.
- In swordtail, male develop a sword-like tail, an elongated part of the tail.
- Livebearers are non-aggressive, prolific breeders.
- They matures sexually in 1-3 months (guppy: 3-4 weeks),
- Fertilization internal.
- Livebearers give birth to successive batches of live young at an interval of a few days.
- Adults exhibit cannibalism.

- Traps, mosquito nets, plants, etc are used to avoid Cannibalism.

CLASSIFICATION
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cyprinodontiformes
Family: Poecilidae
Genus: *Xiphophorus*

PLATY

- Considered to be 'The colour king of the live-bearer fishes'.
- Platy is a common name for two related species of freshwater fish in the genus *Xiphophorus.*

The term 'Platy derives from the generic name. Platypoecilus.

- This fish is native to the east coast of Central America and Southern Mexico.
- Well suited to a Community aquarium.

BIOLOGY

Platy is native to an area of North and Central America.

- Prefers slow-moving waters of canals, ditches and warm springs

Omnivore.

Sexes are separate.

- Females grow larger in size and have rounded body.
- Possess gravid spot anterior and dorsal to anus.
- Males are more colourful and possess gonopodium

REQUIREMENTS IN AN AQUARIUM

- pH of water:7-8
- Water hardness:9-19

- Temperature: 18-25°C
- Floating plants are used to provide shelter for young ones.

Southern Platyfish

Scientific name: Xiphophorusmaculatus

- discovered by Gunther in 1866.
- Native to North and Central America.
- Known as Common platy, Mickey mouse platy or Moon fish.
- Closely related to green swordtail and interbreed with it.
- The fish grows to a maximum length of 6 cm.
- Lifespan is 3 years,

Variatus Platy

Scientific name: Xiphophorusvarianes

- Native to Southern Tamaulipas and Northeastern Mexico.
- Known as Variable platy fish or Variegated platy
- This fish possess an elongated body
- Olive colour with black spots on the side of the caudal peduncle.
- The fourth pectoral ray shows well developed serrae (saw-like notches).
- This fish grows to a maximum length of 7 cm.

Red Platy

- ❖ One of the most popular platy in the aquarium.
- ❖ The body is red in colour.

Wagtail Platy

- ❖ include red wagtail platy, black wagtail platy, golden wagtail platy and mixed wagtail platy.
- ❖ The colour of body may be red or orange-yellow whereas fins are black.

Tuxedo Platy

Has red and black colours in its body.

Gold Twin Bar Platy

Has translucent body with 2 black bars along the top and bottom of its tail.

- ❖ The black bars form distinct open ‘V’ pattern.

Rainbow Platy

- ❖ Tail has multiple colours, but no colour prominent.

Sunset Platy

- ❖ Tail with more than a single colour, but yellow colour is prominent.

CLASSIFICATION
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Family: Poecilidae
Order: Cyprinodontiformes
Genus: *Poecilia*
Species: *latipinna*

Molly

The common name Molly is derived from the genus *Mollienesia.*

The name "*Mollienesia* was coined in honour of Francois Nicolas Mollien, a French politician of the late 18th and early 19th centuries.

Native to fresh, brackish and saltwater in the America.

Currently.39 species are recognised.

IUCN lists 2 species, *Poeciliasulphuraria* (Sulphur molly) and *Platipuncata*(Broadspotted molly) as Critically Endangered.

BIOLOGY

- ❖ Body of female molly is rounded and that of male is slender.

  Molly attains maturity in four months
- ❖ breeds 6-8 times in a year.

  20-100 young ones are produced at a time

  It grows up to 5 inch in length.
- ❖ The life span ranges from 2 to 4 years.

Sailfin Molly

Scientific name: *Poecilialatipinna*

Described in 1821 by Charles Alexander Lesueur.

- The fish survives in oxygen depleted habitats.
- The body is oblong and blue in colour.
- The dorsal fin in males is long and sail-like, with an orange edge.
- a series of black bars toward the outer half and dark lines and spots near the base.
- The caudal fin is orange and blue with dark lines and spots
- Several rows of spots occur along the sides and dorsal fin. The spots blend together forming stripes.
- The parasite is *Saccocoelioidessogandaresi* (trematode).

Dalmation Molly

This fish has a black and white coloured body.

Hence it is known as Marbled or Marbled Sailfin Molly.

White Molly

occur in two varieties. They are:

1. Albino (pinkish or red eyes).
2. Leucistic (normal hued eyes).

   Both have a dazzling pearl-like colouration.

Silver Molly

This fish has a solid silver body and fins

Balloon Molly

A hybrid variation of Poceli Arched back and a rounded, large belly The balloon Fin willy have a large, lyre-shaped caudal fin and a dorsal

Spotted Molly

Inhabits lonic and lotic waters of Mexico, Texas and Virginia The fish has deep black body with scattered white spots

Marble Molly

Results when silver and black mollies interbreed

Amazon Molly

Scientific name: Poeciliaformosa

The amazon molly reproduces female species by gynogenesis. It mates with a male from one of four different species, either Planina, Pesicana, Platipuncata or Psphenops

Pacific Molly

Scientific name: *Poeciliabutleri*

A viviparous fish that inhabits western Mexico and Northern Central America.

Yucatan Sailfin Molly

- Scientific name: Poeciliavelifera
- lives in coastal waters of the Yucatan peninsula.
- The body has both black and golden colouration. The dorsal fin(the distinctive character) have 20 fin rays.
- If the males spread their dorsal fins these have a trapezoid shape.

Chocolate Molly

An albinotic variety produced in captivity.

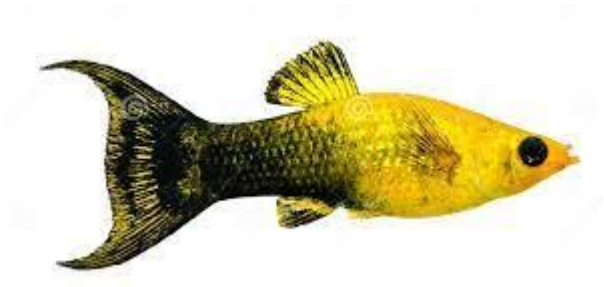
Black Molly

Scientific name: Poeciliasphenops

- ❖ Most popular type in the Aquarium wade

  The body is black in colour and has short fins
- ❖ Juveniles have patches of slight silver colouration.

Gold Dust Molly



This fish has an interesting colour scheme of black and gold.

CLASSIFICATION
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cyprinodontiformes
Family: Poecilidae
Genus: *Xiphophorus*
Species: *helleri*

Swordtail

became aquarium fish in 1910 and known as Moonfish.

- ❖ A good subject for the study of Selective breeding.

  The name "swordtail' is derived from the elongated lower lobe of the male's caudal fin.

  The Sword act as a lever for jumping and as a rudder for steering.
- ❖ Swordtails are distinguished by the colour or the shape of finnage.

BIOLOGY

Swordtails possess bulky holy

Omnivorous

Sexes are separate Adults sexually mature within 6-8 weeks.

- ❖ Females larger in size when compared to males Pregnant females possess gravid spot anterior and dorsal to anus
- ❖ Males possess sword, elongated lower lobe of caudal fin S
- ❖ wordtails exhibit sex reversal.
- ❖ (pH of 5-6 develops Males whereas pH >7 develops Fentales).
- ❖ In the absence of males in the group, older female is transformed into male.
- ❖ Female to male change is common, but Male to female is rare.

Green(Red) Swordtail

Scientific name: Xiphophorushellers (Haeckel.1848)

- A close relative of Southern platy fish
- Prefers swift flowing, heavily vegetated rivers and streams
- Omnivorous

- Male grows to a length of 14 cm. females to 16cm
- Each immature fish develop into male or female depending on development of reproductive organs,

Chiapas Swordtail

Scientific name: Xiphophorusalvarezi

This fish is discovered and described by Don E. Rosen in 1960. It grows to a maximum length of 7.5cm

Montezuma Swordtail (Monty)

Scientific name: Xiphophorusmontezumae

A wild type swordtail which have black spots on a pale back colour. Swords are shorter than Xhelleri

Neon Swordtail

Scientific name: Xiphophortshelleri

- The fish is named for its exciting electric colouration.
- It has neon coloured bands across the length of its body.
- It exudes a rainbow of rich, iridescence that accentuates movements of this active fish.

Pineapple Swordtail

Vibrant shades of red and orange colours are present in the body of this fish.

CLASSIFICATION
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cyprinodontiformes
Family: Poecilidae
Genus: *Poecilia*
Species: *reticulate*

Guppy

- also known as Millonfish.
- One of the most traded ornamental fish.
- Robert John Lechmere Guppy (British Scientist) discovered the fish in Trinidad in 1866.
- introduced to aquariums in England during the 1800's.
- The fish was named Girardinusguppii in his honour by Albert Günther later that year.

BIOLOGY

- Guppy can grow 2-3 inch in size attains maturity in 4-5 months
- Females are viviparous and breeds 8-10 times in a year.
- Life span ranges from 1-2 years.
- Guppy cats on mosquito larvae and hence used in malaria control.
- Important varieties include grass, king cobra, mosaic and tuxedo.

FOOD AND FEEDING IN ORNAMENTAL FISHES. FORMULATED FEED AND LIVE FEED; LIVEFEED CULTURE

Principles of Feed Formulation

- The feed must be a balanced diet.
- The feed should produce optimum growth rate.
- The feed should contain all the essential amino acids and essential fatty acids. Fish meal is a good source of essential amino acids and essential fatty acids. Hence fish meal should be compulsorily included in the feed.
- Ingredients of plant origin and animal origin should be included.
- The feed must be in low cost but in good quality.
- Certain vitamins and minerals may be excluded as the fish may get them from natural feed sources.
- The feed must be acceptable by the fish.
- The typical adult feed should contain more protein but less carbohydrate. In the case of fry, the fats should be less.

- ❖ It should contain all the nutrients essential for life activities. The following nutrients should be included in the artificial feed:
  ***Carbohydrates *Proteins *Fats *Vitamins *Minerals *Additives binders *Preservatives*Chemoattractants**
- ❖ The feed should contain carbohydrate. It is the source of energy. The energy value of carbohydrate is 4kcal/gram.

The following are the sources for carbohydrate (energy source)

1. Rice bran
2. Tapioca flour
3. Wheat bran
4. Corn bran
5. Sorghum, etc.

- ❖ Proteins are the body builders. An ideal feed should contain 40% protein. The energy value of protein is 4.5 kcal/g. The ingredients containing protein are the following:
  Fish meal, Silk worm pupae, Blood meal, Prawn waste, Clam meat, Slaughter housewaste, Ground nut oil cake, Cotton seed cake, Coconut oil cake,Gingelly oil cake, Linseedcake, Sunflower cake
- ❖ The fish feed must contain fats. The fats are the energy producers. They contain more energy than that of carbohydrate and protein. The energy value of fats is 9kcal/g. The following are the fat source of fish feed:
  • Vegetable oils • Fish oils
- ❖ The feed must contain Vitamins. The following vitamins are essential for fish.

1.Vitamin A
2. Vitamin B
3. Vitamin C
4. Vitamin D
5. Vitamin E
6. Vitamin K

- ❖ The minerals are essential for vital activities of fish. The fish feed should contain the following minerals in trace amount:

Calcium, Sodium, Potassium, Phosphorus, Magnesium, Copper, Iron, Zinc, Cobalt

- ❖ The additives are added to make the feed stable. When additives are added the feed will not dissolve and disappear in the water. They bind the feed ingredients. So they are also called binders. Eg. Tapioca flour, Rice flour, agar, etc.
- ❖ Preservatives are added to prevent the decay of the feed.
- ❖ Chemo attractants are added to add flavour and taste to the fish feed.
- ❖ The ingredients are selected according to their availability and cost
- ❖ The ingredients are ground well and mixed thoroughly.
- ❖ 20.They are made into pellets, dried and stocked.

The following is a typical artificial feed formula:

Tapioca flour	-	9 kg
Rice bran	-	27 kg
Fish meal	-	23 kg
Ground oil cake	-	14 kg
Silk worm pupae	-	26 kg

Preparation of Dry Pelleted Feed at Home

- ❖ Take the needed ingredients in appropriate proportion.
  The ingredients are fish meal, soyameal, carbohydrate sources such as cereals, vitamins, minerals, chemoattractants, binders, antimicrobial agents, an- tioxidants, etc.
- ❖ Mix all the ingredients with adequate water and make into dough.
- ❖ Cook the dough in a pressure cooker or by steaming. Take care to avoid overcooking which will degrade the quality of the food.
- ❖ Make the feed into pellets by passing through a machine called pelletizer.
- ❖ Pellets are either air dried or dried in shade without affecting the prescribed moisture content.
- ❖ The dried pellets are stored in air tight containers.

Preparation of Crumbles and Granules

In this feed preparation, the cooked feed is not pelletized but made into small granules or crumbles with hand and then dried in shade.

Feeding Methods

The ornamental fishes may be

Herbivores	-	Plant eaters
Carnivores	-	Meat eaters
Omnivores	-	Eat both plants and meat

Culture of live food organisms

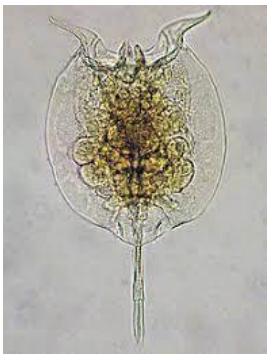
1. Infusorians

Materials used for culturing infusorians include hay, banana peels, dried beans, lettuce, cabbage, egg yolk, malted milk, skimmed milk (dried), hay seed, dried blood, spinach, dried aquatic plants, etc. A medium may be prepared by first boiling any one of the above ingredients. It is then diluted with fresh water, kept in a plastic trough or cement tank of 50 to 100 lit. capacity. The fertilized water medium may be covered with nylon screen for bacterial development, fermentation and subsequent leaching of nutrients. Within four days, the water turns greenish which indicates the production of infusorians. A mild aeration and alkaline pH (8-9) may enhance the production of the infusorians.

2. Zooplankton

Zooplanktonic organisms such as rotifers, copepods and cladocerans like *Moina* and *Daphnia* spp. are ideal live foods for juvenile ornamental fishes such as fighter fish, angel, Oscar, red tail shark and other baby live bearing fish species.

a)Rotifers



The common freshwater rotifer species suitable for feeding a variety of ornamental fishes include *Brachionusrubens, B.calciflorus, B.forficula* and *Keratellatropica*. The mass culture of these rotifers could be undertaken in plastic troughs or circular tanks of 250 lit. capacity. A mixture of poultry droppings, groundnut oilcake and triple superphosphate is prepared at 150ppm, 50ppm, and 20ppm respectively and are added to above tanks containing water. The medium is then inoculated with *Brachionus sp.* on the third day at the rate of 10-15 animals per ml. The above liquid manure may also be added in alternate days when the density reaches 1 ml organisms/m^3. A bolting silk and plankton net of 50mm mesh size could be used to sieve out the organisms for feeding the fishes. The harvested rotifers should be washed in freshwater before their use in feeding the fish fry. Fibre glass tanks of 1.5x0.6x0.6m capacity have been found to be ideal for the mass rearing of *B.plicatilis*, which is inoculated at one individual per 1 ml of the medium. The growing *B. plicatilis* under mass culture is fed normally with yeast at 0.04g/l. Green algal concentrate containing *Chlorella spp*. may also be used to feed these rotifers. Harvesting could be done after 20 days when the population of *B.plicatilis* exceeds 4000/ml. The harvestable rotifers which float in the surface are sifted, collected and stored in tins or aluminium packs as vacuum dried for further use.

b)Copepods

Cyclopoid and calanoid copepods are also known to be ideal live food organisms especially for feeding the fry and fingerlings of ornamental fish species such as fighter fish, angel and tetra.

Tanks of fish ponds manured with raw cow dung, groundnut oilcake and superphosphate at 330/80/60 ppm respectively and are kept under continuous aeration and inoculated with 50 individuals per liter medium would lead to the production of copepods from third day onwards.

c)Cladocerans

Cladocerans are otherwise known as water fleas, the size of which vary from 0.5 to 1.5mm. They are common in seasonal ponds, pools, etc. especially after the development of phytoplankton blooms on which they normally feed. The production of cladocerans such as *Daphnia carinata* and *Moina sp*. is more in ponds receiving liquid organic wastes from cow shed. A liquid manure mixture may be prepared using cow or horse dung, groundnut oilcake and single superphosphate in the ratio of 5:5:1. A culture pond of 30 sq.m..area with 1m depth may be filled with water. The liquid manure may be dissolved in the pond so as to give a concentration of 220ppm. Aeration may be done to speed up the process of decomposition. Individuals of *Moina sp*. or *Daphnia carinata* may be inoculated at a density of 50 individuals per litre of pond after two days. The cladocerans may go up as high as 5000 organisms/l in sixth to seven days. The cladocerans may be harvested from the seventh day onwards in alternate days, when their maximum density is reached and the harvest is made by using a plankton net and the concentrate is freeze dried for regular feeding of the fishes as and when required.

d)Brine shrimp

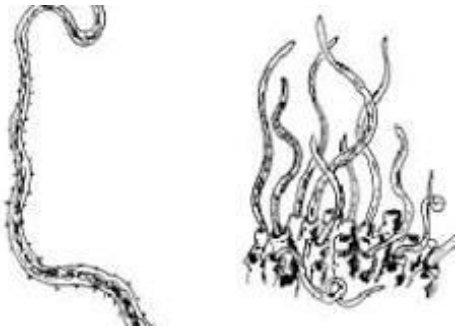
Brineshrimp (*Artemiasalina*) cysts are available in the aquarium shops. Such cysts can be hatched at the time of need and the resulting larvae are fed to the juvenile and adult ornamental fishes. Hatching of *Artemia*cysts may be done as follows: A glass jar of one litre capacity is taken and 35 ppt sea water or 35% saltwater is added to it. The water temperature is maintained at 25-30°C, pH 8-8.5 and dissolved oxygen, 4-5ppm. Continuous and copious aeration facility should be provided to enable the cysts to float in the water current. The hatching of cysts would normally be completed in 24-36hrs. Prior to hatching, encapsulated cysts may be heated with 5% sodium hypochlorite or calcium hypochlorite solution which helps in the removal of the chorion layer of the cysts in 5-10 minutes. Such processed cysts washed in freshwater would ensure 95% hatching in 12-20 hours. Good illumination is also recommended for this purpose. The nauplii could be siphoned out and fed to the fish fry. Adult brine shrimps may also be developed in cement tanks containing 60% ppt. of saltwater and organic manure. The brine shrimps serve as potential live food for many species of ornamental fishes grown in tanks or cisterns. In order to economise the production cost of ornamental fishes, *Artemia* is preferred owing to its higher nutritive value and food conversion efficiency.

e)Blood worm (Chironomus larva)

The intermediate stage of the midge fly (*Chironomus sp.)* is commonly called as blood worms. These worms are ideal live food source to all varieties of ornamental fishes. The chironomid fly normally lays

about 2000 eggs at a time in any substratum of the stagnant water and such eggs hatch out in the presence of sunlight in a period of about three days. The larvae attain the optimum size in about 15-20 days, when they are ready for feeding fishes. These worms could be collected from the wild waters rich in organic nutrients by disturbing the mud bottom. The larvae of Chironomus feed on phytoplankton like *Nitzschia sp.,Naviculasp,Chlorella sp,Chlamydomonas sp.* etc. Hence any organic manure which helps in the generation of these algae may be used for fertilizing the pond to facilitate the adult fly to lay the eggs. Organic manures like cowdung, pigdung, poultry waste either alone or in combination with groundnut oilcake and superphosphate may also be used to enhance the production of algae and flagellates. Tanks of any size may be used in the production of Chironomus larvae. Larvae collected from the wild should be washed and treated with suitable dose of antibiotics in order to prevent bacterial or pathogenic infection.

f)Tubifecid (*Tubifextubifex*)



The tubifecid worms are annelids which normally dwell inside tubular cases. They are common in sludge banks or silty shores of aquatic areas rich in nutrients. As they are available throughout the year, the supply is not restricted. As *Tubifex* contains n3 and n6 fatty acids, it is an ideal live food source especially for brood fishes such as goldfish, angel and ocsar. *Tubifex*could also be cultured in raceways fertilized with organic manures. For harvesting tubifecid worms from the wild habitats i.e. soil, the latter is first dried. During drying, the animals would lump together and form balls. These balls should be washed in running water to remove the gut contents before feeding them to fishes.

g)Microworms

The microworms belonging the species to *Anguilla silusidae* are white tiny nematode worms which also serve as an important live food for ornamental fishes. It can be mass cultured as follows:

Wheat flour is dissolved in water, boiled, cooled and a flopping paste is prepared out of it. Slanting glass plate is kept at 60° angle in the liquid. The worm may be inoculated and allowed to multiply in a closed and cool place. As the worms move towards the plate in numbers, they could be collected by a spatula for feeding the fry of angel or fighter fishes.

BREEDING, HATCHERY AND NURSERY MANAGEMENT OF EGG LAYERS (eg.GOLD FISH) AND LIVE BEARERS (eg.GUPPY)

Breeding and production technologies of ornamental fishes differ from species to species according to the nature of their reproductive habitat and other physiological conditions. However, the following reproduction methods are discussed.

Oviparity-i.e. producing young from eggs released from the body.

Ovoviviparity-i.e. producing young by eggs which hatch within the body of the mother itself, but not nourished by it.

Viviparity - i.e. the mother is giving birth to live young ones which are nourished by the former.

Oviparous fishes

The oviparous ornamental fish species are further subdivided into five major categories. They are:

Fishes which scatter non-adhesive eggs (eg. Neon tetra, widow tetra, etc.).

Fishes which drop or attach adhesive eggs (eg. goldfish, koicarp, etc.).

Bubble nest builders (eg. Fighter fish, gourami etc.)

Fishes which deposit and take care of their eggs (eg. angel, oscar, etc.).

Mouth breeders - fishes which pick up the laid eggs and keep them inside their buccal cavity. These eggs hatch out after a few hours or days of incubation and free themselves (e.g. Oscar, auratus, angel, etc.).

Breeding methods in egg layers

Most of the egg-layers can be domesticated to breed in captivity. Suitable males and females for breeding are selected according to the state of their berry. The brood fish are normally kept in a tank containing suitable medium with favourable water quality parameters. Soft water with acidic pH or hard water with alkaline pH may induce different species to spawn either in tanks or in earthen ponds. Fishes like auratus and blue morph require hide-out materials in the tank itself for inducing spawning. It is preferable to keep the male and female oviparous breeders separately in tanks. Such separation may benefit the female fish to develop more eggs. Breeding will be successful only when suitable brood fishes are selected and are provided with all requirements for the spawning act. The fertilized eggs undergo various stages of development before they become fry . The breeding methods of the various egg laying varieties of ornamental fishes are dealt with here.

Goldfish

Generally the goldfish attains sexual maturity in a period of five months at 27-30°C and under good nourishment. Staple live diets such as earthworms, daphnids, blood worms,

tubifecids, squid meal, clam and oyster meat are preferred by the fish. The sex of berried female may be identified by the swollen belly, which denotes the presence of matured ova. Matured males on the other hand are identified by the presence of tubercles each about the size of a pin's head. It is worthy of mention that such tubercles disappear immediately after spawning. For the purpose of breeding, female and male are introduced in the spawning tank of 50 to 100 lit. capacity at 1:2. Mass breeding is also possible in a large, circular cement tank (3 m dia and 75 cm ht.) containing aerated water and aquatic weeds such as *Ceratophyllumdemersum* or *Hydrilla sp*. or synthetic nylon fibrils in bunches . The water in the breeding tank should have temperature of 20-27°C, pH 7-7.5 and dCH 2°. About 500 sticky eggs are obtained from a medium sized female (10-12 cm) weighing 100-125 g. As the eggs are adhesive, they attach the weeds or fibrils in about 9 to 12 hours early after the spawning process which is normally held in the morning. The eggs measure 1 mm in dia. The incubation period is 65-72 hrs at 25-31°C. The hatchlings do not feed until the fifth day as they depend largely on endogeneous nutrition i.e. yolk. From the sixth day onwards, they are fed with infusorians. The emerged fry are fed with *Artemia*nauplii or cyclops for about 10 days, thrice a day. The young fish are then fed with tubifecids or Chironomus larvae in addition to artificial diets. The weeds containing the adhesive eggs are finally removed to another tank. Alternatively the parents could be removed to the stocking pond leaving the eggs in the spawning tank.

Breeding of livebearing ornamental fishes

The male fish generally develops a thickened rod like organ called gonopodium in between the anal fins at puberty. It is normally pointed backward but can be moved at will sideward and foreward. During mating, the tip of the gonopodium is inserted into the vent of the female and the spermatozoa are thereby injected and the eggs thus get fertilized. Though the

female develops normally a gravied spot, the eggs are attached to the mother's body only and are fed directly by her. The youngones lie motionless for short-time at birth to gather strength.

Mating occurs frequently. A male will mate with any female of the same species. The period of gestation depends more on temperature and the species selected for breeding. It is necessary to remove the bearing mother to a separate breeding tank long before she is expected to give birth. A medium sized female may deliver as many as 100 babies at a time. Female livebearers may produce babies three to five times from the last mating. The breeding pattern of four varieties of livebearing ornamental fish species is dealt with separately.

Guppy

A breeding tank with a capacity of 3 to 10 lit. is ideal. Male and Female sex ratio of 1: 4 is maintained. Temperature of 25-30°C, pH 7-8 and medium hardwater or slightly saline water (2-3 ppt) are preferred. Gestation period in female fish is about 30 days, and about 200 young ones are released at a time. Youngones often cling to the plant thickets kept in the breeding tank. The parent fish should be removed immediately after it gives birth to young ones. The baby fishes are fed with *Artemia*nauplii or sifted zooplankton for the first 15 days. Ricebran and ground nut oilcake mixture may also be used for feeding the baby fish. A water exchange of 10% in the rearing tank once in every 5 days may enhance the growth and ovary development.

Culture techniques

The fish culture technology helps to take care of fertilized eggs, embryos, hatchlings and the fingerlings, in a more scientific way. In livebearers, the problems concerning earlier stages of the fish are considerably less as the emerging youngones are straight away given- birth as baby fish, which are resistant to optimal and small scale changes in water quality. Unlike livebearers, the production rate in egg laying ornamental fish is high, though the maintenance of the fertilized eggs, embryos, hatchlings and the fingerlings of this group require extra care. The commercial ornamental fish culture and the associated management and bulk fish production have three phases, viz. nursery phase, rearing phase and production phase.

Nursery phase

In egg laying varieties of ornamental fishes, the fertilised eggs hatch out either as embryos as in the case of angel fish or as tender spawn as in the case of goldfish, koi carp, fighter, tetra and so on. In cichlids like oscar, *auratus* and blue morph etc, the fertilized eggs are uniquely collected by the mother fish in the buccal cavity for incubation. The hatched out youngones come out as fry from the mouth of the parent and are protected by the parents for a few days. The nursery tanks may be of rectangular structure of 12 X6 X 1 m size are used for effective management of the growth, and survival of these spawn. In the above nursery phase, the fry feed on the naturally growing microscopic organisms such as phytoplankton and zooplankton as starter feed. The growth and survival of the spawn and fry depend largely on the occurrence of such food organisms.

Uniform sized spawn should be stocked in the nursery tank at a time, at a density of 500 per m^2. The period of rearing normally would be 15 days. The spawn and fry are also fed with finely sieved mixture of ricebran and oilcake at

1:1. A survival rate of 40% could be obtained during the nursery phase of rearing. Microscopic organisms such as diatoms, green algae and zooplankton like cladocerans (*Daphnia sp*., *Moina sp*.), rotatorians (*Brachionus sp*.) and calanoid and cyclopoid copepods serve as ideal food to the hatchlings.

Besides the naturally occurring planktonic food organisms, supplementary feed may also be broadcast on the water surface in the morning hours. The feed may also be soaked in water to get a thick paste which is kept in earthen or plastic pots and suspended in the water column. The fry come at the surface mainly during morning hours to feed on this food and take shelter in shady regimes preferably at bottom layers. The survival rate of the fry could be enhanced considerably by treating them with antibiotics and vitamin B12. Among the micronutrients, yeast and vitamin B-complex have been found to increase the growth of the spawn in their order. As the hatchlings grow, their feeding habit normally changes and the fry would start feeding on plant and animal matter. Therefore, artificial feeding is essential to stimulate the growth of the fry. During this period, at least partial water exchange should be done in the nursery tanks. Aeration of the tanks would also help to maintain the level of dissolved oxygen content of the water, besides minimizing the accumulation of the toxic substances and gases.

Rearing phase

After 15 to 20 days of nursery rearing, the fry are transferred to a cement rearing tank for further growth. A fairly larger size of the nursery otherwise called as 'rearing tank' is used for the purpose. It measures 25 X 12 X 1m and the fry are reared here for about 60 days, till they become marketable sized fingerlings (4 to 10 cm). The rearing tank must be devoid of fish predators such as frogs, snakes, turtles,etc. Stocking suitable combination of various fry except predatory fishes like oscar, pirhanus, fighter fish, etc. is recommended

in the rearing tank. Such fry are fed with the grower mash to enhance their growth. A stocking density of 150/m² area has been found to be optimal to obtain 70% recovery and increased body size in a period of three months. Protein- rich feed components such as silkworm pupae, soybean, cowpea, fish meal, chopped beef liver, redworm and tubifex should be supplied depending on their availability. Artificial feed mixture consisting of 40% protein is also suitable for optimum growth of the fish. Such protein-rich feed, when administered at the rate of 4% of the fry weight, the food conversion ratio (FCR) would be 1.5. That is for every 1.5 kg of dry feed given, a live weight of 1 kg fish would be produced. Antibiotics such as terramycin and tetracycline may be mixed with the feed material at the rate of 100 mg/kg of feed to give disease resistance and to safeguard the fingerlings from the attack of parasites. The feed ration may be increased from 1 to 3% of the total weight of the fry or fingerlings gradually. The growth of the fry may be assessed periodically by measuring their length and weight with the help of nylon screen net once in every month. The rearing tank should be guarded from predators such as king fishers, water teals and storks, and a meshed net fence enclosure all along the sides and top would help in this regard.

Production or stocking tank

Though production tank is not strictly maintained for ornamental fish culture practices, such type of tanks are required to raise all kinds of broodfish. Special care in feeding and disease maintenance are a prerequisite for rearing ornamental fishes in tanks. Larger fishes such as goldfish, koi carp, red tail shark, oscar and angel fishes are raised in production tanks only. Some of the management measures followed in rearing tanks should also be adopted in these production tanks. However, the stocking density in this type of rearing system is largely decided according to expected yield and rearing time. The production tank may be designed according to the land area available in the

farm. A production tank of 50 X 10 X 1.5 m or 25 X 25 X 1.5 m water area would be preferable. The fish production of the stocking pond is more related to the natural productivity of the pond as well as other management practices such as fertilization, supplementary feeding, stocking density, species combination, etc. In order to obtain maximum fish yield, the production pond should be stocked with fingerlings at an optimal level. The stocking density suitable for a production pond could be calculated following the formula:

$$\textbf{Number of fish per unit area} = \frac{\textbf{Excepted biomass (kg)}}{\textbf{Excepted weight of individual fish (kg)}} - 10\% \text{ fish mortality}$$

For example, in a stocking tank of 500 m² area, where the expected production is 500 kg and individual growth is 200 g in 6 months (goldfish or koi carp), the stocking density would be:

$$\textbf{Stocking density} = \frac{500 \text{ X } 1000}{200} = 2500 - 250$$

i.e. = 2250 nos/500 m^2 area

AQUARIUM DESIGN, CONSTRUCTION AND PREPARATION

Requirements for an Aquarium

- Aquarium is a tank with colourful fishes and plants maintained for human recreation
- An aquarium requires the following components:
    a. Fish tank
    b. Water
    c. Ornamental fishes
    d. Aquarium plants
    e. Substrate
    f. Aerators
    g. Filters
    h. Thermometer
    i. Heater

j. Nets
k. Artificial feed
l. Live feed
m. Light
n. Air stone
o. Scrapers
p. Feeding cups
q. Siphon tube
r. Breeding traps

Aquarium Tanks

Aquarium tanks are made of glass panes with or without frames.

- Aquarium can be made from materials like concrete, wood, fiberglass, metal framed glass panels, extruded acrylic and all glass.

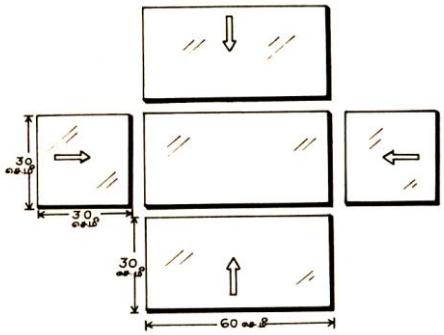
Aquarium Size and Volume

- ❖ An aquarium can range frames small glass bowl containing less than a litre of water to large public aquaria which can house entire ecosystems such as kelp forests
- ❖ Larger aquaria are typically recommended due to their resistance to rapid fluctuations of temperature and pH, allowing for greater system stability.
- ❖ Practical misations of a large aquarium are the weight and internal water pressureHence the maximum size advisable for a home aquariom is around I cubic meter involume Some Aquarists, however, have constructed aquaria of up to many thousands of litres.
- ❖ Reef aquaria, having a small water volume under 100 litres, are termed nano reefs.
- ❖ Public aquaria, designed for exhibition of large species or environments, can be dramatically larger than any home aquarium. The Georgia Aquarium, for example,features an individual aquarium of 6,300,000 US gallons (23,800 m^3).

Construction of an Aquarium Tank

- ❖ The construction of a glass aquarium tank requires the following materials:
    - Glass plates-5 numbers

- Silicone gel
- Squeezing gun
- Adhesive tape
- Thermocol sheet
- Rubbing alcohol (or) acetone
- Containers



Glass plates

- The glass plates are cut in correct size.
- The side glass plates should be just shorter than the final measurement for correct fitting. The difference in size should be twice the thickness of the glass. For example, if the thickness of the glass is 4 mm, the side plate should be 8 mm shorter.
- Spread the thermocol on a smooth ground.
- Place the bottom glass plate in the centre of thermocol.
- Place the other 4 glass plates around the bottom plate as in the figure. Clean the surfaces and edges of the glass plates with alcohol.
- Apply silicone gel using a squeezing gun along the edges of the centre plate and the back plate.
- Keep a heavy object on the backside of the vertical glass plate to held it in position.
- Like this, paste the side glasses one by one and lastly the front glass.
- Apply adhesive tapes on the corners.
- Leave it as such for 1 day
- On the next day, the excess of silicone gel can be removed with a knife.
- The tank may be filled with water.

Types of Substrate

Gravel

- For freshwater aquaria, gravel is the most common substrate.
- To prevent damage to fish, gravel should not be sharp.
- Aquarium gravel can be as pea-sized or as fine as 1-2 mm.
- It is available in a number of colours and may be coloured or dyed.
- Gravel must be chemically inert. It is commonly composed of quartz or other lime free minerals.
- If the gravel is rough or sharp, it is not suitable for bottom-dwelling fish that may dig the substratum

Calcium Carbonate Substrates

- Shell grit, crushed limestone, crushed marble, crushed coral skeletons, coral sand are also used as substrates.
- Calcium carbonate is the primary component of these substrates.
- It increases water hardness and pH. Hence these are used most often for hard water species like cichlids
- Lime free gravels are much preferable for fresh water aquarium fish, particularly river species, which are adapted to soft water

Peat or decomposed plant matter

- Peat, or decomposed plant matter, is used most commonly in soft water systems.
- It is soft in texture and therefore suitable for demersal (bottom-dwelling) species sand
- Sand is often recommended for use with certain species, such as the river stingrays, which bury themselves in the fine substrate.

Ornamental Aquarium Plants

- Visual impact to the aquarium.
- Shelter and territorial boundaries to the fishes.
- Leaves of long plants trailing over the water surface provide shade and a refuge for young fishes.
- At breeding times plants may be used as a spawning site.
- They act as basic building materials for bubble nesting fishes
- Some aquarium plants form food for vegetarian fishes.
- Carbon dioxide produced by fishes is absorbed by plants, thus they control the carbon dioxidein the aquarium.

- ❖ Photosynthetic activity of plants provides a source of oxygen for fishes.
- ❖ Nitrates formed at the end of denitrifying action by bacteria may be taken up by the plants.
- ❖ Live aquarium plants will prevent algal infestation by competing with algae for nutrients.
- ❖ They will provide weaker fish with suitable hiding spots.

Biological Filtration

- ❖ Biological filtration is the removal of wastes from the aquarium using bacteria and plants.
- ❖ Biological filtration deals with the growing of the good bacteria in the filter. The good bacteria are convert ammonia to nitrite and then convert nitrite into nitrate.
- ❖ Thus establishment of bacteria is essential for the success of a tropical aquarium.

Ammonia-> Nitrite-> Nitrate

Accessories for Fish Tanks

Hood

- ❖ The part that covers the part that typically covers the lighting fixture is the hood. It may also incorporate a plastic lid to cover the top of the aquarium.
- ❖ The single hood that covers the aquarium and houses a light usually is less expensive than a separate lid and lighting unit.

Aerator

- ❖ Aerator is an electrical device generating air.
- ❖ It consists of a motor and a pump.
- ❖ It works like a compressor
- ❖ It produces air. The air is passed into the aquarium.
- ❖ This dissolves air in aquarium water. Hence the aquarium water is oxygenated. Fish get sufficient O_2.
- ❖ The turbulence removes CO., from the water.
- ❖ Air bubbles add attraction to the aquarium.

Light

- ❖ Lighting makes an aquarium more attractive. It is also an essential stimulus to the plants and fishes.

- ❖ Aquarium plants need light to photosynthesis-a process by which they remove CO, from water.
- ❖ Light can be easily provided by means of lamps mounted in the aquarium cover usually referred to as hood or reflector.
- ❖ Tungsten lamps, fluorescent tubes or a combination of the two can be used.
- ❖ The aquarium should be lit for at least 10 hours each day.

Nets

- ❖ Nets of various sizes are needed in an aquarium Nets may be used for a variety of tasks.
    1. To skim debris from a tank
    2. To catch fish of various sizes
    3. To scoop up a meal of freshly hatched brine shrimp.

  The following points should be considered while choosing a net:
- ❖ Net material should not cause scale damage.
- ❖ Mesh size should be selected in such a way that it should not allow the fish to go through or get caught in.
- ❖ The net material should be soft (silk or muslin cloth) and flexible. • It must have easy to use handles.

AQUARIUM PLANTS AND THEIR PROPAGATION

Among different species of aquatic plants, some of them could be used to beautify ornamental fish tanks. These plants offer biological and biochemical benefits to the ornamental fishes. Some species of aquatic plants serve as good substrata for spawning purposes especially for the egg laying fish species. The aquatic plants are used in ornamental fish tanks, as floating plants rooted at the bottom of the tank or submerged plants. Almost all the ornamental plants and their root system help the parent fishes and their babies as resting place. Various genera of aquarium plants are identified by their leaf shape and colours. Some of the Indian tropical aquatic ornamental plants possess great demand in the overseas markets.

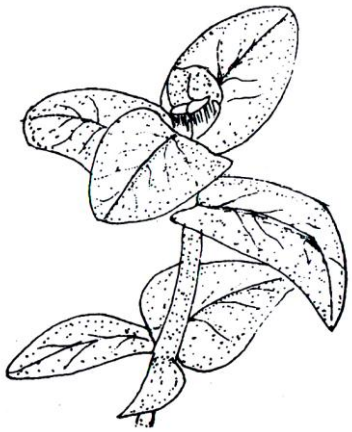
Floating plants

Floating plants like *Lemna minor, Salvinia sp., Azollafiliculoides, Ricciafluitans, Najas sp.* and *Pistia sp.* mask the surface waters and are useful to gouramis for building their nests since plants prevent heating of water especially during hot days

Lace plant (*Aponogetonfenestralis*)

It is widely distributed in India and Sri Lanka and grows up to 30 cm in height. It has a rhizome and is variable in colour and is suitable to bright light. It survives well in water temperature of 20-25°C; pH 6-8 and in softwater to medium hardwater. Large grained sand with a little mud is suitable for propagation, which is by division of offshoots.

Bacopa (*Bacopaamplexicaulis*)



This species is found distributed in the Atlantic coasts of North America and has been acclimated to Indian tropical conditions. It grows up to 60 cm and is an emergent type. The leaves are arranged on opposite sides of the stem. The flowers are blue in colour and bell shaped. It prefers temperature of 25-30°C, neutral pH and mild hardwater conditions. Soil with organic fertilizer is required for propagation which is mainly by sprouting.

Hornwort (*Ceratophyllumdemersum*)

It has cosmopolitan distribution and grows to about 4 cm under temperate, cool and shady conditions. Propagation is by stems which are anchored to the earth or tied with a stone. It favours temperature of 20-25°C, neutral pH and medium hardwater.

Hydrilla (*Hydrilla vulgaris*)

It is found distributed in South Asia, Australia and Northeastern Europe. It is a submerged perennial plant growing up to 20 m. Their whorls are of 3-6 cm width with serration. The plant prefers moderately warm waters and sandy and loamy soils. It is propagated by cutting.

Water sprite (*Cabombaaquatica*)

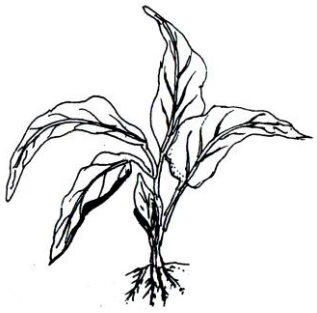
It is widely distributed in North America. It grows up to 6 cm under clean water and mild light conditions. It favours water temperature of 20-27°C, softwater of 6.5-7pH and soil consisting loam, sand and garden earth at 1:1:1. Propagation is by cutting the stem and planting on the bottom sand.

Indian fern(*Ceratopteristhalictroides*)

This species is commonly called as Indian fern. It is a tropical plant and is found distributed in almost all the tropical areas of the world. The leaves are soft and oblong, and are resembling to antlers. Temperature of 25-30°C, acidic pH, hardwater,

normal illumination and sandy or loamy soil conditions are suitable for the growth of this species. The leaflets are covered with buds which give rise to new plants.

Hidden club *(Cryptocorynewillisii*)

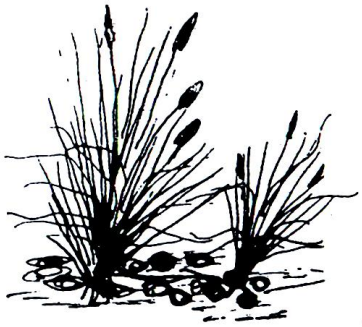


It is distributed in Sri Lanka and tropical Asia and grows up to 20 cm. It prefers water temperature of 20-30°C, acidic pH, and soft or very soft waters. The plant requires sandy soil substratum for propagation which is by rhizome.

Amazon sword plant (*Echinodoruspaniculatus*)

It is commonly called as "Amazon sword plant" and is found distributed in South America. It grows to a height of 50 cm. Water temperature of 20-25°C, neutral pH, medium water hardness and sandy substratum are more suitable. Propagation is by plantlets which are sent out from the main plant as long runners.

Needle grass (*Eleocharisacicularis*)



The plant is commonly called as 'hair grass' or 'needle grass'. It has cosmopolitan distribution and grows to 20 cm. The propagation is by root runners. Temperate or warm water conditions, medium hardwater (120 ppm), pebble substratum and intense

light are needed for its growth. It is a favoured species for ornamental fish tanks.

Hygrophila(*Hygrophiladifformis*)

This species is found distributed in India and Malayan Peninsula. The leaves are oval, serrated, deeply indented or fringed. The submerged leaves are pale green and the partially aerial leaves are black in whorls. Temperature of 25-35°C, neutral pH, hardwater conditions, normal illumination and sandy soil texture are required for its propagation which is by cutting.

Lance leaf plant(*Ludwigiamulertii*)

The species is distributed in Europe, Asia, Africa and America. It is a perennial species tolerating aquatic, semi-aquatic or marshy conditions. The leaves are smooth and are arranged in opposite or alternate sides of the stem. The flowers are small, yellow or green. Propagation is by vegetative method. Temperature of 25-28°C, neutral pH, medium water hardness, intense illumination and sandy soil with equal parts of loam and sand are recommended for cultivation.

Ambulia (*Limnophilasessiliflora*)

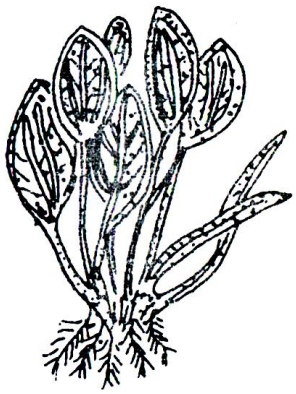
This species is commonly called as 'ambulia'. Though it resembles Cabomba to a larger extent, its leaves are yellowish-green unlike that of Cabomba. It propagates easily by cuttings

taken out from the parent plant root. Soil containing sand and loam is ideal for optimum growth. Temperature of 25-30°C, neutral pH and intense illumination are needed for their growth.

Milfoil (*Myriophyllumverticellatum*)

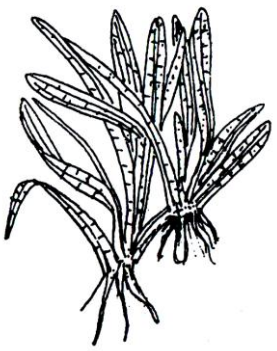
This species is commonly known as 'water milfoil''. It has a cosmopolitan distribution and is partially submerged. The leaves are in whorls of four or five and feather like. Propagation is by cuttings. Temperature of 20-25'', alkaline to acidic pH. (6.0-6.5). medium hardwater, intense illumination and sandy or loamy soil are required for its growth.

Ottelia(*Otteliaalismoides*)



It has a cosmopolitan distribution. The leaves are leathery and ribbon-like when young, and round, lanceolate or wavy when old. It grows to a height of 10-20 cm. Temperature of 25-30°C, neutral pH and medium hardwater and average illumination are required. Clayey soil with sand and loam contents (1:1) are required for its optimum growth.

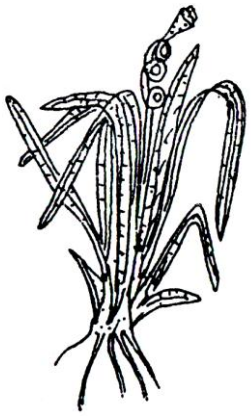
Arrow weed (*Sagittariasagittaefolia*)



This species is commonly called as 'arrow weed'. It is found distributed in Europe, Southern U.S.A. and Asia. It is a perennial, marshy plant, partially or completely submerged. The leaves are arrow

shaped and whorled flowers have three white petals. Propagation is by offshoot and by seed. Temperature of 20-28°C, neutral or slightly alkaline pH, medium hardwater, mild illumination and sandy or loamy soil are required for its growth.

Ribbon grass (*Vallisneriagigantea)*



This species is commonly called as 'eel grass or ribbon grass'. It has a tropical or subtropical distribution. It is a submerged plant with long ribbon-like leaves measuring 0.5 - 1 cm width. Male and female plants are separate. While male flowers are very small and are at the roots, the female flowers are long, threadlike, twisted and appear at stalks. Propagation is by offshoots. Temperature of 20- 25°C, neutral pH, medium water hardness, intense illumination and soil with sand, clay and loam at 1:1:1 are favorable for its optimal growth.

AQUARIUM MAINTENANCE

Water Quality Management in Aquarium

- ❖ Water is the home of the fish. The fish lives, feeds, breathe breeds and defaecates in the aquarium water. So water quality management is vital for the fish
- ❖ If the water is not properly managed, the water becomes toxic and kills the fishes.

Water quality is managed in the following ways:

- ❖ The optimum pH for aquarium is 7 to 8. It is alkaline.
- ❖ The organic wastes released by the fishes make the water acidic. The acidic water is made alkaline by the addition of slaked lime, Calcium hydroxide.
- ❖ Sodium bicarbonate and tries stabilizes the pH for one or two weeks.

- ❖ Aquarium fishes prefer soft water. A hardness range of 100 to 300 ppm is suitable.

The hard water is made into soft water by the Following methods:

- ❖ Boiling the water. It decomposes bicarbonates into CO2, and insoluble monocarbonates.
- ❖ Passing the water through zeolite (sodium aluminium silicate). It absorbs lime and magnesium from the water.
- ❖ By the addition of sodium carbonate, soluble calcium and magnesium salts are precipitated as insoluble CaCO3 and MgCO3. They are removed by distillation.
- ❖ Chlorine from chlorinated water is removed by two methods
    1. Strong aeration.
    2. Addition of dechlorinating additives
    3. Heating
    4. Exposing to sunlight.
- ❖ The optimum O level of aquarium water is 5ppm. The O_2 level is enhanced by the following methods
    1. Aeration
    2. Agitation
    3. Sprinkling of water.
- ❖ The optimum level of CO, is 60 mg/l. CO_2 level increases due to respiration Aquarium plants absorb CO; CO_2 is identified by phenolphthalein indicator.
- ❖ As the fishes are ammonotelic, they excrete ammonia. More than Img/l of ammonia is toxic.
- ❖ The optimum temperature for aquarium water is 23 to 28°C (73 to 82°F).
- ❖ Anaerobic condition in the aquarium bed, converts sulphate into hydrogen sulphide (H_2-S).0.01 to 0.5 mg/l is known to lethal to fishes. H.S can be reduced by the following methods:
    1. Aeration-adding 0_2
    2. 0_2 reacts with H2S and produces sulphate ions
    3. Water change
    4. Application of lime

5. Increasing pH

ORNAMENTAL FISH DISEASES, THEIR PREVENTION, CONTROL AND TREATMENT METHODS.

Diseases can be classified into the following types

1. Bacterial
2. Viral
3. Fungal
4. Protozoan
5. Parasitic diseases
6. Deficiency diseases

1. Bacterial disease

Fin Rot

Causative Organism: Aeromonas, Pseudomonas or Vibrio (Gram negative organism)

Description

- Fin rot is one of the most common and most preventable, diseases in aquarium fish.
- It is caused by several types of bacteria and often occurs concurrently with other diseases.
- It can usually be cured, but if left untreated, it can kill the diseased fish and infect all the others in the tank.

Symptoms

- Fin edges turn white
- Fins fray
- Bases of fins inflamed
- Degeneration of the tissues between individual rays of the fin.
- Entire fin may rot away
- As the disease advances, the area may become red and inflamed, with bloody patches appearing as more of the fin is eaten away.

Causes

- Stress
- Poor water quality.
- Overcrowding the tank

- Feeding outdated food
- Overfeeding

Treatment

- Water change
- Treat with antibiotics like chloramphenicol, oxytetracycline, and tetracycline.
- Removal of food debris.
- Addition of aquarium salt.

Prevention

- Maintain good water quality
- Keep proper water parameters
- Feed fresh food of high quality in small amounts
- Avoid stale foods
-

2. Viral Diseases

Carp Pox

- This results in epidermal hyperplasia.
- It is thought to be due to a herpes virus. It is present as discrete candle like lesions.
- It is an epidemic occurring in spring but disappearing in late summer.
- The disease has also been attributed to avitaminosis and calcium deficiency.

Prevention

- Keeping good sanitary condition
- Avoiding over crowding

Spring Viraemia of Carp (SVC)

- SVC is the most important viral disease of ornamental carp. It is caused by Rhabdoviruscarpio.

Symptoms

1. Lethargy
2. Darkening of the skin
3. Respiratory distress
4. Loss of balance

5. Abdominal distension (dropsy)
6. Exopthalmia
7. Peritoneal haemorrhage of gills and skin

Control

- Isolation of infected school of fishes
- Provide food soaked in a solution of methylene blue.
- Antibiotics such as terramycin, chloromycetin/ chloroamphenicol have proved effective against this disease.

3. Fungal Diseases

- Various fungal diseases are seen in aquarium fish. Most fungal diseases are associated with poor environmental conditions, malnutrition or other primary diseases.

Saprolegniasis

- Saprolegniasis is a fungal disease.
- It is also called water mould disease or dermatotycosis.
- It is caused by the fungus Saprolegniaparasitica.
- The fungus is a coenocytic mycelium without a cell wall
- On a dead fish, the mould can spread and cover the entire body in 12 to 24 hours.
- It is a skin disease.
- The fish secretes a great deal of mucous. Tufts of cotton wool-like structure appear on the skin.
- Ulcer develops on the skin. Haemorrhage occurs from the wound.
- The fish rubs the body against solid materials
- Blindness occurs.
- Loss of appetite
- The fish moves slowly and eventually dies.

Treatment

- Disinfect the pond with quicklime.
- Dip treatment in 3% common salt solution for 5 to 10 minutes.
- Dip treatment in potassium permanganate solution 1:1000.
- Dip treatment for three seconds in malachite green 1:1000.
- Apply malachite green ointment or sulfa-ointment.

4. Protozoan Diseases

Ich

Causative Organism

- Ichthyophthiriusmultifilis- a Protozoan parasite.
- Common Names: Ich, white spot
- This is the most common disease. The parasite is a Protozoan. It is spherical in shape with cilia covering the surface.
- They burrow under the skin of the fish where they set up an irritation and spread, all overthe body and fins.
- When they fully develop and mature, they leave off their host and individually form acyst.
- The cyst will adhere to plants and rocks. The cyst capsule will burst and release thousands of tiny spores which re infects the fish.

Symptoms

- Small white spots resembling sand
- Fish scratch against rocks and gravel
- In advanced stages fish become lethargic
- Redness or bloody streaks in advanced stages
- Infected fish scratch against rocks and gravel in an effort to get relief
- Fishes hold their fins and tail flat.

Treatment

- Medicate for 10-14 days. Malachite green, me- thylene blue, quinine hydrochloride and mepracrine hydrochloride are all effective
- Reduce medication when treating scale less fish
- Discontinue carbon filtration during treatment
- Perform water changes between treatments

Prevention

- Quarantine new fish for two weeks
- Treat plants before adding to tank
- Maintain high water quality
- Provide fish with a nutritionally balanced diet

5. Parasitic Diseases

- Parasites live on or inside the ornamental fishes. Parasites can be classified into two groups, ectoparasites and endoparasites.

Ectoparasites

- Ectoparasites are found on the external surfaces such as skin, fins and gills.
- In ornamental fishes, the common endoparasites are blood parasites, intestinal worms and protozoan.

Crustacean Ectoparasites

Argulosis

- Argulosis is a parasitic disease caused by Argulus.
- Argulus is a copepod crustacean.
- It is commonly called fish lice.
- Argulus is an ectoparasite
- It is attached to the body with the help of suckers and hooks
- It sucks the blood and body fluids of the fish
- Anaemia is caused
- Red patches appear on the body.
- The fish loses scales
- Gills are damaged.
- Stunted growth.
- Mass mortality occurs.

Treatment

- Dip treatment in lysol-water solution 1:5000 for 10 seconds.
- Dip treatment in potassium permanganate 1:1000 for 40 seconds.
- Dip treatment in 1% common salt solution.
- Casuarina poles are planted in the culture pond. This will help the fish to rub the body against the poles to scrap away the parasite.

Endoparasites

- Endoparasites are found in the internal tissues and organs. Most of the endoparasiticdiseases are caused by trematode, cestode and nematode worms.
- Worms protruding from the anus is another indication. Identification of sporozoan andprotozoan endoparasites often requires microscopic examination of tissues

Intestinal Parasites

Symptoms

- Worms sticking out through the vent, emaciation of the body

Cause

- Different varieties of intestinal worms.

Treatment

- Anti helminthics are added to the daily diet. Add 1 tablespoon of aquarium salt for each 5gallons of water to help fish with normal body fluid functions.
- Activated carbon if any is removed during treatment. Change 15 percent of the waterdaily to keep environmental conditions optimal.

CONDITIONING, PACKING, TRANSPORT AND QUARANTINE METHODS

What is conditioning of fish

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

Purpose of conditioning a fish

- ❖ The main purpose of conditioning is to improve the survival of fish during transport.
- ❖ Prior to packing prophylactic treatment is given to fish to ensure fish are free from any disease (good health condition) and starvation of fish is done to empty their stomachs and intestines in order to prevent regulations of partially digested food materials during transport.

- ❖ Other advantages of starving the fish include a decreased amount of excreta from fish and reduced metabolic rate, hence minimizing pollution of the water during the journey.
- ❖ Starvation is also known to reduce stress response to handling and this will reduce the mortality of fish during packaging.

Importance of conditioning and packaging of fish

- ❖ In ornamental fish business, the ability to meet customers needs for high quality fish is always a critical factor.
- ❖ As most ornamental fish are destined for export, the fish must not only be pleasing to tool at but also robust enough to withstand the long journey by any means of transportation.
- ❖ Transportation of live fish from area of collection side to destination or area of farming to destination is an important activity of ornamental fish industry.
- ❖ With the rapid development of ornamental fish industry, transport of ornamental fish by road water and air from local to national and international stakeholders is one the increase.
- ❖ If the transportation of fish is not planned properly, large mortality may occur resulting in heavy loss.
- ❖ Mortality during the transportation is mainly due to poor conditioning and packaging of fish.
- ❖ The success of ornamental fish business (particularly exporters) largely depends on effective conditioning, good packaging techniques and careful handling practices prior to and during shipment.
- ❖ Therefore, it is very essential to conditioned a fish and followed by a good packaging practices to minimal the mortality during the transportation.

How conditioning of fish is done?

A. Removal of dead or damaged fish

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

B. Grading as per size

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

C. Water exchange

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

D. Prophylaxis treatments

- To ensure fish are free of pathogens, parasites etc. few days before shipping.
- The water is treat with potassium permanganate at 5 ppm or methylene blue at 3-5 ppm to fish free from pathogens and2-3% of salt may added to control parasites.
- Sometime fish fed with Vitamin C supplementary diet (8-10%) for 1 weeks to reduce the stress and to improve resistance to disease.

Starvation of fish

- Starving a fish before transportation has a several reasons such as it voids digestive tract (fish may vomit or defecate in the bag), it slow the metabolic rate of fish (Reduces oxygen requirements and Reduces ammonia and carbon dioxide output).
- Generally, a small fish are starved for 12 to 24 hours before transport while for middle sized fish, it is 48 hours and larger fish should be starved for 3 days before shipment.
- Thereafter, fish should be carefully transferred into transparent polyethylene bag (TPB) with oxygenated water for transport with minimal disturbance.

Packaging material

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

Thickness and shape of packaging bags

- Proper thickness of LDPE packaging bags is very important. A LDPE bag of 250 micron thickness is more desirable.
- Many a times some supplier will select bags of less thickness but it is unsafe. The shape of packaging bag is also important.
- In domestic market packaging bags that are sealed straight at corners are commonly used whereas in international trade curved sealing is preferred.

- The use of bags with straight corners is not good for smaller size of fish as these will conglomaerate at these corners. Therefore the corners could be tied with a rubber band.

Size of packaging bags

- Size of packaging bags is also very important as the number of fish packed depends on the size of bag.
- The number of fish that could be packed in a bag is directly proportional to size.
- In domestic trade, the most commonly used bag sizes are 5”x12”x12x20 and 18 “ x 24 whereas in international trade the bags of 3” x 9 “ to 13” to 26 are used.

Size and material of packaging box

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

Advantage of poly-styrene boxes

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

Optimize of packaging density

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

Determining of stocking density

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

Ratio of water and oxygen

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

Removal of ammonia

- Ammonia is highly toxic to fish in its un-iodised form.
- It accumulates in packaging bags due to excretion of fish and bacterial action on the excreta.

- A level of 0.05 ppm could be harmful for the fish.
- It could be controlled by adding granules/rings of zeolite @15- 20 g/litre of water.

Slowing down of metabolic activities

Success of transportation could be further enhanced by adding in tranquiliters/ sedatives in packing bags. The most commonly used sedatives are Eugenol (5 mg/l, Quinaldine (5 mg/l) and MS-222 (20 mg/l). However, it should be ensured that dosages are proper and the use of sedatives is permitted by the importing country

Benefits of sedating fish are

a. Decrease the rate of oxygen consumption and reducing the rate of excretion of carbon dioxide, ammonia and other toxic waste
b. Controlling the excitability of the fish and thereby reducing chances of injury
c. Reduce the time required for handling them.

Process of packaging

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

Preparing of water for packaging

- Water to be used for packaging shall be prepared inadvance.

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

Pre-packaging exercise ensures high transportation survival

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

Final packaging

- ❖ A required quantity of pre-treated water is filled up in poly bags as specified above according to the size of bags.
- ❖ It shall be ensured that the temperature of water being filled in bags is same as that of pre-packed bags after acclimatization period.
- ❖ The bag filled up with water is now placed in another bag of samedimensions.
- ❖ Inserting of a news paper in between the two bags provides additional safety against water leakage and also reduces stress to fish due to excess light.

- ❖ Thereafter, fish are transferred to the new bag with the help of ahand net of very soft material.
- ❖ The air inside the bag is expelled and replaced with oxygen.
- ❖ The bag is then sealed by twisting the top of the bag and foldedover, with rubber bands or metal clips used to fasten the top of the bag.
- ❖ In domestic trade bags are tied with rubber bands while in international trade tying with metal clips is popular and a fast process.
- ❖ The details of species, total number of fish and average size are again mentioned with the help of a marker pen on the bags.

Packaging of aggressive fish

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

Box packing of poly-bags

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

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

Labelling of box for transportation

- ❖ Labelling of box is very essential during the transportation of ornamental fish.

- ❖ Labelling must be included on each box. Boxes must be marked as this end up " Live Fish", Handle with Care", Customer contact details, etc.

TRANSPORT OF FISHES

Transport system

There are basically two type of live fish transport systems:

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

Ornamental fishes meant for Stocking and sale need to be transported from on place to another in live condition for lesser or longer duration. During normal transport, toxic gases like carbon dioxide and ammonia tend to accumulate in the transporting medium due to metabolic activities of the fishes. Death of fish would occur if the concentration of unionized ammonia exceeds I ppm level. Inorder to overcome the oxygen limiting condition, the transport of fishes especially their seeds is made now a days with water and compressed oxygen. However, this technique is not quite suitable for many small scale farmers either due to non-availability of oxygen cylinders in the hours of need or due the high cost of these equipments. In the case of fingerlings at carps and other juvenile fishes, transportation is generally done after acclimatizing them in running water conditions to evacuate their gut contents. Following this, the fishes treated with antibiotics such as oxytetracyclin and furazolidone and packed in containers under oxygen pressure for safer transport-upto 48 h, On the other hand, if the fish or their seed are-anaesthetized and packed in oxygen pressure, they could be able to withstand the transportation stress considerably well for an extended duration.

Depending on the species, size and density, the fishes are packed and transported from one place to another. In such oxygen packing, polythene bags of varying sizes are used, Generally, the volume of water and oxygen would be 1:3 ratio in the inflated bags containing the fishes. Now a days, the method of packing fishes under sedation using anaesthesiais followed to prolong the period of transport. However, the optimal concentrations of these chemicals for the different species for fish seeds have not been fully assessed. Owing to the demand for aquarium fishes in national and international markets, fish packing needs to be standardized.

During the normal transport of Ornamental. fish, accumulation of toxic ammonia gas excreted by them causes death especially when its level goes beyond > I ppm. Therefore, these fishes have to be transported in oxygen inflated containers. The fishes are kept in hapas and are acclimated prior to packing in running water condition in nelon screen hapas. While doing so the fish will evacuate their gut contents and faecal remnants present in the intestine. Then the fishes are kept in water treated with antibiotics such as oxytetracycline and chloramphenicol to avoid bacterial infection. By this process, these fishes will excrete mucus and could tolerate and undue stress out of transport. Oxygen packed and tied bags containing optimal number of fishes would be transported in corrugated hard boxes or in thermocal (Styrofoam) boxes well fed fish, starved for atleast 24 hrs before packing could withstand about 40 hr transport.

Oxygen packing

An oxygen cylinder of desired capacity should first be kept ready for filling the polythene bags containing fishes Required number of fishes are then introduced into the bag. Oxygen is then passed through the mouth of the bag through a polythene tube introduced fully in water. After filling the swollen bag is finally twisted. folded and fed with the help of a thick thread. Then the oxygen bag is packed carefully in thermocol box Styrofoam or for distant transport by road and air. The filled in oxygen in the inflated bag gradually

gets dissolved in water. During the transport, the fishes use the diffusing oxygen in the water for respiration. This packing in guaranteed for about 48 hr transport under ambient temperature.

Anaesthetic used in fish transport

Anaesthetics are drugs which reduce physical and metabolicactivities, thereby the oxygen consumption of the fish is very much reduced. By this technique, more number of fishes could be accommodated in minimum area of the transporting box. Various anaesthetics are used for the transport is Tricaine methane sulphatequinaldine, carbonic acid,chlorobutanol, chloride hydrate etc.

Mechanism of action

The drugs used as anesthetics depress the sensory centres of the brain to various degrees and finally eliminate reflex action. Further these agents reach the brain through the circulatory system and influence the various parts of the brain depending on their dosage levels. Based on the regaining time, the fishes are transported within the stipulated time interval.

The number of fishes to be packed in the oxygen inflated polythene bag can also be calculated by using the following formula.

$$N = \frac{(DO - 2)\ x\ V}{C\ x\ H}$$

Where

DO = Dissolved oxygen content of the water (ml)

V = Volume of water to be used for transport (lit.)

C = Rate of oxygen consumption of fish (ml/kg of the fish)

h = Duration of transport (hrs)

Transport of export consignment

The ornamental fish farms which export fish to foreign countries should keep the following materials ready for transport:

- Glass tanks and circular or rectangular cisterns for acclimatizing the fishes.
- Mechanical or chemical filters
- Air compressors and oxygen cylinders with accessories
- Hand nets made of bolting Silk cloth.
- Thermocal or Styrofoam carbon boxes.
- Polythene bags (300-350kg) and rubber bands
- Marking pens, printed labels, adhesive tapes, etc

Preparing of fishes

Acclimated at 48 hrs. starved fish well aerated water dissolved with the following chemicals 5% Methylence blue (10 drops in 50 lit of water) 0.01% of common salt solution (10 mg of sodium chloride dissolved in 100 ml of water)

Epsom salt (2teaspoonful of this salt dissolved in 50 lit)

Tetracycline (500 mg dissolved in 50 lit of water)

Previously well fed and 4 hr starved fish could withstand rigorous packing and air transport. Tranquilizers like quinaldine can be used in mild concentration to reduce activity of the fishes.

Method of sedation

Prior to anaesthetization and healthy ornamental fishes collected from the rearing tank and are kept under starvation for 24 hours in aerated water.

The desired concentrations of anathesia are well in advance for use for sedating the under transport.

Carbonic acid

Carbonic acid for use an anaesthetic is prepared by mixing 6.75% of sodium carbonate (W/V) and 3.95% of concentrated sulphuric acid. Ornamental fishes which are ready for packing and transport are introduced in polythere bags (30x20 cm) containing 250m of well aerated freshwater. Required dose of carbonhic acid is pipetted out from the instantly prepared stock solution and is added in to the polythene bag. The bag is then packed with or without oxygen inflation depending on the mode and duration of transport. The fishes are packed immediately after sedation.

Tertiary butyl alcohol

Desired concentration of the teritiary butyl alcohol prepared by diluting with known volume of freshwater for use as an anaesthetic.

Sedation

The exact time (in seconds) taken by the fish for loosing balance partially or completely in known as induction time. The subsequent behavioral changes especially to time (in seconds) in which the respiratory movement became irregular is considered as reflex activity. The period prevailing between the Induction time and reflex activity is considered as anaesthetic period. When the fishes show imbalance in a particular anaesthetic concentration, they are carefully removed and are transferred to a glass tank (30x15x30 cm) containing aerated water for test purposes.

Quarantine of ornamental fishes

Many beginners may not know this, but one of the easiest ways to stop your fish from getting sick is to set up a quarantine tank. This separate aquarium is used to temporarily hold newly purchased fish or ailing animals that need a quiet environment to heal. By putting them in isolation, it allows you to closely observe their health, administer any treatments, and prevent illnesses from spreading. Once they are completely healthy and disease-free, you can safely add them to your main display tank without infecting the existing fish.

Materials for the quarantine Tank

- Clear plastic tub or aquarium with a lid
- Aquarium filter with low flow, like a sponge filter
- Aquarium heater and thermometer
- Aquarium decorations and hides
- Water conditioner
- Trio of quarantine medications (includes Mardel Maracyn, Aquarium Solutions Ich-X, and Fritz ParaCleanse)

How to set up a Quarantine Fish Tank

1. To avoid cross contamination, place the quarantine tank in a different room away from your main display tanks if possible. (Other best practices include using a separate set of nets and siphons for the quarantine setup and washing your hands after each time you touch the quarantine fish tank.)
2. If you are using a plastic tub, prepare the lid by drilling some holes for air flow and cutting a small rectangle on the side for power cables and airline tubing to pass through. Another optional step is to mark up the side of the

tub with 1-gallon measurement lines to help make water changes and medicine dosing easier.

A clear plastic container can be used as a cheap quarantine setup. Cut or drill some holes in the lid to allow for easy equipment installation and better air flow.

1. Fill the tank with water and add water conditioner.
2. Install the aquarium filter and heater, and add fish tank ornaments to give the animals some shelter. There is no need to use gravel or other substrate because a bare bottom setup allows you to easily clean the tank and examine the fish's waste if needed.

Use a bare bottom tank with aquarium decorations to provide plenty of cover. Sick fish often want to hide, so the extra shelters will make them feel more comfortable.

1. Add the fish, observe their physical appearance and behavior, and treat with medication if needed. Remove any chemical filtration (like activated carbon) and UV sterilizers before adding medicines.
2. If your fish are already sick and you can identify the disease, treat the fish with the specific medication for that illness and follow the manufacturer's instructions on the packaging. If you are not sure which disease they have,
3. If you purchased fish from a local fish store or breeder that you trust to have healthy animals, feed and observe the fish for a couple days. If you detect an illness, see Step 5a above. If you do not see any symptoms, consider proactively treating them with Para Cleanse (as per the manufacturer's instructions) to clear out any remaining internal parasites that are harder to spot.

4. If you bought new fish from an online retailer, pet store chain, or untested source, proactively treat them with the quarantine medication trio. These medicines contain a blend of antibiotic, antifungal, and anti-parasitic active ingredients that are safe for scaleless fish, fry, shrimp, snails, live plants, and beneficial bacteria. Dose 1 packet of Maracyn, 1 packet of ParaCleanse, and 1 teaspoon (5 ml) of Ich-X for every 10 gallons of water. Let the medication soak in the water for 7 days without feeding the fish.

Medication	**Maracyn**	**Ich- X**	**ParaCleanse**
Active Ingredient	Erythromycin	Formaldehyde, Methanol, malachite green chloride	Metronidazole and praziquantel
Treatment for	Bacterial Infections	Fungal Infections and external parasites	Internal and external parasites
Common Disease	Fin rot, popeye, gill disease open wounds	Cottony growths, ich (White spot disease)	Tapeworms, flukes, wasting disease

Description of quarantine medication trio

6. After treatment is completed, do regular water changes each week to gradually remove the medications over time. Help the fish to build up their immune systems by feeding high quality fish food like frozen foods, which are nutritionally dense and easy to clean up.
7. We recommend quarantining most new fish for 4-6 weeks since the last disease symptom or death was seen. If you want to be extra safe, consider adding two healthy fish from your main display tank to the fish hospital

tank and see if they get sick. If everyone remains well, you can finally release the isolated fish from quarantine.

8. Once quarantine is done, clean the hospital tank setup and store everything dry. If you plan on purchasing more fish in the near future, just leave everything running so that it will be ready for the next batch.

ECONOMICS, TRADE REGULATIONS, DOMESTIC AND EXPORT MARKETING STRATEGIES

The FAO statistics indicated that the world export of ornamental fish steadily rose from US $ 160.7 million since 1999 to a peak of US $ 282.6 million in 2006. Most of the world's supplies of ornamental fishes are from Asian countries. Singapore is the largest exporter of ornamental fish contributing 21.70 per cent followed by Spain, Czech Rep and Malaysia during 2006 (Dey, 2008). USA is the world's largest single market for ornamental fishes and imported US $ 48.40 million worth of fish in 2006, followed by UK (US $ 30.80 million) and Japan (US $ 27.20 million).

The ornamental fish market can be divided into four main sectors. The largest sector is the tropical freshwater species sector, which occupies about 80 – 90% of the market. The other sectors are tropical marine and brackish water species, including invertebrates; coldwater (freshwater) species, mainly goldfish and koi and cold water marine and brackish water species.

In all there are about 1600 species of ornamental fish in the market, out of which 750 are freshwater species. More and more species are being added to the list as a result of advances in breeding, transport and aquarium technology. Some 90% of the species are cultured while the remaining 10% are collected from the wild. The annual world turnover for ornamental fish aquaculture is estimated at about US$ 200 million. The marine fish species constitute about

20% of the market. About 95% of marine fish are collected from the wild while 5% are bred fish.

The price of an ornamental fish is considerably higher than the price of a fish destined for human consumption. On average, there is a ratio of 1:100 between prices of food fish and aquarium fish. In general, marine ornamental fish have higher unit value compared to freshwater ornamental fish. The freshwater species dominating the market are mainly from the families *Poecilidae, Characidae*, *Cyprinidae*, and *Cichlidae*. The main species are guppy, platy, swordtail, molly, goldfish neon tetra, angelfish, , zebra danio and discus. The guppy and the neon tetra represent more than 25% of the world market in volume and more than 14% in value.

World exports of ornamental fish rose from US$ 125.819 million in 1996. There was a dip during 1997 – 98 to a low of US$ 162.399 million in 1998 after which exports rose again to US$ 182.668 million in 2001. The downtrend during 1996-98 is attributed mainly to the Asian financial crisis.

With a share of 22.8% (US$41.58 million), Singapore was the world's largest exporter in 2001. It is also the main trading hub for Asia. Singapore does not produce all its exports but re-exports additional species, which are collected or reared in other Asian countries. Singapore is a duty free zone, so there are no heavy imports to pay. It exports to more than 60 countries around the world, including Japan, USA, UK, Germany, France, Italy, Spain, the Netherlands and Australia.

The second largest exporter was Malaysia with exports valued at US$14.37 million, 7.9% of exports. This was followed by Indonesia (US$ 13.72 million, 7.5%) Czech Republic (US$ 11.27 million, or 6.2%) and Peru (US$9.78 million, 5.4%). China came next with total exports of US$ 11 million. China's exports were mainly through its special Administrative Region of Hong

Kong, which also serves as a trading center. Hong Kong's exports amounted to US$8.97 million. This was followed by Japan (US$7.69 million, 4.2%), USA (US$7.05 million, 3.9%), the Philippines (US$ 6.50 million, 36%) and Sri Lanka (US$ 5.94 million, 3.3%).

Asia is by far the biggest exporter contributing 59.1% of world exports or US$107.96 million in 2001. The other regions which export in significant quantities are Europe (20.6%, US$37.68million), South America (10.0%, US$18.34 million), North America (3.9%, US$7.06 million) an the Middle East (3.2%, US$5.81 million). The major Asian countries involved in the export of ornamental fish are Singapore (38.5% of Asian supplies), Malaysia (13.3%), Indonesia (12.7%), China including Hong Kong and Macau (10.2%), Japan (7.1%), the Philippines (6.0%), Sri Lanka (5.5%), Thailand (3.1%), Taiwan (1.6%) and India (1.2%).

Otal world imports of ornamental fish rose from US$216.327 million in 1991 to a peak of US$5337.625 million in 1994. Thereafter, imports declined gradually to US$244.097 million in 1999, raising slightly to US$246.161 million in 2000 and finishing off at US$244.618 million in 2001.

Fish keeping is a hobby, which is practiced mainly in the industrialized countries. Consequently, the main importers of ornamental fish are USA, Japan and countries in Western Europe. Total world imports of ornamental fish in 2001 were valued at US$244.62 million. The top importer was the USA with US$61.77 million worth of imports equivalent to 25.3% of total imports. This was followed by Japan with US$528.40 million or 11.6% of total imports. The other major importing countries were Germany (US$21.09 million; 8.6%), UK (US$21.09 million; 8.6%), France (US$20.56 million; 8.4%), Singapore (US$9.93 million; 4.1%), Belgium (US$9.45 million; 3.9%), Italy (US$9.07 million; 3.7%), the Netherlands (US$8.16 million; 3.3%), China/Hong Kong

(3.1%) and Canada (2.7%). Both Singapore and Hong Kong, being important trading hubs, re-export a major portion of their imports.

The USA is the world's largest single market for ornamental fish. Its imports declined in value from US$ 77.860 million in 1996 to a low of US$57 359 million in 1999, and then rose again from 2000 to a figure of US$61.766 million in 2001. With about 10% of households possessing aquaria, the country is estimated to have more than 10 million home aquaria. Some 40% of the households with aquaria have more than one aquarium. The imports are mainly of freshwater species. With two species the guppy and the neon tetra accounting for 40% of the market. Some of the other popular species are mollies, swordtails, goldfish, discus, angelfish, African cichlids, zebra danios and platies. The major suppliers to the US market are Singapore, Thailand, Indonesia, Philippines, Malaysia and Brazil.

Japan is the second largest single market. The growing prohibitions on keeping animal pets such a cats and dogs in high-rise apartments has given a boost to the aquariums becoming an important feature of the home décor. The country is estimated to have some 1.2 million aquarists. The most popular species are guppy (28% of the market), neon tetra, red nose tetra, cardinal tetra, black tetra, tiger barb, harlequin fish, discus, *angelfish. Siamese fighting fish, gourami, platy, swordtail, julli catfish (corydoras), algae eater, white clouds and Zebra danio.* Imports fell in value gradually from US$73.94 million in 1996 to US$28.398 million in 2001. The decline has been attributed mainly to the recession the country has been going through. The main suppliers to the Japanese market are Singapore, Brazil, Indonesia, Malaysia, USA and China (Hong Kong).

Estern Europe is the largest trade block. It imports almost 40% of world ornamental fish production. Freshwater species account for more than 90% of imports by value, the rest being marine fish, invertebrates and live rocks.

Among the most popular species are neon tetra, cardinal tetra, guppy, platy, swordtail. Siamese fighting fish, angelfish, corydoras, rasbora, gouramy and loach. Imports fell from US$123.226 million in 1996 to US$107.217 million in 2000 rising slightly to US$107.767 million in 2001. The major suppliers to this market are Singapore the Czech Republic Israel and Japan. The top importing countries in 2001 were Germany (21.0%), UK (19.6%), France (19.1%), Belgium (8.8%), Italy (8.4%) and the Netherlands (7.6%). The main suppliers to the Western Europe market are Singapore, Czech Republic, Israel, Japan, Malaysia, Indonesia, China (Hong Kong), Sri Lanka, Thailand, USA and Brazil.ndia, despite its vast area of sea coast and flow of perennial rivers and consequent abundant resources of freshwater and marine ornamentals, is still way behind other developing countries in the matter of development of this trade. In fact, the natural resources of India are more varied as compared to those of Sri Lanka, Africa, Singapore, Indonesia and Malaysia. Several freshwater varieties of Indian fishes are well known in the international market. The lagoons and coral reefs of lakshadweep and Minicoy islands. Andaman & Nicobar Islands, Gulf of kutch complex, coast of kerala around cape comorin, Gulf of mannar and Palk Bay abound with highly attractive and varied species of ornamental fishes. We could certainly makes a good deal of money and enjoy a considerable share in the world trade by supplying marine ornamental fishes and live rocks originating from the vast resources which are the basic material essential in keeping the aquarium environment healthy. Live rocks afford organisms living in it a much longer life span. Poor knowledge on the part of our people about aquariculture and live fish trade could be the principal reason for our backwardness in this field.

India’s contribution to global aquarium trade is worth of Rs.5.7 crores, 0.5 per cent of international trade in 2005-06 while we have a great potential to

increase the level of exports to about US$30 million (about Rs.110 crores) every year.

The Wildlife Protection Act of 1972 refers to a package of legislation enacted in 1972 by the Govt. of India applicable to entire India except Jammu and Kashmir which has its own separate act. The act consists of established schedules that lists protected plant and animal species and hunting or harvesting these species was largely outlawed.

It has six schedules which give varying degrees of protection. Schedule I and part II of Schedule II provide absolute protection - offences under these are prescribed the highest penalties. Species listed in Schedule IV are also protected, but the penalties are much lower. Enforcement authorities have the power to compound offences under this Schedule (i.e. they impose fines on the offenders).