# PREFACE

In a bid to standardise higher education in the country, the University Grants Commission (UGC) has introduced Choice Based Credit System (CBCS) based on five types of courses viz. *core, discipline specific, generic elective, ability* and *skill enhancement* for graduate students of all programmes at Honours level. This brings in the semester pattern, which finds efficacy in sync with credit system, credit transfer, comprehensive continuous assessments and a graded pattern of evaluation. The objective is to offer learners ample flexibility to choose from a wide gamut of courses, as also to provide them lateral mobility between various educational institutions in the country where they can carry acquired credits. I am happy to note that the University has been accredited by NAAC with grade 'A'.

UGC (Open and Distance Learning Programmes and Online Learning Programmes) Regulations, 2020 have mandated compliance with CBCS for U.G. programmes for all the HEIs in this mode. Welcoming this paradigm shift in higher education, Netaji Subhas Open University (NSOU) has resolved to adopt CBCS from the academic session 2021-22 at the Under Graduate Degree Programme level. The present syllabus, framed in the spirit of syllabi recommended by UGC, lays due stress on all aspects envisaged in the curricular framework of the apex body on higher education. It will be imparted to learners over the *six* semesters of the Programme.

Self Learning Materials (SLMs) are the mainstay of Student Support Services (SSS) of an Open University. From a logistic point of view, NSOU has embarked upon CBCS presently with SLMs in English / Bengali. Eventually, the English version SLMs will be translated into Bengali too, for the benefit of learners. As always, all of our teaching faculties contributed in this process. In addition to this we have also requisitioned the services of best academics in each domain in preparation of the new SLMs. I am sure they will be of commendable academic support. We look forward to proactive feedback from all stakeholders who will participate in the teaching-learning based on these study materials. It has been a very challenging task well executed, and I congratulate all concerned in the preparation of these SLMs.

I wish the venture a grand success.

**Professor (Dr.) Subha Sankar Sarkar**

Vice-Chancellor

# Netaji Subhas Open University

**Undergraduate Degree Programme**

**Choice Based Credit System (CBCS)**

**Subject : Honours in Zoology (HZO)**

**Course : Aquarium Fish Keeping**

**Course Code : SE - ZO - 21**

First Print : August, 2022

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Printed in accordance with the regulations of the
Distance Education Bureau of the University Grants Commission.

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# Netaji Subhas Open University

**UG : Zoology (HZO)**

**Curse : Aquarium Fish Keeping**

**Course Code : SE - ZO - 21**

# Unit 1 ❑ Introduction to aquarium fish keeping

**Structure**



## 1.0 Objectives

By studying this unit the learners will be able to understand about—

(i) Aquarium maintenance

(ii) Ornamental fish suitable for aquarium

(iii) Aquarium and ornamental fish as source of business

## 1.1 Introduction

Ornamental fishes are the main attractions of an aquarium. Various colourful fish species are cultured for this purpose. Some of these species are indigenous, while some are exotic. Some species are cultured exclusively for aquarium purpose, while some other species have both ornamental value as well as commercial value. It is necessary to have a knowledge about different species available in India to start aquarium fish keeping successfully. Successful aquarium keeping of fish can lead to a good business and employment potential for the unemployed youth.

## 1.2 What is an aquarium ?

Aquarium is a glass container which displays the aquatic organisms in a simulated natural environment. It is made decorative by introducing aquatic plants, rocks, gravels etc. and illuminating the aquarium. The physicochemical and biological parameters of the aquarium environment are maintained with the aid of equipments that control aeration, water movement, temperature, suspended organic matter *etc.* besides feeding.

In effect, an aquarium is a biological entity in which each of its elements - water, glass, light, sand, gravel, plants, fish or other aquatic organisms must interact among them and make a harmonious entity, with almost similar connectedness as exists in nature.

## 1.3 Ornamental fishes

Ornamental fish can be defined as attractive colourful fishes of peaceful nature that are maintained as pets in confined spaces of an aquarium or a garden pool with the purpose of enjoying their prettiness for fun and fancy. Ornamental fishes are also recognized as **'live jewels'** for their beautiful colours and playing behaviour.

## 1.4 Advantages of keeping ornamental fishes

Keeping ornamental fishes is advantageous to us for following reasons:

(i) Keeping of ornamental fishes in home/ office aquaria or garden pools gives pleasure to the young and old alike.

(ii) Keeping ornamental fishes have many advantages over other pets viz., there is no barking or mewing in the middle of night, no biting or scratching visitors, no shedding of fur or feathers all over the house, no botheration of cleaning the floor or cage every day.

(iii) With their glittering colours and graceful movements, ornamental fishes offer rewarding feast to our eyes and relaxation to the mind, more particularly when we feel tired or depressed.

(iv) The hobby of keeping ornamental fishes offers opportunity to watch the behaviour of these tiny creatures from closure quarters makes us marvel at the fantastic creations of the nature and develops a sense of attachment with nature.

(v) Ornamental fishes kept in an aquarium or garden pool become an attractive focal

point and add to the aesthetic beauty of the home and its surroundings.

(vi) The hobby of keeping ornamental fishes can be groomed as a source of self employment by taking to various types of subsidiary activities such as culture of native varieties of ornamental fishes and their export, supply of accessory apparatus viz. filters, aerators, reflectors, lighting and heating equipments decorative dolls, natural and artificial plants, natural and artificial food etc.

## 1.5 Aquariculture

The culture of ornamental fishes is called as aquariculture. Ornamental fish culture is the culture of attractive, colourful fishes of various characteristics, which are reared in a confined aquatic system. Farmers and hobbyists mainly grow it. Ornamental fishes are also known as living jewels. Near about 30,000 fish species are recognized around the world, out of which near about 800 species belong to ornamental fishes. Most of the ornamental fishes survive in freshwater. These come under eight directly related families namely, Anabantidae, Callichthyidae, Characidae, Cichlidae, Cobitidae, Cyprinodontidae, Cyprinidae and Poeciliidae.

Aquarium fishes are mainly categorized into two groups namely, egg layers (oviparous) and live bearers (ovo-viviparous). Majority of aquarium species are egg layers and normally external fertilization occurs. Both indigenous and exotic (procured from other countries) aquarium fishes are cultured in India (tables 1-6).

Based on their habits these fishes are categorized into the following types.

1. Egg scatter laying non-adhesive eggs
2. Egg scatter laying adhesive eggs
3. Egg buriers
4. Mouth incubators
5. Nest-builders and
6. Egg -carriers

The commercially important indigenous and non-indigenous species list are presented below.

**Table 1:** Commercially important indigenous species of aquarium fish

| Sl. No. | Scientific name | Common name |
|---|---|---|
| 1 | *Botia lohachata* | Reticulated loach |
| 2 | *Brachydanio rerio* | Zebra fish |
| 3 | *Chandra nama* | Glassfish |
| 4 | *Colisa chune* | Honey gourami |
| 5 | *Labeo nandina* | Pencil gold labeo |
| 6 | *Lebeo calbasu* | All black shark |
| 7 | *Notopterus notopterus* | Black knife fish |
| 8 | *Oreichthys cosuatis* | Hi fin barb |
| 9 | *Puntius conchonius* | Rosy barb |
| 10 | *Puntius denisonii* | Deninson, S-barb |
| 11 | *Colisa lalia* | Dwarf gourami |

**Table 2:** Commercially important exotic egg layers species of aquarium fish

| Sl. No. | Scientific name | Common name |
|---|---|---|
| 1 | *Astronotus ocellatus* | Oscar |
| 2 | *Balantiocheilus melanopterus* | Bala shark / Silver Shark |
| 3 | *Betta splendens* | Siamese Fighting Fish |
| 4 | *Carassius auratus* | Goldfish |
| 5 | *Cichlasoma meeki* | Firemouth cichlid |
| 6 | *Cyprinus carpio var koi* | Koi carp |
| 7 | *Helostoma temmincki* | Kissing gourami |
| 8 | *Labeo bicolor* | Red-Tailed Black Shark |
| 9 | *Paracheirodon axelrodi* | Cardinal Tetra |
| 10 | *Paracheirodon innesi* | Neon Tetra |
| 11 | *Pterophyllum scalare* | Angelfish |

| Sl. No. | Scientific name | Common name |
|---|---|---|
| 12 | *Rasbora heteromorphy* | Rasbora, Harlequin Fish |
| 13 | *Scleropages formosus* | Asian arowana |
| 14 | *Symphysodon discus* | Discus / Pompadour fish |
| 15 | *Trichogaster trichopterus* | Three spot gourami |

**Table 3 :** Commercially important exotic livebearers species of aquarium fish

| Sl. No. | Scientific name | Common name |
|---|---|---|
| 1 | *Poecilia reticulata* | Guppy |
| 2 | *Poecillia sphenops* | Marble Molly |
| 3 | *Poecillia velifera* | Sail fin molly |
| 4 | *Xiphophorus helleri* | Swordtail |
| 5 | *Xiphophorus maculatus* | Platy |

Detailed lists of ornamental fish species available from freshwater, brackishwater and marine water for aquariculture are given in Annexures I to III.

## 1.6 Ornamental fish culture as a cottage based industry

Ornamental fish culture is a dominant economy in Indian villages and has an enormous scope of-developing a livelihood option for the unemployed youth and improving agri-horticulture-live stock-aquaculture yields in rural sector. Women folk is the target rural population, who can be made aware of the opportunities offered by the Non-Govemment Organizations, Krishi Vigyan Kendras (KVKs), Agricultural Technology Information Centres (ATIC) of ICAR and University and college departments who have involvement with people at grass root level and who can transfer the ornamental fish culture technologies through training programmes and develop market channels and post-harvest and packaging technologies for the stakeholders. Establishment of bioparks is one of the entrepreneurship development opportunities given to professionally qualified women for setting up self-employment ventures including fisheries and post harvest activities and product development. There are several other opportunities such as culture of algae for feeds and fertilizers and preparations of raw feeds for aquaculture, which can be explored through use of biotechnology. Women entrepreneurship in various aspects of aqua-farming such as ready-to-market fish preparations, shrimp seed production and marketing, other managements and cooperatives are being promoted. Active involvement of women in

natural resource management is the need of the hour. Therefore, there is a need to provide education and intensive training to rural women to help them in improvement of skills and make them as entrepreneurs to take up a fulltime / part-time aquaculture as avocation. The cottage level production of fish seeds and feeds for ornamental fish are simple technology and can be transferred to women folk in developing a viable livelihood. Developing an appropriate rural technology for the cottage level production and preparation of balanced fish feed for ornamental fish by utilizing the locally available ingredients is inexpensive and suitable for the welfare of the rural community.

## 1.7 Marketing potential

Keeping of aquarium has emerged as the second most popular hobby in recent years, next to photography. The ever-increasing demand for aquarium fishes gradually paved the avenue towards global trade of ornamental fishes. India's overall trade presently is over Rs. 150 million. About 80% of ornamental fishes from India to International market are exported via Kolkata Airport, of which the lion's share is contributed from North Eastern Region.

North Eastern Region is blessed by the presence of mild climate and abundance of ornamental fishes in nature and contributes the lion's share of total ichthyo species in North Eastern region of India. Presence of diverse natural water bodies is also an added advantage. However, there is vast unexplored potential for indigenous ornamental fishes in this region. Scientific and systematic exploration of this potential will definitely ensure a significant place for our Region in this sphere, besides employment generation and earning of foreign exchange.

Kolkata, the capital of West Bengal is the main distribution centre. From here the fish are sent to different states of India by air or road. A fair amount is also exported. Two parallel marketing procedures exist for exotic and native fish. In the case of exotic species, more than 99% is consumed by the domestic market and a few species like gold fish and angelfish are exported. On the other hand, 90% native ornamental species are collected and reared to meet export demand. The amount of marine ornamental fish trade is negligible in this area.

The marketing process is generally being done through the following channels:

**[I]** the producers directly sell the ornamental fish directly to the wholesalers, but the amount is very negligible

**[II]** there are some big middle tired men who buy large volumes of fish at very low prices from the producers, rearing the fish for 2-3 months before selling at the wholesale markets again for increased profit.

**[III]** from the wholesale markets, retailers and others purchase the ornamental fish.

For export, the Marine Products Export Development Authority (MPEDA) has 20 registered exporters. They either have their own farm or collect the fish from different areas for export. The USA, Japan and Singapore are the main buyers.

## 1.8 Selected questions

[i] Keeping ornamental fishes in home aquaria or garden pools prove advantageous-give reasons.

[ii] What is the export potential of ornamental fishes from India? Give your suggestions for improving export promotion.

## 1.9 Suggested readings

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## *Annexure-I*

**Table 4:** Freshwater ornamental fishes

| Sl. | Common name | Scientific name | Family name |
|---|---|---|---|
| 1 | Badis | *Badis badis* | Badidae |
| 2 | Indian garfish | *Xentodon cancila* | Belonidae |
| 3 | Siamese fighting fish | *Betta splendens* | Osphronemidae |
| 4 | Dwarf gourami | *Colisa lalia: Colisa chuna* | Osphronemidae |
| 5 | Chinese paradise | *Macropodus opercularis* | Osphronemidae |
| 6 | Pearl gourami | *Trichogaster leeri* | Osphronemidae |
| 7 | Silver gourami | *Trichogaster microlepis* | Osphronemidae |
| 8 | Snake skinned grurami | *Trichogaster pectoralis* | Osphronemidae |
| 9 | Blue gourami | *Trichogaster trichopterus* | Osphronemidae |
| 10 | Kissing gourami | *Helostoma temminki* | Helostomatidae |

| | | | |
|---|---|---|---|
| 11 | Zebra danio | *Brachydanio rerio* | Scorpaenidae |
| 12 | Goldfish | *Carassius auratus* | Cyprinidae |
| 13 | Koicarp | *Cyprinus carpio* var koi | Cyprinidae |
| 14 | Redtailed black shark | *Labeo bicolor* | Cyprinidae |
| 15 | Bridle shark | *Labeo frenatus* | Cyprinidae |
| 16 | Rosy barb | *Puntius conchonius* | Cyprinidae |
| 17 | Black spot barb | *Puntius filamentosus* | Cyprinidae |
| 18 | Tiger barb | *Puntius tetrazona* | Cyprinidae |
| 19 | Red rasbora | *Rasbora einthoveni* | Cyprinidae |
| 20 | Striped aplocheilus | *Aplocheilus lineatus* | *Aplocheilidae* |
| 21 | American flsg fish | *Jordanella florida* | Cyprinodontidae |
| 22 | Black widow tetra | Gymnocorymus *callistus* | Characidae |
| 23 | Serpea tetra (Jewal) | *Hemigrammus* callistus | Characidae |
| 24 | Buenos aires tetra | *Hemigrammus caudovitatus* | Characidae |
| 25 | Lemon tetra | *Hyphessobrycon pulchripinnis* | Characidae |
| 26 | Neon tetra | *Paracheirodon innesi* | Characidae |
| 27 | Indian glass fish | *Chanda ranga* | *Ambassidae* |
| 28 | Oscar (Velvet cichlid) | *Astrnonotus ocellatus* | Cichlidae |
| 29 | Firemouth cichlid | *Cichlasoma meeki* | Cichlidae |
| 30 | Thorichthysmeeki Zebre cichlid (Convict cichlid) | *Cichlasoma nigrofasciatum* | Cichlidae |
| 31 | Auratus (Nyasa golgen cichlid) | *Melanochromis auratus* | Cichlidae |
| 32 | Ramirez (Butterfly cichlid) | *Papiliochromis ramirezi* | Cichlidae |
| 33 | Blue morph | *Pseudotropheus erophyllum scalare* | Cichlidae |
| 34 | Discus | *Symphysodon discus* | Cichlidae |
| 35 | Tiger loach | *Botia hymenophysa* | Cobitidae |

| | | | |
|---|---|---|---|
| 36 | Clown loach | *Botia macracantha* | Cobitidae |
| 37 | Pencil loach | *Nannostomus trifasciatus* | Lebiasinidae |
| 38 | White spotted spiny eel | *Mastacembelus armatus* | Mastacembelidae |
| 39 | Finger fish | *Monodactylus argenteus* | Monodactylidae |
| 40 | Sebea sliver fish | *Monodactylus sebea* | Monodactylidae |
| 41 | Indian knife fish | *Notopterus notoprterus* | Notopteridae |
| 42 | Scat | *Scatophagus argus* | Scatophagidae |
| 43 | Glass catfish (Three striped) | *Eutropiellus bicirrhis* | Schilbeidae |
| 44 | Indian glass catfish | *Kryptopterus bicirrhis* | Siluridae |
| 45 | Somphongs puffer | *Carinotetradon somophogsi* | Tetraodontidae |
| **Live bearing ornamental fishes :** | | | |
| 46 | Moontail molly | *Mollienesiae formosa* | Priacanthidae |
| 47 | Sailfin molly | *Mollienesie poecilia* | Priacanthidae |
| 48 | Black molly Lyretail | *Mollienesie sphenops* | Priacanthidae |
| 49 | Yucatan molly | *Poecilia velifera* | Poeciliidae |
| 50 | Guppy | *Poecilia reticulate* | Poeciliidae |
| 51 | Simpson swordtail | *Xiphophorus helleri* | Poeciliidae |
| 52 | Black lyretail sword | *Xiphophorus helleri* | Poeciliidae |
| 53 | Common platy | *Xiphophorus maculates* | Poeciliidae |
| 54 | Variegatus platy | *Xiphophorus variatus* | Poeciliidae |

## *Annexure-II*

**Table 5 :** Brackishwater ornamental fishes

| **Sl.** | **Common name** | **Scientific name** | **Family name** |
|---|---|---|---|
| 1 | Silver Moonyfish | *Monodactylus argentus* | Monodactylidae |
| 2 | African Moonyfish | *M. sebae* | Monodactylidae |
| 3 | Spotted Scat | *Scatophagus argus* | Scatophagidae |
| 4 | Pearlspot | *Etroplus suratensis* | Cichlidae |

| | | | |
|---|---|---|---|
| 5 | Orange chromide | *Etroplus maculates* | Cichlidae |



| | | | |
|---|---|---|---|
| 5 | Orange chromide | *Etroplus maculates* | Cichlidae |
| 6 | Indian glass fish | *Ambassis* sp | Ambassidae |

Brackishwater ornamental fishes such as *Monodactylus argentus*, *M. sebae* and *Scatophagus argus* are common in Indian waters and they could be collected, reproduced, cultured and sold in national and international market. The brackishwater pearlspot, *Etroplus suratensis;* orange chromide, *Etroplus maculates* and brackishwater Indian glass fish, *Ambassis* sp. have been successfully bred in the low saline fish ponds.

## *Annexure-III*

**Table 6**: Marine water ornamental fishes

| Sl. | Common name | Scientific name | Family name |
|---|---|---|---|
| 1 | Clown fish | *Amphiprion alkallopisos* | Pomacentridae |
| 2 | Tomato clown | *Amphiprion frenatus* | Pomacentridae |
| 3 | Rose clown | *Amphiprion preideration* | Pomacentridae |
| 4 | Sea angle | *Holacanthus annularis* | Pomacanthidae |
| 5 | Mooris idol | *Zanclus spp.* | Zanclidae |
| 6 | Scorpion fish | *Pterois spp, P. antennata, P.vadiata, P.volitans* | Scorpaenidae |
| 7 | Bloonion fish | *Canthigaster spp* | Tetraodontidae |
| 8 | File fishes | *Rhinecanthus* spp | Balistidae |
| 9 | Blue triggerfish | *Odonus niger, Pseudobalistes fusech* | Balistidae |
| 10 | Butterfly fish | *Chelmon rostratus*, *Forciper longirostris*, *Forciper flavissimus* | Chaetodontidae |
| 11 | Therapon | *Therapon jarbua* | Terapontidae |
| 12 | Cardinal fish | *Apogon spp.* | Apogonidae |
| 13 | Blue stripe wrasses | *Labroides dimidatus* | Labridae |
| 14 | Sea horse | *Hippocampus spp*. | Syngnathidae |
| 15 | Mandarin fish | *Synciropus spp.* | Callionymidae |

# Unit 2 ❑ Biology of aquarium fishes

**Structure**



## 2.0 Objectives

By studying this unit the students will be able to understand about the distribution, biology and life cycle of some fish used as popular aquarium fish in India.

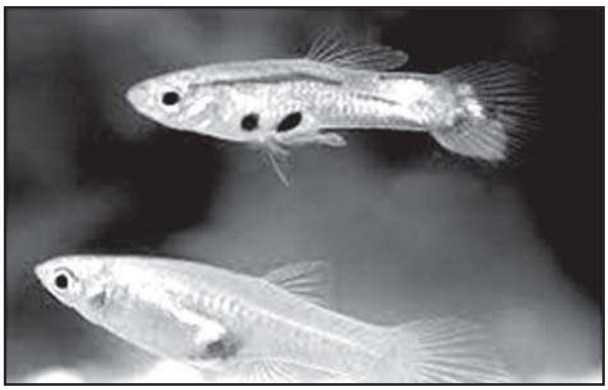
## 2.1 Introduction

It is necessary to understand the distribution, biology and life cycles of the fish for its successful culture in aquarium. It will help in procuring seeds / juveniles of the fish, their culture and breeding under controlled conditions. Out of the several species of ornamental fishes, descriptions of only a few important fishes are given below. Students can access information on other fishes through references listed below and online platforms.

## 2.2 Biology of aquarium fishes

A detailed account of biology of a few popular aquarium fishes cultured in India are given below:

### 2.2.1 Guppy (*Poecilia reticulata* Peters, 1859)



## Systematic position

**Kingdom :** Animalia
**Phylum :** Chordata
**Class :** Actinopterygii
**Order :** Cyprinodontiformes
**Family :** Poeciliidae
**Genus :** *Poecilia*
**Species :** *Poecilia reticulata*

## Distribution

**South America :** Venezuela, Barbados, Trinidad, Northern Brazil and the Guyana; **Africa :** Feral populations reported from the coastal reaches of Natal rivers from Durban southwards. However, it had been widely introduced and established elsewhere, mainly for mosquito control, but had rare to non-existing effects on mosquitoes, and negative to perhaps neutral effects on native fishes.

## Biology

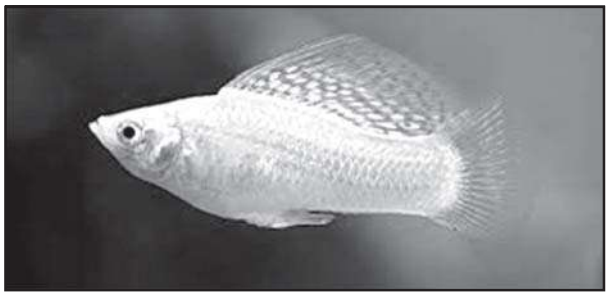
The fish inhabits warm springs and their effluents, weedy ditches and canals. It is found in various habitats, ranging from highly turbid water in ponds, canals and ditches at low elevations to pristine mountain streams at high elevations with low predation pressure. It is found usually in very small streams and densely vegetated lakes and springs. It can tolerate wide range of salinity but requires fairly warm temperatures (23-24°C) and quiet vegetated water for survival. It feeds on zooplankton, small insects and detritus. It is one of the most popular aquarium fishes with many standardized varieties and is used in genetics research. Female reaches 5 cm in length and male reaches 6 cm in length. Males matures at 2 months

and females at 3 months of age. Aquarium keeping: in groups of 5 or more individuals with minimum aquarium size 60 cm is preferable. Guppy is a very popular and widely available species in the aquarium trade in India.

## Life cycle and mating behavior

Males are about half the size of females with colorful tail and caudal fin; the anal fin is transformed into a gonopodium for internal fertilization. Males are continuously chasing and mating females. Females can store sperms for later fertilization and may produce young every four weeks. Pregnant females are recognizable by black triangle between anal and pelvic fins. After a gestation period of four to six weeks females give birth to 20-40 live young. No parental care is found and parents may even prey on their young.

## 2.2.2 Molly (*Poecilia sphenops* Valentines, 1846)



## Systematic position

**Kingdom :** Animalia

**Phylum :** Chordata

**Class :** Actinopterygii

**Order :** Cyprinodontiformes

**Family :** Poeciliidae

**Genus :** *Poecilia*

**Species :** *Poecilia sphenops*

## Distribution

**Central and South America :** Mexico to Colombia.

## Biology

Molly feeds on worms, crustaceans, insects, plant matter. The black variety (black molly) is a very popular aquarium fish throughout the world. In the aquarium it feeds

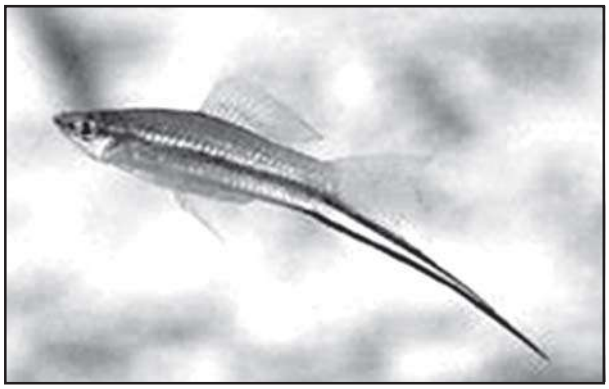
on green algae and also readily accepts dried food. Minimum aquarium size is 60 cm. Contrary to popular belief, this species of fish is actually a freshwater species, spending little time in brackish water before swimming back to their freshwater biotope. However, individuals of the same species have been found living and breeding in coastal sea waters, brackish swamps and freshwater streams. Molly appears to be a hardy and highly adaptable species (this has been diluted over years of interbreeding in tank-bred specimens).

Individuals of Molly are similar in appearance to their livebearer cousins, the platy, swordtail and guppies; the molly tends to be slightly larger and more energetic. Many aquarists have noted the stronger individuality and aggression of Molly when kept with Platies, who appear much more docile.

### Life cycle and mating behavior

Produces 20 to 150 youngs after 28 days of gestation.

## 2.2.3 Green Swordtail (*Xiphophorus hellerii* Heckel, 1848)



### Systematic position

**Kingdom :** Animalia
**Phylum :** Chordata
**Class :** Actinopterygii
**Order :** Cyprinodontiformes
**Family :** Poeciliidae
**Genus :** *Xiphophorus*
**Species :** *Xiphophorus hellerii*

## Distribution

North and Central America: Rio Nantla, Veracruz in Mexico to northwestern Honduras. Africa: Feral populations reported from Natal and eastern Transvaal as well as in Lake Otjikoto, Namibia. Several countries report adverse ecological impact after introduction.

## Short description

Dorsal spines (total): 0; Dorsal soft rays (total) : 11-14 ; Anal spines: 0; Anal soft rays: 8 - 10. This species is distinguished by having a medium to large swordtail with a long straight caudal appendage. Midlateral stripe may be dusky or brownish (northern populations) or red; 2 additional reddish stripes may be present above midlateral line and one beneath; terminal segment of gonopodial ray 3 produced into a crescent-shaped hook and blade pointed distally. There are ray 4a curves strongly backward over the blade at an angle greater than 90°; distal serrae of ray 4p reduced in size and number and proximal serrae rather slender; terminal segment of ray 5a produced into a claw, several times larger than the distal serrae of ray 4p.

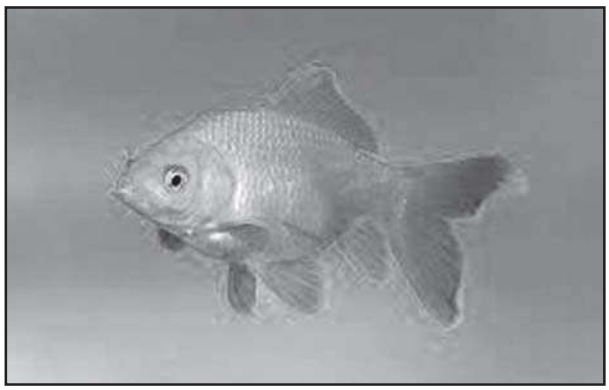
## Biology

Adults are found mainly in rapidly flowing streams and rivers, preferring heavily vegetated habitats. They occur in warm springs and their effluents, weedy canals and ponds. They feed on worms, crustaceans, insects and plant matter. This species is used for genetics research. The red varieties are very popular aquarium fishes. The features favoured for aquarium keeping: the males are aggressive towards each other; minimum aquarium size is 80 cm.

## Life cycle and mating behavior

Female produces 20 to 200 young after a gestation period of 24 to 30 days. The fish attains sexual maturity after eight to twelve months. This species has a tendency to undergo sex reversal (from female to male) under certain environmental conditions.

### 2.2.4 Goldfish *(Carassius auratus* Linnaeus, 1758)



**Systematic position**

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cyprinodontiformes
Family: Cyprinidae
Genus: *Carassius*
Species: *Carassius auratus*

## Distribution

**Asia:** central Asia and China and Japan. Introduced throughout the world. Asian form of the goldfish. Several countries report adverse ecological impact after its introduction.

## Short description

Dorsal spines (total) : 3-4 ; Dorsal soft rays (total) : 14-20 ; Anal spines : 2-3 ; Anal soft rays: 4 - 7; Vertebrae: 30. Body stout, thick-set, caudal peduncle thick and short. Head without scales, broadly triangular, interorbital space broad, snout longer than eye diameter, maxillary reaching posterior nostril or not quite to eye, barbels lacking on upper jaw. Lateral line is complete. Dorsal and anal fins with serrate bony spines, pelvic fins short, broad and thoracic. Nuptial tubercles of male fine, on operecula, sometimes on back and a few on pectoral fins. Hybridize readily with carp, hybrids showing intermediate characteristics. Caudal fin with 17-19 ray. Last simple anal ray osseous and serrated posteriorly; no barbells. Pigmentation: wild-caught specimens are olive brown, slate olive, olive green, with a bronze sheen, silvery, grayish yellowish, gray-silver, through gold (often with black blotches) to creamy white; yellowish white or white below. Cultured forms vary

through scarlet, red-pink, silver, brown, white, black and combinations of these colors.

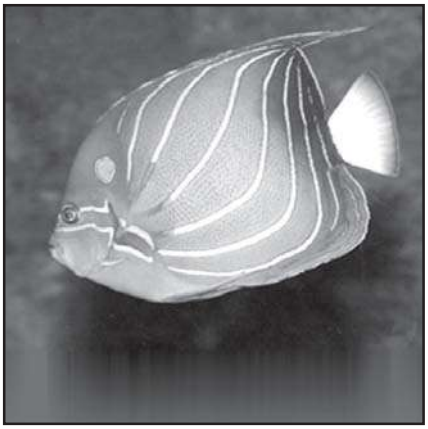
## Biology

Inhabit rivers, lakes, ponds and ditches with stagnant or slow-flowing water. Occur in eutrophic waters, well vegetated ponds and canals. Live better in cold water. Feed mainly on plankton, benthic invertebrates, plant material and detritus. Goldfish lay eggs on submerged vegetation. Females spawn multiple times during the spawning period. Oviparous, with pelagic larvae. They last long in captivity. Maximum recorded salinity is 17 ppt, but unable to withstand prolonged exposure above 15 ppt. Used as an experimental species. Valued as ornamental fish for ponds and aquaria; edible but rarely eaten. Aquarium keeping: in groups of 5 or more individuals; minimum aquarium size 100 cm.

## Life cycle and mating behavior

Cold water temperatures during the winter months are necessary for proper ova development. Spawning takes place in shallow water among weeds, often where willow roots grow exposed in water, also meadows inundated by spring flood. Spawning activity begins just before dawn, to mid-afternoon. Individual fish spawn 3-10 lots of eggs at intervals of 8-10 days. Juveniles need high temperature to grow. Eggs are sticky, attached to water plants or submerged objects. Females spawn multiple times during the spawning period.

### 2.2.5 Bluering Angelfish *(Pomacanthus annularis* Bloch, 1787)



## Systematic position

**Kingdom :** Animalia
**Phylum :** Chordata
**Class :** Actinopterygii
**Order :** Perciformes
**Family :** Pomacanthidae
**Genus :** *Pomacanthus*
**Species :** *Pomacanthus annularis*

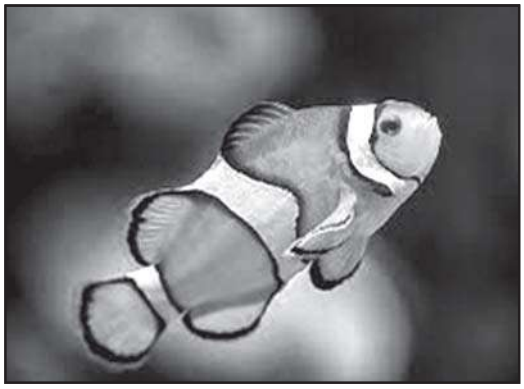
## Distribution

**Indo-West Pacific:** East coast of Africa, throughout Indonesia and New Guinea to New Caledonia, north to southern Japan.

## Biology

Inhabits coastal reefs to at least 30 m. Adults often found in pairs inside caves. Juveniles settle in very shallow inshore habitats with short filamentous algae growth on rock or dead coral substrates. The fish feeds on sponges and tunicates. It undergoes a complete color transformation from the juvenile to adult stage. The fish is regularly exported, to India from different countries, especially Sri Lanka, for the aquarium trade.

### 2.2.6 Clown anemone fish *(Amphiprion ocellaris* Cuvier, 1830)



## Systematic position

**Kingdom :** Animalia
**Phylum :** Chordata
**Class :** Actinopterygii
**Order :** Perciformes

**Family :** Pomacanthidae
**Genus :** *Amphiprion*
**Species :** *Amphiprion ocellaris*

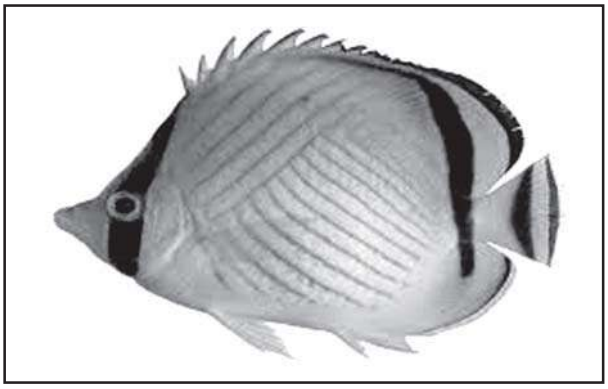
## Distribution

**Indo-West Pacific:** eastern Indian Ocean including Andaman and Nicobar Islands, Thailand, Malaysia, and northwest Australia to Singapore, Indonesia, and the Philippines; ranges north to Taiwan and the Ryukyu Islands.

## Biology

Adults inhabit coral reefs where it lives in association with the venomous large sea anemones: *Heteractis magnifica*, *Stichodactyla gigantea*, and *Stichodactyla mertensii*. Distinct pair is monogamous, oviparous and exhibits distinct pairing during breeding. Eggs are demersal and adhere to the substrate. Males guard and aerate the eggs. It is one of the most popular marine aquarium fishes. It is bred artificially in Florida for the aquarium trade. It has been reared in captivity and found to survive to age of 12 years in captivity (Alexandre Fontayne, pers. comm., 2006).

## 2.2.7 Vagabond Butterfly fish *(Chaetodon vagabundus* Linnaeus, 1758)



## Systematic position

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

**Genus :** *Chaetodon*

**Species :** *Chaetodon vagabundus*

## Distribution

**Indo-Pacific :** East Africa to the Line and Tuamoto islands, north to southern Japan, south to the Lord Howe and the Austral islands. Closely related to *Chaetodon decussatus*.

## Short description

Dorsal spines (total): 13; Dorsal soft rays (total): 23-25; Anal spines: 3; Anal soft rays: 19 - 22. This species is distinguished by the following characters: snout length 2.5-3.2 in head length; greatest body depth 1.5-1.7 in SL. Body pattern chevron with narrow lines on side; black band across posterior body which does not include entire rear part of dorsal fin.

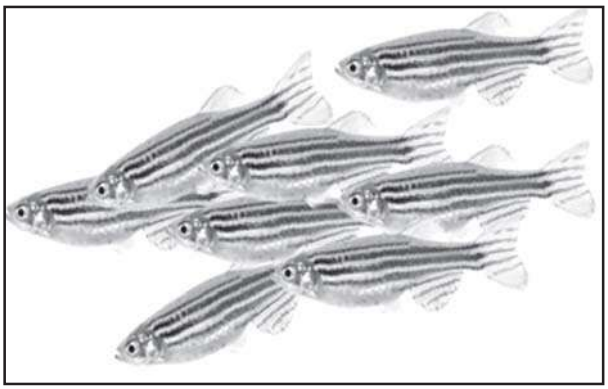
## Biology

Adults are found in reef flats, lagoon and seaward reefs and sometimes in turbid waters subject to freshwater runoff swimming in pairs. They are omnivorous, feeding on algae, coral polyps, crustaceans and worms. They are oviparous and monogamous. Stable monogamous pairs with both pair members jointly defend a feeding territory against other pairs, but often accompany other species without being aggressive. They are easily maintained in tanks.

## Life cycle and mating behavior

Distinct pairing. Stable monogamous pairs with both, pair members jointly defending a feeding territory. Pelagic larvae settle to shallow (<4 m) back reef habitats consisting of rubble, seagrass and low coral cover. Monogamous mating is observed as both obligate and social.

### 2.2.8 Zebrafish *Danio rerio* Hamilton, 1822)



## Systematic position

**Kingdom :** Animalia
**Phylum :** Chordata
**Class :** Actinopterygii
**Order :** Cypriniformes
**Family :** Cyprinidae
**Genus :** *Danio*
**Species :** *Danio rerio*
**Common name :** Zebra fish

## Overview

Zebrafish (*Danio rerio*) are small, freshwater fish, found in the tropics. The fishes are native to South Asia (Nepal, India, etc).. With regards to habitat, the fishes are typically found in shallow ponds, canals and streams, etc. As omnivorous organisms, they feed on a range of organisms such as insects, worms and zooplankton as well as various plant matter in their environment.

## Morphology

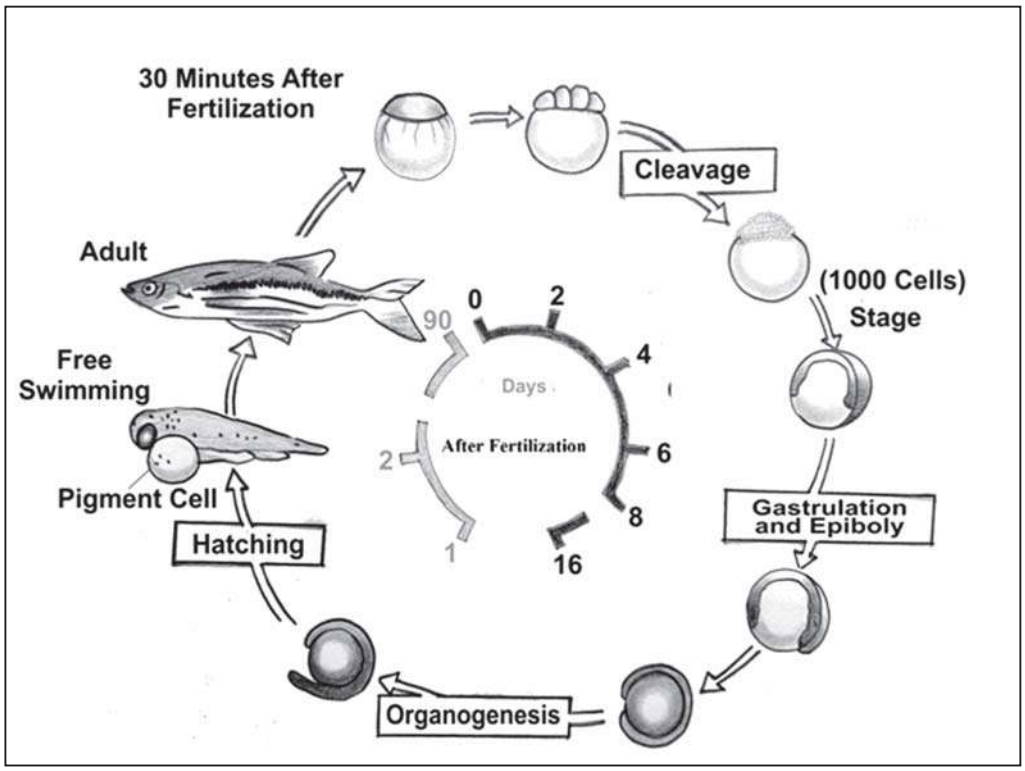
Zebrafish are small fish that measure about 6 cm in length on average. The fishes have a mouth that forms slightly upwards and a dorsally compressed head. They lack oral teeth but Zebrafish have teeth attached to their fifth brachial arch consisting of a dentine layer, an enamel coating as well as a pulp core.

Zebrafish also have two pairs of skin sensory appendages known as barbels. These include the rostal (nasal) barbels that extend to the orbit's anterior margin and the long maxillary barbels on either side of the mouth that act as taste buds and are also used to search for food.

Zebrafish are generally silvery white in color, they have about 5 horizontal lines (blue in color) on either side of their body extending to the caudal fin. Moreover, the upper (dorsal) part and belly part may appear pale yellow in color causing some Zebrafish to appear more golden.

## Life Cycle

Zebra fish have a lifespan of three and a half years $3\frac{1}{2}$ years . However, some live up to $5\frac{1}{2}$ years .




The following are some of the main stages of the life cycle of a Zebra fish (Figure-1) :

- Unfertilized egg
- Embryo
- Larval stage
- Juvenile
- Adult

**Figure-1**: Life cycle of the zebrafish. Zebrafish develop rapidly from a one-cell zygote that sits on top of a large yolk cell. Gastrulation begins approximately 6 h post fertilization, hatching at 2 days as a free-swimming larvae. Zebrafish reach sexual matu- rity around 3 months of age and can live for up to 5 years.

A female Zebrafish can produce as many as several hundreds of eggs per spawning. Given that eggs are released to be fertilized externally. The eggs, about 0.7mm in diameter, are released on a substrate where they become activated and start undergoing developmental steps. Although they are non-adhesive and tend to be released on un-prepared substrate, the eggs of Zebrafish have been shown to be activated by water even in cases where they are not fertilized by male sperm. Zygotes are formed once the eggs are fertilized. This may occur immediately as the eggs are released (and fertilized) or within a period of 72 hours. Fertilization is followed by egg division in the cleavage phase. This may take between 40 minutes and 2 hours.

During this phase, cell division may result in between 16 and 64 cells as the embryo moves to the next phase. The cleavage phase in which cell division is experienced produces the blastula. This is the form of the embryo resembling a hollow ball and contains many layers of cells that surround a cavity known as the blastocele.

Hatching occurs between 48 and 72 hours after fertilization. This, however, has been shown to largely depend on the thickness of the chorion as well as the muscular activity of the embryo.

Depending on these factors, hatching of some embryo may be delayed. Once it is hatched, the larvae measures about 3mm in length.

In a period of about 3 days, the larval undergoes morphogenesis which is characterized by the development of various anatomical structures. By the late larval stage the organism is capable of swimming, moving its jaws and even feeding on various food material. Once they mature, they are ready to reproduce and the life cycle continues.

## Breeding

Essentially, breeding refers to the mating and consequently the production of offspring by given organisms. With Zebrafish becoming increasingly important models for research studies, breeding of these organisms has also become vital in order to study the various characteristics of the organism as it develops to adulthood.

For between 5 and 10 fish, a 5 to 10-gallon tank is recommended. This allows sufficient space for the fish to be social and not too small to become aggressive. The same

number of males to that of the female is also recommended.

Although Zebrafish have been shown to be particularly hardy, breeding requires that they are fed well in order to keep them healthy. For the most part, live foods such as Brine shrimp larva are recommended in place of foods purchased from the pet store. However, crumbs of hard-boiled egg yolk have also been shown to be excellent food for the fish.

When ready to collect the eggs, marbles should be laid out at the bottom of the tank the night before. This helps prevent the fish from consuming the eggs given that they settle between the marbles. To collect eggs, a net can be used to take out the marbles or water strained through a tea strainer. Eggs can then be kept in a Petri dish (about 100 eggs per Petri dish) with a pipette being used to clean the eggs (to remove dead embryo). For optimal development, the embryo should be maintained at between 24 and 29 degrees Celsius.

## 2.3 Selected questions

1. Write down biology and distribution of Molly.
2. State the biology of Guppy.
3. Write down biology and economic importance of Zebrafish.
4. Write down biology and distribution of Green swordtail.
5. State the systematic position and biology of Goldfish.
6. Write down the systematic position and the biology of Bluering Angel fish.
7. Write down biology and distribution of Clown Anemone fish.
8. State the systematic position and biology of Vagabond Butterfly fish.

## 2.4 Suggested readings

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# Unit 3 ❑ Food and feeding of aquarium fishes

**Structure**



## 3.0 Objectives

By studying this unit the learners will be able to understand about the live and artificial feed of the ornamental fish and how to prepare the artificial feed for the ornamental fish.

## 3.1 Introduction

Variety of artificial feeds in the form of floating pellets, powder granules, flakes, tablets etc. are available. The feeds can be procured and kept in bottles or containers at room temperature. Fishes should be feed with very small quantities of feed one to four times a day. Instead of dropping entire ration of feed at a time, it is better to give a small pinch and wait for a few minutes within which the fishes pick up all the particles. If completely consumed, then another small pinch of feed can be given. In addition to the artificial feed, the fishes of the aquarium could also be provided with live feed. Organisms like tubifex worms, daphnia, mosquito larvae etc. serve ideally as food for the aquarium fishes. Earthworms can be collected from garden soil, cut into very small pieces, washed and fed to the fishes, The biggest advantage with the use of live feed is that it does not make the aquarium water dirty and also helps in making up for any nutritional deficiency.

## 3.2 Live food organisms for ornamental fishes

### 3.2.1 Infusoria

Infusoria belong to the Class Ciliata and under the Phylum Protozoa of the animal kingdom. The tiny microscopic single celled animalcules are collectively called infusoria. The infosorian micro-organisms inhabit freshwater, brackishwater and marine habitats. Infusoria are most primitive living components of all organisms in the animal kingdom. Besides being small in size, they are soft bodied and nutritionally very rich. They serve ideally as starter feed for early stages of ornamental fish larvae.

#### Freshwater infusoria

There are numerous species of infusoria, but the most commonly cultured species are *Paramaecium* and *Stylonychi*a. These ciliates are found in ponds, tanks and ditches containing foul smelling debris. They can be easily collected with fine mesh (0.13 mm) cloth.

They are cultured using several methods.

#### Marine infusoria

**(a) *Fabrea salina***

A pelagic euryhaline micro-organism, it grows and reproduces over a wide range of temperature (5-40°C) and salinities (up to 100 ppt). It serves as a delicious food for early stages of fish larvae. Its size varies from 60 to 400 micron.

**(b) *Euplotes* spp.**

It is a saline benthic tiny organism, found in stagnant water, where there is an accumulation of decaying organic matter The organism is a bacterial feeder and thus, besides serving as food for fish, it can also control the excessive growth of bacteria in the system.

### 3.2.2 *Brachionus* culture

*Brachionus* belongs to the Family Brachionidae of the Order Ploima of the Class Monogononta under the Phylum Rotifera of the animal kingdom. Slightly larger than infusoria, it inhabits a wide range of water bodies such as freshwatar, brackishwater, salt lakes and backwaters. Brachionus is a nutritious pelagic rotifer and forms best feed for early stages of ornamental fishes.

### 3.2.3 *Moina* culture

Moina belongs to the Family Daphnidae of the Order Cladocera under Sub-class Brachiopoda of the Class Crustacea belonging to the Phylum Arthropoda. It inhabits freshwater ponds, tanks and lakes, multiplies very fast, and feeds on algae, bacteria, organic debris etc., having in the range of 10-60 micron. Measuring 0.5- 2.0mm in length, Moina forms a cheap source of live food for fry of ornamental fishes.

### 3.2.4 *Daphnia* (water flea) culture

It is a Cladoceran, inhabiting, freshwater ponds, tanks and lakes. The food and feeding habits of Daphnia are the same as that of *Moina*. It is larger in *size* than *Moina* and serves as a cheap source of live food for advanced stages of fry and juvenile stages of ornamental fishes.

### 3.2.5 Culture of C*yclops*

*Cyclops* belongs to the Order Copepoda of Class Crustacea under the Phylum Arthropoda. It inhabits freshwater well as marine water and forms useful food for fry and fingerlings of ornamental fishes.

### 3.2.6 Culture of *Artemia*

Artemia, commonly called brine shrimp, belongs to the Family Artemidae of the Order Anostraca under the Sub-class Branchiopoda of the Class Crustacea under the Phylum Arthropoda. It inhabits salt pans and tolerates a wide range of environmental conditions. It is a non-selective filter feeder and capable of growing at very high densities. It has high nutritive value, high fecundity rate and considerablly long life span. All the life stages of Artemia are used as feed for various stages of ornamental fishes, but nauplii particularly acts as an excellent feed for early stages of fish.

### 3.2.7 Culture of tubifex worms (sludge worm)

Tubifex worm belong to the Order Archioligochaeta of the Class Oligochaeta under the Phyllum Annelida. Tubifex worms form an ideal food for the adult stages of all ornamental fishes. Clusters of Tubifex worms can be commonly seen in sewage drains. When present in plenty, the worms can be seen as reddish wriggling carpet in average drains. They jerk into the mud when disturbed.

### 3.2.8 Culture of chironomus larvae (blood worm)

Chironomus belongs to the Family Chironomidae of the Order Diptera under the Class Insecta of the Phylum Arthropoda. It constitutes one of the important food items of nearly all carnivorous young fishes. Flat trays filled with water are added to soil

and composted cattle manure to attract Chironomus flies to deposit eggs. Each female lay a batch of about 20,000 eggs which hatch out in about 3 days. The larvae are harvested and washed thoroughly and kept for conditioning to evacuate the gut contents before feeding to the fish.

### 3.2.9 Mosquito larvae

Mosquito larvae belong to the Order Diptera of the Class Insecta of the Phylum Arthropoda. Mosquito larvae are an ideal food for the larger aquarium fishes. Mosquitoes breed in stagnant water bodies. The females lay eggs on the water surface as a floating raft, from which the larvae hatch. The larvae rest below the water surface, in upside down position by touching their tail to the surface, from where air is taken in for breathing. If water get disturbed, the larvae swin downwards with somersaulting movement. Since, the larvae cannot breathe in the water, they come back to the surface after some time. After few days, the larvae metamorphose into pupa. Pupa moults into mosquito. The mosquito larvae are collected with a scoop net just like *Moina* and *Daphnia* and fed to the larger aquarium fishes. The pupa have a slightly harder head, and often some fishes may have to spit them out after grabbing them.

## 3.3 Artificial feed for ornamental fishes

Artificial feeds for ornamental fishes can be broadly classified into four major groups.

### 3.3.1 Dry feed

The dry feed can be further classified in three sub-groups viz.

1. Pellets 2. Flakes and 3. Freeze - dried feed.

Generally, pellets are given to large size fishes whereas flakes and freeze dried feeds to smaller ones. Flakes are made using scientific formula so as to make a nutritious feed . Flakes are made to float on the water surface long enough to facilitate aquarium fishes to feed on. Flakes come in different colours.

Freeze-dried feed are kept fresh for long periods. These are available in cubes which adheres to tank glasses. Fishes nibble at it as it dissolves.

### 3.3.2 Moist feed

Generally, moist feeds are prepared daily and fed to fishes. They cannot be kept for longer periods due to their high moisture content (35%) which cause them to rot.

### 3.3.3 Semi-solid/Paste feed

Fine particles of food are required for baby fishes as their mouth size is very small. So all the feed ingredients are compounded into a semi-solid mass or paste like mash. This ‘can be squeezed a little at a time and fed to babies through feeder.

### 3.3.4 Preparation of pelleted feed for ornamental fishes

The nutritional requirement for ornamental fishes may be broadly classified into 2 groups, given in Table-1.

**Table-1:** Requirement of protein, lipid and carbohydrate for the fishes

| Sl.No. | Age group | Protein requirement | Lipid requirement | Carbohydrate requirement |
|---|---|---|---|---|
| 1 | Small | 40-45% | 4-6% | 40% |
| 2 | Adult | 30-35% | 6-8% | 50% |

Generally. attempts are made to fulfill the protein requirement of the feed and the requirement level of other nutrients get automatically adjusted. The next step after it is to find out the feed ingredients to be incorporated in the diet. Generally, locally available feed ingredients are selected so as to make it cost-effective. The most commonly available fish feed ingredients are given in the Table-2:

**Table-2 :** Crude protein availability of different feed ingredients

| Ingredients | Crude Protein (%) |
|---|---|
| Groundnut oilcake | 40 |
| Soybean flour | 45 |
| Rice bran | 10 |
| Maize | 8 |

Select any of the two ingredients. Suppose groundnut oilcake and rice bran are fixed @ 25% each. So, protein contributed from both these ingredients is given in the Table-3.

**Table-3:** Protein percentage in the feed ingredients

| Ingredients | % inclusion | Protein contribution (%) |
|---|---|---|
| Ground nut cake | 25 | 10.00 |
| Rice bran | 25 | 2.50 |
| Total | 50 | 12.5 |

### 3.3.5 Some important points for preparation of fish feed

- Giving single large meal to fishes should be avoided. Instead, fishes should be fed 4 to 5 times a day.
- Amount of food should be given by monitoring daily intake. If major amount of feed is left uneaten, it is indicative of excess feeding or perhaps, feed is not palatable to the fishes. The reason should be found out and steps taken accordingly.
- Efforts should be made to siphon out unconsumed feed to avoid microbial contamination.
- Be sure that feeds are not contaminated by mould or fungus before feeding.
- Feed should be water stable, at least for 1 hour. If with the application of feed aquarium water turns cloudy, it indicates that the feed has low stability. In such a situation, binders like wheat flour, agar, gelatin, sodium alginate etc. are incorporated in the feed mixture
- The feed formulation can be manipulated by different ingredients. Selection of ingredients by experiencing with intake of the fishes will be the best feed compared to other ones.

## 3.4 Selected questions

(i) What are the two commonly cultured species of freshwater infusoria?

(ii) Describe the process of producing Artemia nauplii.

(iii) Where do tubifex worms commonly occur?

(iv) What are the different types of artificial feeds available for ornamental fishes?

(v) Formulate a diet by taking the following ingredients so as to keep protein content at 25% level. The feed ingredients are - Fish, mustard oilcake, wheat flour and wheat bran.

## 3.5 Suggested readings

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# Unit 4 ❑ Packing, transportation and marketing of ornamental fishes

**Structure**



## 4.0 Objectives

By studying this unit, the students will understand how to pack live ornamental fishes for small scale business, their transportation and various factors involved in these processes. Understanding of this unit will help the students to start a business of ornamental fish.

## 4.1 Introduction

Ornamental fishes intended for marketing, both domestic and export have to use modern post harvest technology or modifications of the current post harvest technology to improve the post harvest survival and post shipment survival that is critical to the industry. Therefore, the significance of packing and transport come into picture. To overcome the problem of huge mortality of fish species at their different stage during transportation, it becomes essential to assess the most suitable and ideal situation for transportation. At present the mortality rate during fish catching, collection, transportation are very high. This is due to the lack of the use of appropriate technology for fish packing and transportation/shipment. Similarly, since

the airfreight charges are very high, the exporters have no idea of the optimum number of a particular live fish to be packed in a container to reduce transportation cost.

## 4.2 Packing

Before starting the packaging, it is advisable to study the climatic conditions of the destination to which consignment is to be sent and the total time of journey required to reach to destination. Knowledge about transportation time will help in deciding the total biomass of fish or the number of fishes to be packed in one bag.

### 4.2.1 Methods of packing

Two methods are in vogue

■ **Open system comprising open carriers, with or without artificial aeration/ oxygenation/water circulation**

■ **Closed system having sealed airtight carriers with oxygen.**

Before starting transporting to long distances whether in open or in closed system, spawn and fry are to be conditioned in order to clear them excreta and to adjust them to the transporting environment. Information about handling and packaging studies in ornamental fish field in India is scarce. The modern transportation devices comprise closed systems i.e., plastic bags, bins, buckets, collapsible plastic pools and fibreglass tanks. But the most convenient way of transportation of fish is the use of oxygen packed polythene bags. All that is needed is a plastic bag, an insulating box, rubber bands and pure oxygen. The fish in the plastic bags are after that packed in boxes and can be transferred like regular cargo by road, rail or air.

### 4.2.2 Steps of packing

The fishes are packed in polyethylene bags in a small volume of water and oxygen in the ratio of 1 :3. These bags are tied tightly and further kept in corrugated card board boxes or thick moulded styrofoam boxes, which have been recently introduced. Before booking the consignment, the care should be taken that entire space of the pallet (Cargo boxes) is used. Depending on the climatic conditions of the destination, an insulation material should be provided to protect the consignment from extreme cold or heat. A lining of the thermocol on the polyethylene bags will help to increase the insulating ability during winters (Figure 1).

## Bags

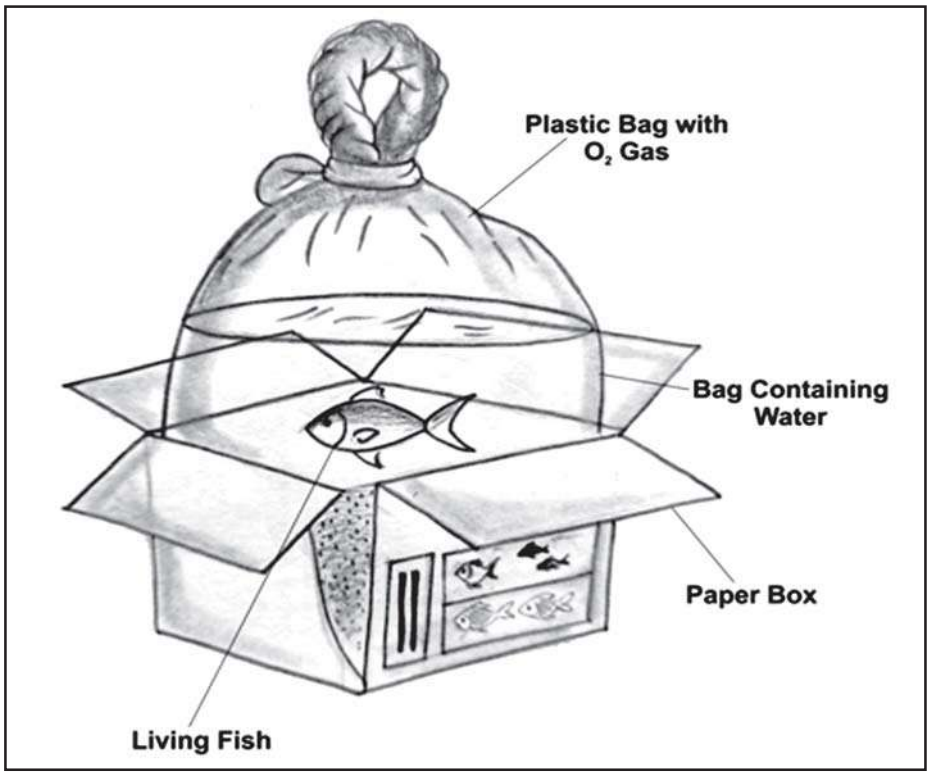


**Figure-1:** Square bottom bag for packing of the ornamental fishes

Many of the domestic producers use square bottom bags, as show in figure 1. These bags exploit the surface area of the box more competently. Use of a pleated flat bottom bag is highly recommended. Pleated bags use the entire surface area of the box allowing maximum oxygen transfer during the surface of the water. They also decrease the effects of crowding by utilizing all of the accessible area in the box. If the bag is properly placed in the box, crowding in the corners by the fish is kept to a minimum. Boxes are usually packed in bag sizes of full to quarter. Full bags are those that utilize the entire box, half bags are packed two to a box, quarter bags four to a box. Bags have the following size: full size, 37.5 cm (W) x 37.5 (L) x 55 cm (H), half size, 40 cm x 20 cm x 55 cm, and quarter bags at 40 cm x 10 cm x 55 cm. Square-bottom bags are available pleated and flat bag sizes are listed in table 1. Fish packers in India generally use bags manufactured from stock tube plastic and heat-sealed at one end so there is only a single ridge. These are called “pillow bags” in the industry, because when they are inflated there is no flat surface, and packing water surface is augmented by shipping these bags on their side.

**Table-1:** Types and size of the bags for shipment of the ornamental fish

| Bags (pillow bags) ($Cm^2$) | Pleated bags (Square bottom) ($Cm^3$) |
|---|---|
| 65 × 35 (bull bags) | 37.5 × 37.5 × 55 (Full bag) |
| 60 × 27.5 | 40 × 20 × 55 (half bag) |
| 57.5 × 25 | 20 × 20 × 45 (quarter bags) |
| 57.5 × 22.5 (half bag) | 15 × 10 × 45 (eight bag) |
| 42.5 × 22.5 | 10 × 10 × 40 (sixteenth bag) |
| 37.5 × 20 | |
| 22.5 × 17.5 | |
| 25 × 12.5 (quarter bag) | |
| 20 × 10 (eight bag) | |
| 17.5 × 7.5 (individual bag) | |

## 4.2.3 Steps in packing of ornamental fishes for transport

***Preparation for fish transport***

Weak or diseased fish have to be removed. The fish should not be fed for several days. Feeding for very small fish should be stopped 12 to 24 hours before transshipment while for fish up to 3 grams body weight feeding should be stopped before 48 hours. Larger fish may not be fed for 3 days prior to shipment. Then the fish should be cautiously transferred to their water tank of newly aerated water for transport with a minimum of disturbance. If continuous aeration is not possible during the journey a final topping up with oxygen or air will be necessary at the last possible moment before final sealing.

***The packing process***

The plastics to be chosen for the live fish transport may satisfy the needs like,

- High oxygen retainability
- Tensile strength
- Tearing strength

Ornamental aquarium fish are packed in a polythene bag (thickness not less than 0.1mm) filled to 1/3 of its volume. After filling with water and fish the upper part of the plastic bag is compressed to drive out the air and then inflated with pure oxygen and then the aerating tube is withdrawn through the constricting neck. The top of the bag is then bent and tied with two or three rubber bands and then placed in Styrofoam boxes. The moulded

Styrofoam (thermocole) boxes, seems to have revolutionised packing. And today the most acceptable packing material world over is either a complete moulded Styrofoam box or a carton lined with Styrofoam of minimum 15 mm thickness (Figure-2).

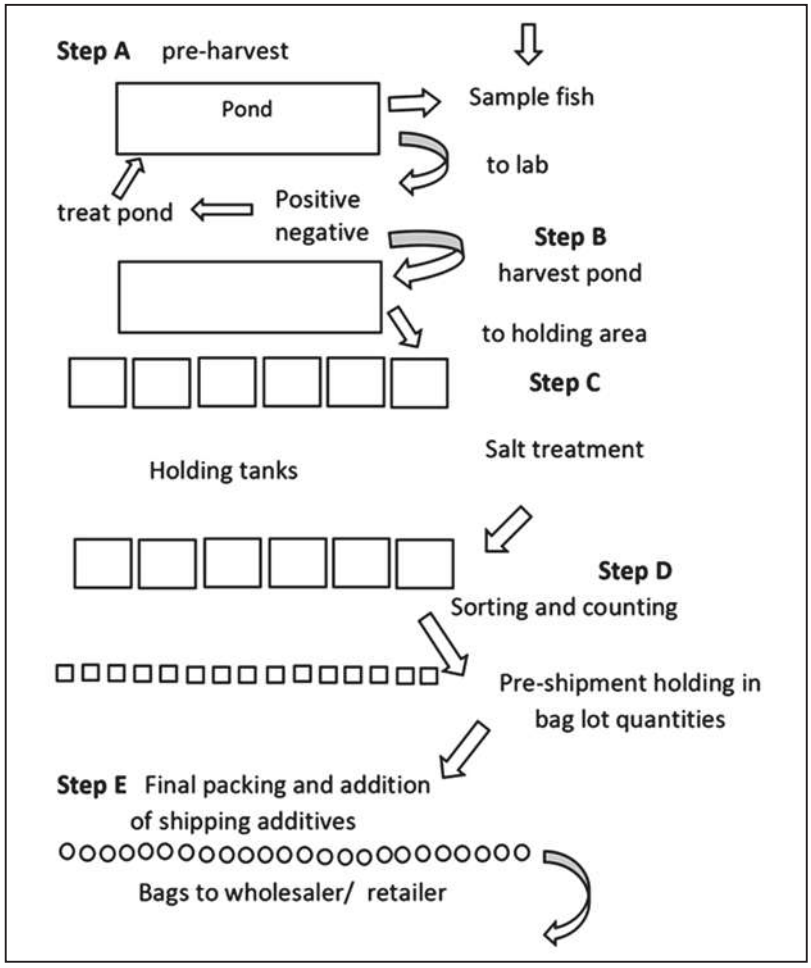


**Figure-2 :** Flow chart of fish packing steps and procedures

## 4.2.4. Factors to be taken into consideration while packing

### (a) Density

Under carefully controlled conditions densities of up to 1 kg of fish per litre of water have been successfully transported. Densities of around one tenth of this are more usual and ensure that the health and well being of the fish are preserved. As a suitable guide 2 kg of fish can be placed in 20 liters of water inside a polythene bag, with oxygen filled space above it, and at $10^0$C can be carried for 5h without the need for further oxygenation.

However the density chosen will in practice depend upon the species, the type of the tank, the temperature and many other factors, and must really be determined by trial and error for each specific situation. At high densities fish become agitated; this increases oxygen consumption and risk of damage. Loss of mucous may also occur which can cause discomfort or choking of the gills. Foaming of mucus laden water may occur with aeration, and may be suppressed by the non-toxic antifoaming agent.

### (b) Temperature

Temperature influences the activity and the oxygen consumption of the fish, and also the oxygen carrying capacity of the water. High temperature especially may also be directly lethal to fish. From all these aspects a low water temperature at least as cool as the water from which the fish were taken is preferred. Cooling the fish has often been used successfully to calm fish for transport. Chipped or crushed ice is satisfactory for most of the journeys but not for long distance air freighting of fish. Dry ice has a greater cooling capacity for its weight. However, caution must be exercised to prevent from the evaporating $CO_2$ from dry ice coming into contact with the water. Deep frozen blocks of ice or special cooling bags are safer and last a very long time.

When fish from warm tropical waters are transported, water-cooling can be a handicap. Heavy insulation reduces cooling to a minimum and chemical-heating packs can be helpful. In most cases extreme temperature changes can be avoided by adequately insulating the fish container with plastic foam or expanded polystyrene and by traveling only at the appropriate time of the day.

### (c) Dissolved gases

To maintain fish in healthy state there must be sufficient oxygen in the water. In addition, the build up of carbon dioxide and ammonia must be prevented. Gas concentration can become critical under transport conditions where the fish are stressed and their oxygen requirement is greatly elevated. Oxygen concentration can be maintained by bubbling compressed or pumped oxygen or air, or by surface agitation. For small quantities of transport for a short period, continuous aeration is necessary. The fish are provided with well aerated water with an air space above it. The vehicle movement will provide an agitation effect. The effectiveness is increased by maximizing the surface area, or by providing an atmosphere of oxygen above water.

Carbon dioxide is toxic to fish, both directly and by decreasing their ability to extract oxygen from the water with low densities and high aeration rates it is unlikely to attain toxic levels. Where fish are transported without continual aeration, $CO_2$ does build up.

Ammonia is produced as the major nitrogenous excretory produce by most teleosts and is very toxic. Oxygen concentrations and pH both affect ammonia toxicity. It is unionized ammonia which is particularly toxic and the equilibrium is markedly influenced by

pH. A shift from pH 8 to 7 produces tenfold decrease in the quantity of unionized ammonia. Decrease in dissolved oxygen increases the toxicity of unionized ammonia.

### (d) Salinity

The body fluids of salt water fishes and freshwater fishes have salt concentration between those of freshwater and seawater. Thus both are under osmotic stress and are having to work to maintain their internal ionic equilibrium. When fish is physically damaged the rate of exchange can increase and represent a greater stress.

### (e) Anesthetics

Increased physical activity during transport can adversely affect the health of the fish in two ways. First is physical damage by the abrasion with the packing container and second is by a physiological reaction to a physical activity and other environmental factors such as low dissolved oxygen. Such reaction is manifested in high blood lactate levels, which can cause serious debilitation or death. The level of physical activity of the transported fish must be kept to the minimum. Lower temperature can help, as can covering carrying tanks with light proof material. A third possibility is the use of tranquilizers. A considerable range of chemicals are potentially useful as tranquilizers, some being employed at higher concentrations as anesthetics.

Several anesthetics now find application in the transportation of fish seeds. Though the concentration of various anesthetics used differs widely depending upon the species, size, etc. they have common characteristic feature, *viz*., lowering the metabolic activity of the fishes by their depressing action on the brain. This actually leads to the low consumption of oxygen in the media during transit and thus facilitates higher survival and long duration of journey in oxygen packed containers under higher stocking densities.

The sedating of fish brings in practical benefits by way of

(a) Decreasing the rate of oxygen consumption and reducing the rate of excretion of carbon dioxide, ammonia and other toxic wastes.

(b) Controlling the excitability of the fish and thereby reducing chances of injury.

(c) Reduce the time required for handling them.

Any anesthetic that are used for the transportation of fish must possess the following characteristics:

(i) Must be water soluble ;

(ii) Dosage required should be low ;

(iii) Time of induction and recovery should be short

(iv) Fish should tolerate well for several hours at low concentrations

(v) Should not have any side effects in the fish

(vi) Lethal concentration should not be high, so that, fish do not die accidentally.

The most inexpensive method of tranquillizing fish is the use of water chilled down to 5-10$^{o}$C without the use of any drugs. The common tranquilizers used in live fish transportation are Amobarbital sodium, Barbitol sodium, Chloral hydrate, Hydroxyquinaldine, Tricaine methansulphonate : MS 222, Methyl paraphynol (Dormison), Quinaldine, Sodium amital, Tertiary amyl alcohol, Thiorucid, Urathan, 2-phenoxy-ethanol, etc. The dosage of these tranquilizers has to be standardized for each species and packing density to avoid any adverse affect.

## 4.3 Transportation

In recent years, transportation of live fish and shellfish is becoming an important activity of the fish industry. With the development of aquaculture, transport of cultured live fish fry, fingerlings and post larvae by road, water and air from hatcheries to nearby farms and other states and countries is on the increase. Trade in export of ornamental aquarium fish is a multimillion-dollar business. The success for all of which depends on effective packaging techniques and careful handling practices prior to and during shipment with minimum mortality.

Transportation of ornamental fishes is done through air cargo services. Therefore, the selection of the airlines and the time required for the consignment to reach the destination are of utmost importance. If any change over is required enroute, the details of connecting flight should be known and arrangements made accordingly. The services of a reliable and reputed cargo agent should be utilized. However, an airline should be selected where no change of air craft is required . Strict care should be taken that all the paper formalities are completed before booking the consignment. An insurance coverage for the consignment is also very useful to avoid the losses in unforeseen and unavoidable conditions.

Transportation of live fish and shellfish from areas of collection to destination or from area of farming to destination is an important activity of the ornamental fish industry, and the success of transportation depends on:

- Careful handling practices right from harvesting /quality assurance
- Conditioning for a period of time before packing.
- Effective packaging techniques.
- Stocking density.

- Maintenance of low temperature and high humidity during storage and transit.
- Minimum mortality.
- Replenishment of air with oxygen and reduction in accumulation of toxic wastes and controlling acidity of water medium with suitable buffers.
- To reduce the metabolic activity and thus their oxygen consumption.
- Conditioning the fish to the environment prior to transportation/shipment.
- Lower temperature of water.
- Addition of permissible and correct dosage of anesthetics.

If not properly planned and implemented large scale mortality would occur resulting in heavy loss. The most important reasons for mortality of fishes during transport are :

- Mistakes made before transportation (Fed fish, fish density too high, inclusion of weak and diseased fish, etc.).
- High carbon dioxide tension and or/deficiency of oxygen in the transporting medium.
- Toxicity of accumulating wastes like ammonia and other metabolites in the medium
- Improper handling of fish while collection, packing and after arrival leading to physical injuries.
- Too quick transfers into new water without proper acclimatization, wrong treatment for diseases affecting the health of fish.

### 4.3.1 Shipping additives

Shipping additives over the last 15 years, several additives to shipping water have been developed or adapted to help reduce stress and increase survivability. They generally fall into three categories: sedatives water quality stabilizers, and antibiotics. The most common sedatives are quinaldine or quinaldine sulfate, and Tricane methane sulfonate (MS-222), with commonly used concentrations listed in table 2. Quinaldine is used 25 ppm in shipping water, MS-222 at 60 to 70 ppm with adjustments made for sensitive species. These compounds reduce the metabolic rate of fish, and can also prevent injury from jumping or swimming into the sides of the box. Water quality stabilizers include pH buffers, zeolite at 20 gms/ liter (which removes ammonia), activated carbon also at 20 gms/liter, ice or heat packs to maintain temperature, and sodium chloride at 9.0 ppt. Other products have become available from the bait minnow industry these usually contain a combination chelating agents, buffers, ammonia or chlorine removers and some form of antibiotic.

**Table 2.** Common shipping additives and concentrations typically used in water for transport of ornamental fish (Herwig, 1979)

| Concentration | Chemical |
|---|---|
| Quinaldine | 25 mg/L |
| Tricane methane sulfonate (MS-222) | 60-70 mg/L |
| pH buffers | 7 |
| Zeolite | 20 gms/L |
| Activated carbon | 20 gms/L |
| Salt (NaCl) | 9.0 ppt |
| Furanace | 0.05-0.2 mg/L |
| Neutral acriflavine | 3-10 mg/L |

mg/L – milligrams per liter

gms/L – grams per liter

ppt – parts per thousand

### 4.3.2 Post shipment mortality

Packing ornamental fishes for marketing, both domestic and export, have to use modern post harvest technology or modifications to improve the post shipment survival that is critical to the industry. It is in this context that the significance of packing and transport come into picture. To overcome the problem of high mortality of fish species at their different stage during transportation, it becomes essential to evaluate the most suitable and ideal condition for transportation. At present the mortality rate during fish catching, collection, transportation are very high. The claim by the importers due to Death On Arrival from India is on the higher side compared to the consignments from other developing countries. This is due to the lack of the use of appropriate technology for fish packing and transportation/shipment. Similarly, since the airfreight charges are very high, the exporters have no idea of the optimum number of a particular live fish to be packed in a container to reduce transportation cost. Such information is lacking on Indian fishes.

## 4.4 Marketing

Kolkata, the capital of West Bengal is the chief distribution centre. From here the fish are transferred to different states of India by air or road. Two parallel marketing systems exist for exotic and native fish. In the case of exotic species, more than 99% is consumed

by the domestic market and a small number of species like gold fish and angelfish are exported. On the other hand, 90% native ornamental species are collected and reared to meet up export demand. The amount of marine ornamental fish trade is insignificant in this area. The marketing system is commonly being done through the following channels:

**[I]** The producers directly trade the ornamental fish directly to the wholesalers, but the amount is very insignificant.

**[II]** There are some big middle men who buy big volumes of fish at very low prices from the producers, rearing the fish for 2-3 months before selling at the wholesale markets again for increased profit.

**[III]** from the wholesale markets, retailers and others purchase the ornamental fish.

For export, the Marine Products Export Development Authority has 20 registered exporters. They either have their own farm or collect the fish from different areas for export. The USA, Japan and Singapore are the main markets.

## 4.5 Summary

Even the most successfully ornamental fish production operation is likely to fail if inadequate attention is paid to fish packing and shipping procedures. This can be summarized as a matter of minimizing risks at every step of the packing and transport process, without going to the costly excess of shipping under packed bags. Packing procedure should take into consideration of the species being shipped and the expected time in transit. Concentrating sales in easily reached destinations, and adherence to recognized packing methods, materials, and densities described in this manual will contribute to the consistent delivery of fish in excellent condition.

## 4.6 Selected questions

(i) What precautions are taken during collection of ornamental fishes from nature and their conditioning?

(ii) Describe the essentials of packaging and transportation of consignments of ornamental fishes.

(iii) Discuss the different channels of transportation.

(iv) What factors are to be considering during the time of the packing ?

## 4.7 Suggested readings

1. YADAVA Y.S. (2000) A review of the Status and Trends of Exported Ornamental Fish Resources and Their Habitats in Sri Lanka. for the Bay of Bengal Programme,
2. Ninawe A.S. and Diwan AD. (2005) Women Empowerment in Fisheries. Narendra Publishing House, Delhi, India.
3. Collins R. A. (2012) Identification of Ornamental Fishes for Biosecurity. A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy at Lincoln University.
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# Unit 5 ❑ Maintenance of aquarium and garden pool

**Structure**



## 5.0 Objectives

By studying this unit the learners will be able to will understand :

(i) How to construct aquarium?

(ii) How to decorate aquarium?

(iii) How to maintain aquarium?

(iv) Placement of aquarium for indoor decoration.

(v) Construction and maintenance of garden pool.

## 5.1 Introduction

Aquarium and garden pool, both have aesthetic values, one designed for indoor and the other for outdoor.

Aquarium gives pleasure in viewing colourful fish in a simulated aquatic environment at home. Aquarium can be constructed easily by using available materials in the local markets and decorated in various ways. This unit explains how aquarium is constructed, decorated and maintained for indoor use.

A garden pool together with a variety of flower beds for decorating its margin, offers a quick and rewarding means of landscaping a new place. A garden pool in a new landscape can become the centre of attraction around which the rest of the garden is

designed. A garden pool holding colourful ornamental fishes and water lilies indeed makes a lovely refreshing sight to anybody's eyes. By the strategic placement of a pool just outside a window, one can bring the beauty and serenity of colourful fishes and water-borne flowers right into the house.

## 5.2 Maintenance of aquarium

Water quality must be monitored all of the time, mainly during initial set-up and when stocking the tank. This helps to reduce the possibility of causing any damage to the animals because of the build up of high ammonia ($NH_3$) and nitrite ($NO_2^-$) levels. It is also desirable to test for nitrate ($NO_3^-$), temperature, pH and hardness. Regular limited water changes are required to eliminate excess nitrate. Filters need to be checked for blockage and waste build up. If they require cleaning, never rinse them under a tap as this washes away the beneficial bacteria. If blocked, rinse the filter media in some of the waste tank water during a routine water change.

### 5.2.1 Framework of aquarium

An aquarium is made of glass sides and bottom fitted into a metal frame of either angle-iron or aluminium by means of bitumen or a cement made up of equal parts of zinc oxide and red lead in double-boiled linseed oil. The most popular size of home aquarium is 60 cm length × 30 cm width × 40 cm height with a capacity of 57 litres (15 gallons) (Figure-1).

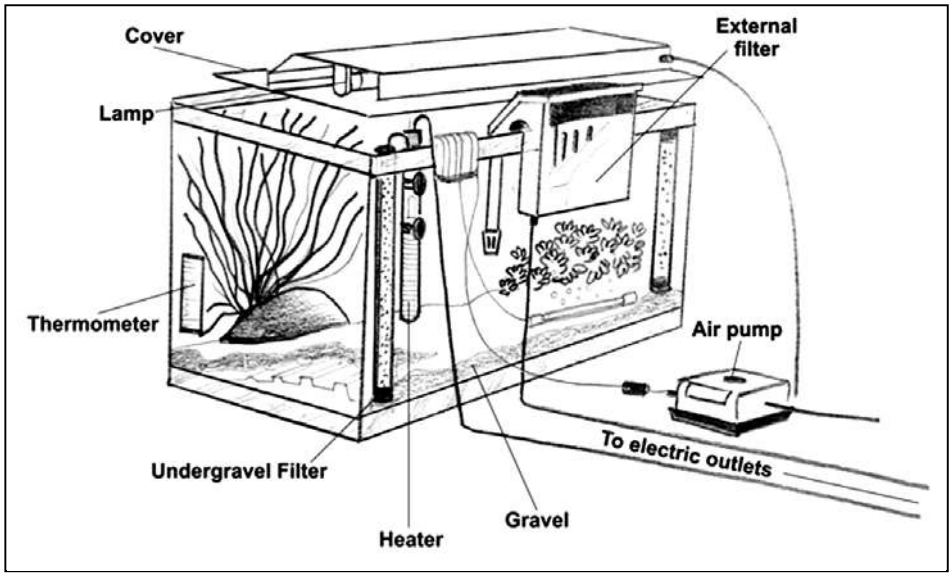


**Figure-1** : A standard framework of aquarium

### 5.2.2 Site for setting the aquarium

For setting the aquarium, one must find a stand on which the aquarium can rest so that it is at eye level. In living and study rooms, a small low table can also be used for the purpose. In all cases, one must take into account the weight of the aquarium and be sure that the table or stand on which it is going to be kept, is strong enough to prevent the aquarium from wobbling every time there is slight push or jerk.

Interior decorators and architects make increasing use of fish aquaria as integral part of the design of a room. It is fit into the decor of the house in several ways *viz*. i) built into a wall, thereby giving an effect of an animated picture ii) as a room divider (iii) built into a book-case and iv) for making aquarium-cum-indoor garden.

Aquarium tank should not be located at a place where it faces direct or excess sunlight. Too much of sunlight cause over heating and promote excessive algal growth in the aquarium tank.

### 5.2.3 Light arrangement

Proper illumination is important for healthy functioning of a home aquarium. Apart from providing visual display of ornamental fishes to their best effect, it also stimulates growth of fishes and plants. Light intensity, quantity and duration are important aspects to be looked into. As a thumb rule, 40 watts of tungsten light or 10 watts of fluorescent tube work is ideal for every square foot of water surface. Lighting for 10 to 15 hours a day is considered enough. Fluorescent tube lights are preferred over tungsten bulbs as they have a longer life, less heating effect and low running cost. Nowadays, specially designed glow lux' tube lights are available which give attractive illumination, enhance pigmentation glow in fishes and provide a good balance between infrared and ultra-violet light.

### 5.2.4 Heating arrangement

The ornamental fishes kept as pets in home aquarium (except goldfish) come from different tropical countries and are accustomed to live at 22 to 30°C. In places along the coast-line the climate remains quite conducive, there being not much abrupt difference between the temperatures at day and night. Fish lovers at these places are fortunate in not having to bother about keeping the water warm or cool. At other places in the country, however, measures are required to be taken to heat the water in winter, especially at night. Heating is most commonly

### 5.2.5. Aeration

During summer months, the water in the aquarium will have to be cooled down to at least 29°C. This is best done by having an aerator (air pump). Connected to a diffuser by a plastic or rubber tube, the aerator forces a stream of air bubbles into the water. The

aerator should be kept at a level higher than the water level of the aquarium, otherwise water will creep into it when switched off. Besides lowering the temperature, the aerator also helps in increasing the dissolved oxygen content in the water Aeration is also required for the running of filteration systems, toys etc.

### 5.2.6 Filters

Harmful substances like ammonia and nitrites produced mainly through fish metabolites, keep on accumulating in the aquarium. They may exceed the lethal limits and eventually poison the fish. For maintaining a stable and healthy environment in the aquarium, these harmful substances are removed using filters. Various types of filters are available such as under-gravel filter, foam filter, power filter, etc. Under-gravel filter is the most popular among the aquarists because it is simple, inexpensive, occupies less space and is easy to install. It consists of a hard plastic perforated plate with air-lift pump tube. When air is injected into the air-lift tube, the water is lifted upwards, flows through the gravel below the filter plate and finally filtered clean water is lift back into the main body of the tank.

Gravel size is an important factor in mechanical trapping of suspended particles. Dark coloured coarse sand of 3 to 5 mm size and 5 to 7 cm thickness above the filter-plate works ideally for filtration. It is important to clean the gravel every month to remove excess detritus matter by vacuum Siphoning.

Bacteria helps in purification of water. When ammonia loaded water is passed through the gravel bed, it is subjected to the action of aerobic nitrifying bacteria that oxidizes toxic ammonia into nitrite by Nitrosomonas bacteria which get further oxidized by Nitro bacteria groups into nitrate which is less toxic to the fish and finally gets absorbed by the plants.

### 5.2.7 Decorative toys

A number of decorative toys are available for according attractive look to the aquarium. They include plastic bubblers in the guise of mermaid, underwater diver, oyster shells, angler, human skull, tortoise, frog etc. Artificial rocks, logs, roots and plants are also available Plastic plants should be of good quality.

### 5.2.8 Putting the base of sand or gravels

Putting a layer of sand or gravels at the bottom of the aquarium tank helps in creating a simulated natural environment. It facilitates fixing of aquarium plants and support their growth. A medium sized (2 to 3 cm) sand or gravel is ideal for the purpose. Adequate quantity of sand or gravel is needed to cover about 5 to 6 cm height at the bottom. This provides required depth to hold the plants as also to facilitate aquarium landscaping .

### 5.2.9 Planting

Decoration of aquarium tank with plants is an art that can be praised with imagination, experience and availability of plants. *Vallisneria* and *Sagittaria* are two common aquarium plants. They have the appearance of grass (hence called eel or tape grass) and are ideal for background. Bushy plants like *Ludwigia* and *Ceratophyllum* should be used to fill up the corners. *Echinodorus* (Amazon sword plant) is a perfect centre piece while small

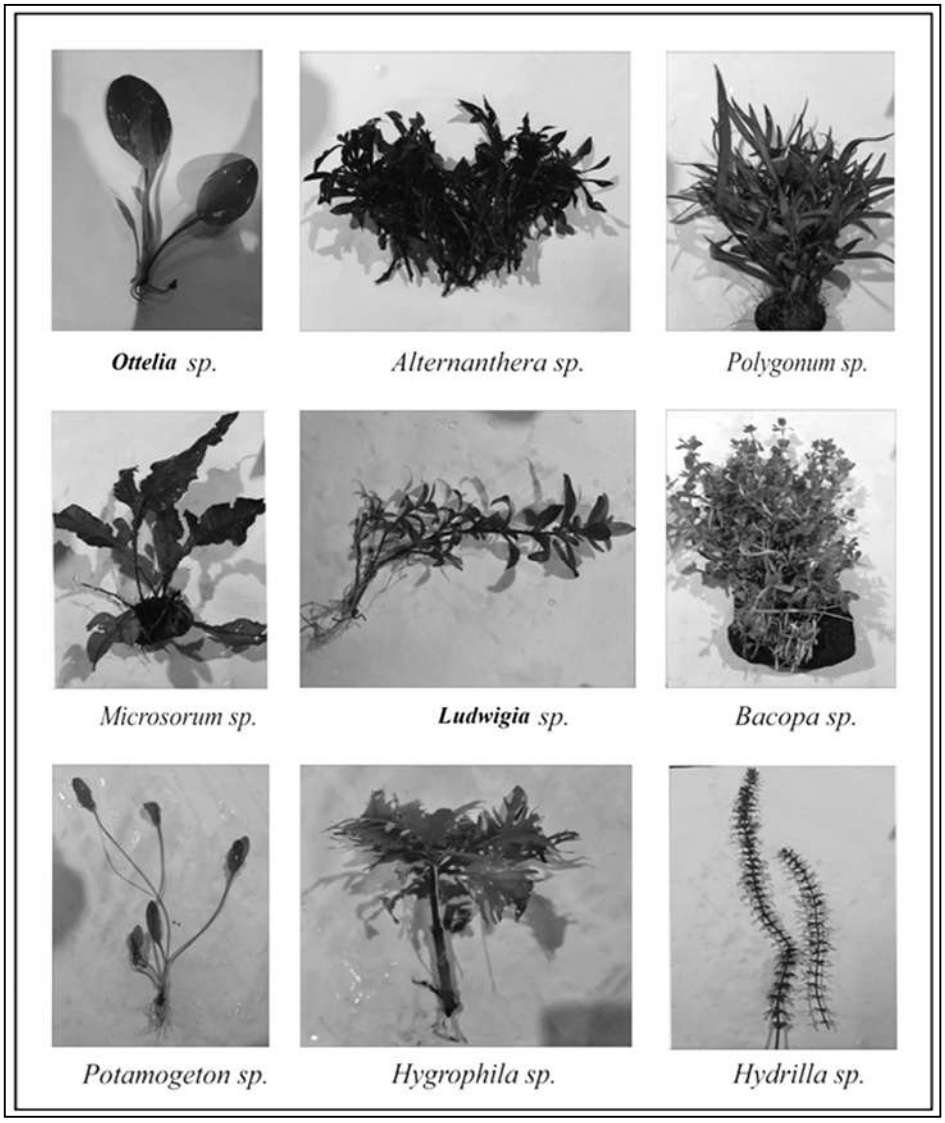


**Plate-1:** Different aquatic plants of aquarium

plants viz. Marigrass, *Ottelia* sp., *Alternabthera* sp., *Polygonum* sp., *Microsorum* sp., *Bacopa* sp., *Potamogeton* sp., *Hygrophila* sp., *Hydrilla* sp. etc. (plate 1)are used to decorate the front portion. Before planting, plants should be disinfected so as to kill harmful germs, parasites, insects and other enemies of fish. This is done by dipping them in 0.1 % potassium permanganate solution for 20 minutes and then thoroughly washed in running water. In addition to plants, stones can also be used to beautify the aquarium. Sharp edged stones, shells and corals should be avoided as these might injure fishes. The shells and corals also leach out into the water and turn it alkaline. Arches made of stones offer good shelter to fishes.

## 5.2.10 Choice of fish and their quantity

After conditioning, the aquarium is ready to receive fishes. The desirable species of ornamental fishes in required numbers are purchased from the market. The fishes should be first acclimatized to aquarium temperature for 30 to 40 minutes and then only released in the aquarium.

Normally, the number of fishes to be kept in an aquarium / tank is a relative fact. Care should be taken that the aquarium /tank does not get overcrowded. Normally, the recommended rate of stocking ornamental fishes is 50 square cm of water surface to each fish of 2.5 cm total length. On this basis, an aquarium of 60 cm x 30 cm offering 1800 $cm^2$ of surface area, can hold 36 fish of 2.5 cm size, 18 of 5 cm and 12 of 7.5 cm size. On the basis of above calculation, a composite structure of ornamental fishes to be kept in an aquarium may be as given in the figure 2.

## 5.2.11 Food and feeding

Different types of artificial feeds in the form of floating diet pellets, powder granules, flakes, tablets etc. are available. The feeds can be procured and kept in bottles or


**Figure 2** : Composite structure of ornamental fishes to be kept in an aquarium

containers at room temperature. Fishes should be feed with very small quantities of feed one to four times a day. Instead of dropping entire ration of feed at a time, it is better to give a small pinch and wait for a few minutes within which the fishes pick up all the particles. If completely consumed, then another small pinch of feed can be given. Overfeeding makes the water dirty, depletes dissolved oxygen and emits foul smell due to putrefaction. Such conditions cause stress to the fish and make them susceptible to various infectious bacterial diseases. In addition to the artificial feed, the fishes in the aquarium should also be provided with live feed from time to time. Organisms like tubifex worms, *Daphnia*, mosquito larvae etc. are given ideally as food to the aquarium fishes. Earthworms can be collected from garden soil, cut into very small pieces, washed and fed to the fishes, The biggest advantage with the use of live feed is that it does not make the aquarium water dirty and also helps in making up for any nutritional deficiency.

### 5.2.12 Regular maintenance

A few minutes of watching everyday for any noticeable change in the aquarium water, plants or fishes will give the idea about its proper upkeep. For regular maintenance of home aquarium, it is better to have a check-list prepared and see that they are scrupulously attended to the aquarium. The more important points to be looked into are :

(i) Regular water change (20 to 30% every two to four weeks).
(ii) Cleaning of algal scum from the glass at periodical interval.
(iii) Removal of lead fishes, if noticed inside the aquarium.
(iv) Raking the surface layer of the substrate and removal of dirties etc. by vacuuming device every week.
(v) Pruning of excess plant growth, when noticed.
(vi) If aquarium water turns cloudy after one or two months, it indicates the need to change water.
(vii) Water loss caused by evaporation should be made up once a week.

### 5.2.13 Precautions

Besides above, some notes of safety should also be kept in mind, viz.

(i) Never try to move a filled up aquarium, the glass could crack with pressure.
(ii) Always remember that electricity and water could be a deadly combination. Therefore, all electrical fittings should be completely waterproof.
(iii) Always keep the heater/thermostat completely immersed. If they are removed from water while in operation, they may crack.
(iv) Do not locate the aquarium near a door as frequent hangings will stress the fishes. Knocking on the glass is equally undesirable.

(v) Try to keep atmospheric pollution free in the room, such as cigarette smoke etc. to a minimum. The quality of air in the room is important to fishes, as the quality of water, since the two interact.

(vi) When unhealthy fishes are noticed, they should be removed from the tank and treated separately.

(vii) Snails should not be added to aquarium tank, they may carry diseases and eat plants.

(viii) Large fishes should not be kept with small fishes to prevent predation and injury to small fishes.

(ix) Don't use tap water directly. It should be aerated overnight to remove chlorine. Chlorinated water is harmful to fishes.

(x) Overfeeding of fishes should be avoided at all cost. It spoils the quality of water resulting in death of fishes.

## 5.3 Setting up of garden pool

### 5.3.1 Selection of site

While selecting a site for garden pool, the following points are to be kept in mind :

(i) The site should be located at such a place where the pool will look the best.

(ii) The most important limiting factor to any site is the amount of sunlight that falls upon it. Any spot in the garden which receives a minimum of 5 to 6 hours of sunlight could be expected to give satisfactory results.

(iii) The pool should never be constructed under a tree. Even a pool partially under trees is to be avoided, if possible. This is because the leaves and other matters dropping from the tree would generate obnoxious gases as they decompose in the pool and create an unhealthy environment for the stocked ornamental fishes.

(iv) The garden pool should be located at such a place where it is protected from the north by a building or a hedge of bushy trees or similar wind-breakers.

(v) The only other consideration in selecting a site is that of providing facilities for filling up and draining out the garden pool. For this, the pool should be located close to an assured source of water supply and constructed at an appropriate elevation so as to facilitate emptying of pool by gravity.

### 5.3.2 Shape and size

The shape of garden pool should be kept as simple as possible. Though it can be made in various shapes like triangles, stars, crescent or kidney but they are not considered good from the point of view of operational convenience. Moreover, the more intricate the pool design is, the more cumbersome it will be to construct. Pools of simple square or rectangular shapes are ideal for the purpose. There is no standard size as such for garden pools. However, for a simple straight sided garden pool, an average size of 3.5 m length, 2.5 m width and 0.6 m depth is recommended.

### 5.3.3 Construction of garden pool

Two types of garden pools can be constructed, the still water pool which is the commonest, and the running water pool. For a running water pool you will have to have a stream or spring located nearby. Alternatively, however, a gravity flow system with an overhead water tank and low lying drainage outlet and channel can be made to maintain flowing condition of water. To facilitate this, the bottom of the pool should slope towards one side.

For 0.6 m depth, the actual excavation should be 0.9 m. The base layer of the pool, both bottom as well as on sides, is made up of 15 cm thick lining of compactly rammed cinders, gravels or crushed stones. A high grade concrete properly reinforced with steel/ chicken mesh is placed on the base layer of the pool. This concrete layer is cured atleast for 21 days to achieve full structural strength and also to avoid any cracks. Proper drainage system is a must for garden pools.

### 5.3.4 Planting the pool

In a garden pool stocked with ornamental fishes, the water can seldom take in enough oxygen by surface absorption to replace the amount that is utilized by the ornamental fishes in their breathing. It is, therefore, necessary, to keep some aquatic plants in garden pools so that they could exude oxygen constantly as a waste product to keep oxygen content at a healthful level. Fishes as they take oxygen from the water, throw off carbon dioxide, a product quickly assimilated and converted into plant tissue by water plants. Aquatic plants also contribute to the pool's welfare in other ways. Overabundance of tiny micro-organisms (algae) however may turn pool water into unattractive green. Foliage of submerged aquatic plants also serve as substrate for the fish spawn to adhere upon or as hide-outs for the newly hatched fish babies.

Amongst the submerged type of aquatic plants, the most ideal ones are *Anacharis, Cabomba, Ludwigia* and *Myriophyllum.* They will grow without planting. Plants like *Vallisneria* should be planted in pots of loamy soil and placed on the pool's floor. Floating

plants like *Azolla, Lemna, Nymphoides, Salvinia. Pistia* etc. grow quite well in garden pools if merely dropped into the pool. They live on air, water and microscopic matters suspended in water. Their excess growth can be easily controlled by simply scooping them out of the pool. Water lilies (*Nymphaea* spp.) go very well in garden pools.

### 5.3.5 Fertilizing

For having a productive garden pool, both for fish and plants, application of fertilizer is a must. Fertilizers, besides providing nutrition to plants, also support the growth of algae and other organisms on which fish feed. A commercial mineral fertilizer is the best for the purpose. Organic manures should be used with caution for they tend to encourage scum formation. For deciding about the use of fertilizers, it is better to seek advice from fisheries consultants.

### 5.3.6 S tocking

Goldfish is the most ideal fish for keeping in garden pools. For giving a decorative effect, the garden pools should be stocked a bit heavily so that there will be enough of them to see, and also enough to reproduce. They can be attracted close enough to the shore line of the garden pool to be seen and enjoyed by establishing attractive spots as feeding locations. The rate of stocking would depend upon the size of the fish as also according to the type of pool, still water or running water. In a still water garden pool, goldfish of average 10 cm size can be stocked at the rate of 5 fish/$m^2$ while in a running pool at the rate of 10 fish/$m^2$.

### 5.3.7 Feeding

Goldfish will eat practically anything. Conventional feed mixture of rice bran and oilcake fortified with mineral premix, as given to carps, go quite well for goldfish too. Alternatively, you will perhaps find it more convenient to buy a prepared fish food from the market.

Observe the fish as they eat what you throw them. After a few days of watching, limit them to only as much food as they will consume in five minutes. Goldfish should be fed only once a day. If they become torpid and slow moving, try feeding them every other day or every third day till they turn livelier.

### 5.3.8 Maintenance

During the course of maintaining a garden pool, you may come across situations which may worry you. Some such situations are discussed below :

**(a) Scum formation on the surface of pool :** This generally occurs shortly after the initial filling of the pool. To remove the scum, simply raise the water level of the pool and allow it to run down the overflow drain.

**(b) Green water :** Crystal clear water is not the indicator of a healthy pool. The water should have a slightly cloudy greenish tinge. This green cast is caused due to the millions of suspended microscopic algae, plankton etc. which are necessary for the health of the goldfish.

**(c) Insects infestation :** Many types of aquatic insects and their larval and pupal forms may develop in the garden pool. Their overpopulation may be harmful, both for the fish and plants. In order to get rid of them, stock a few insectivorous fishes viz. *Clarias batrachus* or *Anabas testudineus* in the garden pool.

**(d) Snail infestation :** Snails although help in keeping a check on algal bloom but if their population increases, it may cause damage to the plants and also serve as disease carriers.

**(e) Ailing fish :** Watch for drooping dorsal fin, sluggishness, excrements containing slime or bubbles. If such fishes are noticed, take them out immediately and treat them taking advice of a fisheries expert.

**(f) Overheating of pool water :** During the spells of peak summer, the pool water, exposed to sun, may get overheated. To deal with such situations, it is desirable to provide shady patches towards deepest zone of the pool.

**(g) General threats :** If any goldfish is missing, don't ignore the event, search for the culprit. It may be a naughty boy from neighbour's house, greedy cat or a rat, snake or a frog, or birds like kingfisher, heron etc and take appropriate measures accordingly.

**Table-1 :** Project cost for Ornamental fish Hatchery (Hatchery Tank area ( sq.m) 100 Hatchery total area (sq.m (330)

| Item of investment | Quantity | Rate in Rs. | Total Cost |
|---|---|---|---|
| **A. Building & civil works** | | | |
| 1. Hatchery shed with A/C sheet roofing & side wall (sq. m.) | 330 | 1200.00 | 396000 |
| 2. Tank volumes (lts) | 60000 | 1.25 | 75000 |
| 3. Flooring (sq. m.) | 200 | 10.00 | 2000 |
| 4. Drainage pit and net work | | | 12000 |
| 5. Water supply net work | | | 3000 |
| 6. Filtration system / outlet | | | 3000 |

| | | | |
|---|---|---|---|
| 7. Electrification and Installation | | | 5000 |
| **B. Machinery & Equipments** | | | |
| 1. Air blower (3 hp x 1 no.) | | | 12000 |
| 2. DG set (8 hp with 6/8 KVA alternator) | | | 36000 |
| 3. Heater | | | 3000 |
| 4. Sand filter | | | 2000 |
| 5. Pump (3 HP) | | | 17000 |
| 6. Tube well | | | 40000 |
| 7. Pump House | | | 5000 |
| **C. Misc. Fixed Assets** | | | |
| 8. Plastic pools | | | 5000 |
| 9. Glass aquarium | | | 3000 |
| 10. Lab instruments | | | 2000 |
| 11. Glass wares | | | 2000 |
| 12. Furniture | | | 2000 |
| **D. Preliminary Expenses** | | | |
| ● Preoperative expenses | | | 20500 |
| Total | | | **645500** |
| **E. Recurring cost** | | | |
| Cost of Brooders | | | 5000 |
| Feed | | | 10000 |
| Medicines | | | 500 |
| Electricity | | | 3000 |
| Miscellaneous | | | 2000 |
| Labour | | | 10000 |
| Total | | | **35500** |
| **Total cost** | | | **676000** |
| **F. Production / Income** | | | |
| Summer /Monsoon species | 150000 fry | 1.00 / fry | 150000 |
| Gold Fish | 50000 fry | 2.50 / fry | 125000 |
| **Total Income per year** | | | **275000** |

## 5.4 Conclusions

Worldwide, the keeping of ornamental fish in aquaria is a popular hobby; aquaria are a regular sight in many homes, in workplaces and other public spaces. Nowadays keeping ornamental fish in home aquaria for internal decoration, in shopping complex, restaurant, and reception hall and waiting hall has become the symbol of their social status. Ornamental fish keeping is considered as the best hobby. Even then it removes mental stress from the minds of brain working people. Ornamental fish has emerged as a resource with considerable economic potential. With many millions of fish being transported around the globe, many well beyond their natural range, importation of aquarium fish is seen by many countries as a major potential source of invasive species. India is endowed with rich resources of freshwater and marine ornamental fishes. India can certainly become a major contributor in international trade of ornamental fishes. Culture and breeding of ornamental fishes can be a promising alternative for many people as well as unemployed youths. For ornamental fish farming, only a clear understanding of habits and biology of the fishes is required. The profit of ornamental breeding and rearing unit depends upon the carrying capacity, candidate species, management practices and infrastructure. It is better to rear the fish to an optimum size and get more profits rather going for large scale.

## 5.5 Summary

Ornamental fishes are the most popular animals in the world and aquarium keeping is gradually replacing outdoor leisure activities. Ornamental fish keeping is the second most popular hobby of the world next to photography. The course Aquarium fish keeping is incorporated with biology, food and feeding, packing, transportation and marketing of ornamental fishes as well as maintenance of aquarium. Aquarium fishes are mainly categorized into two groups namely, egg layers (oviparous) and live bearers (ovo-viviparous). Majority of aquarium species are egg layers and normally external fertilization occurs.

Biology of the some Indian ornamental fishes i.e., Guppy, Molly, Green swordtail, Goldfish, Bluering Angelfish, Clown Anemonefish, Vagabond Butterflyfish and Zebra fish have been discussed here.

Variety of artificial feeds in the form of floating pellets, powder granules, flakes, tablets etc. are available. Organisms like *Brachionu, Moina, Daphnia,* C*yclop, Artemia,* tubifex worms and chironomus larvae etc. serve ideally as food for the aquarium fishes. Infusoria are also used as natural feed of the ornamental fish. Infusoria belong to the Class Ciliata and under the Phylum Protozoa of the animal kingdom.

The ornamental fish as well as aquatic plant industry is fast gaining importance due to its tremendous economic opportunities and prospects. This sector assumes special significance due to its huge potential in providing employment to the people hailing especially from rural sector and as a foreign exchange earner. Ornamental fishes intended for marketing, both domestic and export have to use modern post harvest technology or modifications of the current post harvest technology to improve the post harvest survival and post shipment survival that is critical to the industry. Therefore, packing methods should take into account the species being shipped and the expected time in transit. Recently the mortality rates during fish catching, collection, transportation are very high.

The low production cost and higher returns within a very short time span, involvement of a wide variety of ornamental organisms, ever growing demand for fishes both in the domestic and international markets and the scope for development of new accessories to cater to the dynamic needs of the sector are the major attractions when compared to any other sector. Ornamental fisheries bestow several benefits through aesthetics and recreational values, and provision of foreign exchange and employment, resulting in improved economies and poverty alleviation especially in the developing countries.

In the ornamental fishery sector, besides the fishes all other items/materials /accessories which are required to maintain an aquarium and rearing of fishes viz. weeds, aerator, filter, feeds, air stone, medicine, live and dry feed-all these are produced / manufactured and supplied by this unit. These are very important part of this trade. The real development of this trade is only possible if all the people of the above mentioned areas get required assistance to improve their respective areas.

Water quality determines not only how well fish will grow in an aquarium operation, but whether or not they survive. Fish influence water quality through processes like nitrogen metabolism and respiration. Some water quality factors are more likely to be involved with fish losses such as dissolved oxygen, temperature and ammonia. Others such as pH, alkalinity, hardness affect fish, but usually are not directly toxic. Each water quality factors interacts with and influences other parameters, sometimes in complex ways. The importance of each factor, the determination method and frequency of monitoring depends upon the type and rearing intensity of the production system used.

Ornamental fishes also known as ‘live jewel’ are kept as pets in confined spaces of an aquarium or a garden pool with the purpose of enjoying their beauty for fun and fancy. A garden pool together with a variety of flower beds for decorating its margin and rewarding means of landscaping a new place. A garden pool holding colourful ornamental fishes and water lilies indeed makes a lovely refreshing sight to anybody’s eyes. By the

strategic placement of a pool just outside a window, one can bring the beauty and serenity of colourful fishes and water-borne flowers right into the house.

## 5.6 Selected questions

(i) What are the criteria for selecting good quality ornamental fishes for aquarium ? How do you sort out the bad ones ?

(ii) How an under-gravel filter works ? What are the other types of filters for aquarium ?

(iii) Describe the ideal sites for setting a home aquarium. How would you like to keep the lighting arrangements for displaying ornamental fishes in a home aquarium to their best effect ?

(iv) What are the important do's and dont's of aquarium keeping ?

(v) Why garden pools are stocked heavily than the normal ?

(vi) During the course of maintaining a garden pool, what sort of worry-causing situations one come across? How they should be dealt with ?

## 5.7 Suggested readings

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# NOTES