Farming Ornamental Fish

By Shane Willis MSc
Email: shanew@natiaquaculture.com

NATIONAL AQUACULTURE TRAINING INSTITUTE

OFI Executive Board Member

There are thousand's of species of freshwater fish sold throughout the world in the ornamental fish industry. While traditionally, many of these fish have been captured from the wild, there has been an increasing trend towards captive breeding over the past twenty years. Indeed, as many as 90% of freshwater fish now sold in the hobby are farmed. To this end, this series of articles is aimed at providing information for new producers in the industry in production techniques.

Options for growing ornamental fish

Successful production of ornamental fish (like all aquaculture ventures) is dependant on a range of factors, the most important being:

- The climatic and water quality conditions needed by the species
- Quality and quantity of water available
- Land availability, topography, geology and soil type
- Infrastructure including access to markets (airports, roads), utilities (electricity, gas etc)
- Skilled and unskilled labour

When selecting a site to establish an ornamental fish production facility, the above factors will play an important part in the success of the venture. These factors will also influence the type of technology that is best used for producing the fish, and the amount of inputs (costs) used and level of stocking of the fish or stocking density. The 3 types or classes can be defined as:

1. Extensive – low cost, low stocking density, low output
2. Semi-intensive – medium cost, medium stocking density, medium output
3. Intensive – high cost, high stocking density, high output.

In general, the more intensive that production becomes, the more expensive it is in terms of capital costs (ponds, tanks, pumps and other equipment) and operating costs (food, electricity, labour and other inputs) due to increased management needs of the system. However as intensity increases so do yields and a greater financial return can be realised per unit volume. The following section provides more detail on the different production levels.

Extensive culture systems

The most basic extensive system would be wild collection. This model is particularly suited for people with little or no money to invest in tanks and other equipment – as long as they have nets or similar they are able to catch fish.

Figure 2: Wild collection requires very little equipment to start

However, this type of subsistence wild collection typically leads to poor quality fish and high mortality which reduces the financial return to the collector. This is also the case in India where mortality of wild collected fish is often high due to poor training of collectors and inadequate holding systems and practices.

Another example of extensive production systems is pond culture of fish. A pond or dam usually consists of shallow ponds with large surface areas – these ponds may be man made or could be parts of rivers or flood areas that are sealed off to prevent them draining. Water for the ponds is generally limited to run-off from surrounding catchment area and/or rainfall, which can make it difficult to manage the water quality and provide good conditions for the fish. Run-off can also be contaminated with agricultural chemicals such as pesticides or herbicides that are toxic to fish and sediment which can affect gill function or compromise water quality. Rainfall is also intermittent and run-off water may not always available to provide water changes.

Figure 1: Basic earthen ponds are one of the most common systems used for ornamental fish

The main food for the fish comes from naturally occurring plankton within the pond. This plankton generally consists of microalgae species and zooplankton such as Moina, Copepods and various other invertebrate species. The amount of these natural foods may be increased through fertilising the ponds to stimulate microalgal growth. While artificial fertilisers such as superphosphate can be used, animal manures are generally used due to the low cost and availability. Artificial feeds are not used. The yields are generally low and growth or survival is often limited by the amount of suitable foods in the water. Yields or productivity are typically between 400 - 1,000 kg/ha (a 5cm comet weighs around 5g, this would be 80,000 to 200,000 5cm comets per hectare)

Semi-intensive culture systems

Semi-intensive production generally consists of smaller ponds man made

ponds of less than 1 ha – for ornamental fish culture they are typically even smaller than this with a surface area typically 200 – 500m^2. These ponds are generally specifically made to allow the ponds to be totally drained and filled again. Water changes may be carried out using water from wells, streams in addition to rainfall and run-off.

Ponds are often fertilised with manures or artificial fertilisers to stimulate algal blooms and supplementary feeding of artificial feeds is given to the fish in addition to the natural feed available in the pond. Additional aeration may be supplied through paddle wheel aerators or similar to ensure Dissolved Oxygen levels remain within safe limits (4ppm and above) particularly at night when algal blooms can significantly reduce oxygen levels.

Yields are higher than extensive system, typically 1,800 - 3,600 kg/ha (a 5cm comet weighs around 5g, this would be 36,000 to 72,000 5cm comets per hectare).

Intensive culture systems

Intensive culture systems use relatively smaller culture units (ie tanks, raceways, ponds less 0.4 ha). Ponds are generally not fertilised and much higher rates of water exchange are carried out to ensure good water quality. Mechanical filtration to remove solids and biological filters to remove nitrogenous fish wastes are also used to help maintain water quality. The fish are fed solely on artificial feeds and generally receive no natural feeds from the culture unit.

Stocking are significantly higher and operators need to have a much higher level of competence to deal with the added complexity and risk involved with stocking fish at these higher densities. Yields are much higher and can exceed 500,000 kg/ha (5cm comet weighs approximately 5g 100,000 comets per ha).

Pond Culture of Ornamental Fish

Pond production of ornamentals is probably the most commonly used system for growing ornamental fish. Traditionally, most Asian production of ornamental fish has been undertaken extensively, using static outdoor ponds or tank systems with little or no water exchange. However, there is an emerging trend towards the intensification of production and most producers would use semi-intensive production systems. Water quality is

generally maintained through regular water changes and aeration – some producers also use biological filtration to help maintain water quality.

Ponds or tanks are fertilised with a mixture of organic (eg. manure) and inorganic (eg. superphosphate) fertilisers to encourage zooplankton growth. Supplementary feeding is also undertaken with pelleted feeds and/or wet mash foods that are prepared from plant and fish meal. These types of production systems are extensive in nature, characterised by low stocking densities and low levels of management input. They have the advantage of being simple and cheap to operate, and requiring low levels of capital investment.

However, these production systems provide little opportunity to control the culture environment and can result in production of poor quality fish. Disease control is also difficult to effect, with treatment or exclusion of disease often difficult. Similar culture methods are used in places such as Florida, USA, where a large industry supplying the USA and Europe has developed.

Production of Ornamentals in Indoor Facilities

In most western countries, more intensive production systems are used. These are characterised by:

- the use of smaller culture units, generally aquariums up to 200 – 300 Litres,
- greater reliance on artificial feeds such as pellets or crumbles,
- higher stocking densities – guppies can be grown at up to 20 fish per litre,
- greater environmental control and higher capital cost are utilised in cooler climates such as Europe, the United Kingdom and northern USA – this may include insulated buildings and large heaters.

These systems are generally housed in insulated buildings that are heated to 28 to 30°C to obtain consistent water temperatures of around 27°C. Glass aquariums are sometimes used to provide good visibility of fish, particularly for keeping and spawning broodstock.

However, these culture units are more expensive to purchase and maintain compared to larger plastic/fibreglass tank systems. Light is normally provided by fluorescent tubes with photoperiod of 14 hr light:10 hr dark maintained.

Production differences for species groups

The following sections provide more detailed information on the breeding and production of some of the more popular ornamental species groups. However, it must be noted that this information should only be used as a general guide as differences between the performance of individual species exist within these group. It should also be remembered that the most suitable production strategy for individual producers will depend on a range of factors as outlined above.

Carps and Barbs

This group includes species such as Koi carp, goldfish, Danios and Barbs, with approximately 35 species in the group. They are regarded generally as voracious egg eaters, so eggs need to be separated from parents as soon as possible after spawning. Some form of substrate (eg mesh netting, plants, fibrous material) is normally provided for the eggs to fall into to protect them from being eaten. Species from is group are often spawned in colonies of 20 to 40 fish (2 males:1 female) in 200 L tanks. The parents are removed once eggs are noticed in the tank, with the eggs hatching within 24 hours of release. Fry begin feeding on rotifers and Artemia within a further 24 hours. The fry are then ready to be stocked directly into fertilised ponds or tanks.

Barbs and carps should be kept with sexes separate for conditioning, and fry maintained indoors for at least two weeks before stocking into ponds or tanks. Most species reach market size by four months at a size of 4 cm. While the majority of species within this group are relatively easy to produce, species such as sharks and knife fish may require the use of induced spawning techniques.

Livebearers

Livebearers produce fully formed fry rather than eggs and are classed as having a viviparous reproductive type. In general, livebearers are capable of producing fry every 28 to 35 days (depending on species) at a temperature of approximately 25^{o}C. The number of fry produced per batch varies from ten for small guppies up to 300 for larger swordtails. Most livebearers have a useful reproductive life of 12 months, after which time fecundity is reduced.

Cannibalism of fry by siblings and parents is normal, therefore, floating plants or some form of shelter must be provided for fry. Harvesting of fry must be undertaken daily. Livebearers reach market size

(approx. 4cm for guppies and platys and 5cm for mollies & swordtails) within four to five months. Sexual maturity can be reached within eight weeks of age and can cause growth depression. To avoid line breeding, sexes should be segregated by this age.

Livebearers may be fed powdered dry feeds from first feed, although the provision of some form of live feed for the first two weeks can increase growth rates of fry. Broodstock do not require any special requirements for conditioning, although again, the provision of live feed may increase the fecundity and health of fry.

Production is generally undertaken in ponds up to 1.5m deep. Typical production pond sizes in Florida are 6m x 24m, while in Asia they are 5m x 10m. Ponds are fertilised with inorganic and organic fertilisers to generate an algae bloom prior to stocking with six to eight month old broodstock. The stocking density of broodstock varies with species with average stocking rates of 300 guppies per 5m x 10m pond, 400 platys per pond, 200 swordtails per pond are used. Supplementary feeding with pelleted feeds or wet mash consisting of cooked animal meal and cereals is provided five to six times per week in the late afternoon. Selective harvesting of the ponds is commenced after five months using a variety of methods that include the use of seine netting, fish traps or the draining of ponds. Ponds are normally drained, dried-out and restocked every one to two years to ensure high productivity and to minimise the likelihood of inbreeding. Liming of the pond can also be used to reduce disease organisms and balance soil pH.

Tank culture of livebearers is also undertaken, with broodstock being kept in large tanks at a ratio of two females per male (normally 100 fish stocked into 200L tank). Harvested fry are transferred daily to nursery tanks, where they are kept at a density of up to 20 fry per litre. The density is reduced during growout to around three fish per litre at market size. Considerable research into the development of more intensive culture methods is being undertaken. Supplementary feeding with pelleted feeds is considered necessary throughout the production cycle. Fish are generally harvested for sale within 16 to 20 weeks.

Anabantids (bubble nest builders)

The Anabantids include species such as Gouramis, Siamese Fighting Fish and Paradise Fish, which all breed similarly, with the males constructing and maintaining a nest of air bubbles in which eggs & larvae are incubated (differences are mainly in the size of bubble nests and the degree of parental care by males). This group is best spawned in tanks rather than ponds and fish should be bred as pairs. The number of eggs per spawn varies between species, ranging from 100 eggs for small species (eg. dwarf gouramis) up to 30,000 eggs for large species (eg. kissing gouramis). Breeding tank size varies, with 10 L tanks being suitable for smaller species and 500 L tanks for larger species.

A suitably conditioned male will begin to build the bubble nest soon after being introduced to the breeding tank at 27 to 30°C, with spawning generally occurring in the evening. The female should be removed from the tank immediately after spawning. Eggs normally hatch within 24 to 48 hours (depending on the species) at 27°C.

Fry become free-swimming within 48 hours, after which time the male is also removed from the tank. The fry are fed on live feed such as infusoria, paramecium and microalgae for first feed, with artemia introduced after two to three days. Weaning onto pelleted food occurs after two to three weeks, at which stage they can be stocked into fertilised ponds or grow-out tanks (up to 200 pairs may be spawned at a time to provide enough fry to stock a pond or tank). Stocking densities of two fish per litre can be achieved at market size.

Cichlids

Cichlids are a very important group of ornamentals and also contain important food fish species such as Tilapia. The cichlid family includes about 500 species. About 70% of these are suitable for use as ornamentals. This group is generally difficult to breed and requires specific water conditions in relation to pH, water hardness and mineral content.

Reproductive strategies vary considerably from substrate spawners to mouth-brooders, with all species displaying high levels of parental care of eggs and fry, and are not as suited for pond breeding. Cichlids also have considerable size differences between species, from four to five cm up to more than 60 cm, and accordingly, produce a range of egg numbers from 100 up to several thousand for large species. Most species breed as pairs and often mate for life. Tanks with a thick layer of sand and gravel are normally used, with pieces of slate (or similar) and some sort of cave or cover provided. Once the pair has spawned, they generally care for the eggs and fry. However, they are known to eat eggs, so higher productivity can be achieved by removing the eggs for artificial rearing. Eggs generally hatch after two to three days at 27°C, with the fry free-swimming seven days after swim-up.

Most species produce fry that are relatively large and are capable of feeding on Artemia at first feed. They are generally weaned onto dry foods within three weeks of swim-up. After weaning, fish are stocked into fertilised ponds or tanks and reach market size within three to five months, depending on species.

Tetras

Tetras are generally considered easy to breed, however, water chemistry plays a major role in fertility and hatch rate of eggs. In particular, tetras prefer soft, acid water for spawning and growth. Sexes should be conditioned for spawning separately, and spawned as pairs similar to carps and barbs. Parents should be removed soon after spawning which

usually occurs within 24 hours of mating. The eggs hatch between one to several days after spawning depending on species and fry are generally free swimming after a further 24 to 48 hours.

As these species are generally small, rarely exceeding 5cm at maturity, fry are small and need to be fed on Infusoria, paramecium, rotifers and microalgae, with Artemia after three to four days and weaning onto dry food after two to three weeks. Fry must be fully weaned before being stocked into ponds or grow-out tanks (ie. three to four weeks old). Fish generally reach market size after three to four months at three to four cm in length.

Catfish

There are over 150 species of catfish, with the most popular from the genus *Corydoras*. Spawning of catfish is generally difficult, with many species rarely breeding in captivity. It is important that sexes be held and conditioned separately until spawning. Environmental conditions such as water quality and photoperiod are important cues for spawning. Catfish are generally considered unsuitable for pond breeding and are bred in tanks. Induced spawning techniques are also sometimes used, particularly for larger species.

Corydoras are spawned in pairs or groups (2 males: 1 female) in tanks with cool fresh water. A drop of 2 to 5°C or low-pressure fronts can often stimulate spawning. Parents do not eat eggs and young and can be safely left with them.

Most catfish are generally benthic scavengers and should be provided with a diet high in organic matter. Catfish are generally stocked at low density with other species in ponds or tanks (ie. polyculture). Under polyculture conditions, it is important to keep fish of similar size to prevent aggressive interaction between species.

This paper has been the first in a series produced by the National Key Centre for Aquaculture Pty Ltd or NATI. NATI is an Australian based company that supplies high quality training and consultancy for aquaculture and ornamental fish. NATI has experts with more than 100 years combined experience in most areas of aquaculture from Salmonids, Abalone, Barramundi, Prawns, Pearl Oysters, Marine Ornamentals including corals and invertebrates, and freshwater ornamental production, export and marketing.