Chapter 10
Fish husbandry

Broodstock selection
A classic mistake made in fish farming is assuming that all fish of one species are the same. In any type of farming, be it stock (cattle, sheep, goats, chickens, pigs) or crops (maize, cotton, sorghum, fruit), selection of the founder stock is highly important. So it is with fish. Too often people have assumed that any tilapia, barbel or carp from the local dam or hatchery are suitable. The reality is that while stock selection with animals such as cows is highly developed in southern Africa, this is not the case with fish. For example, no one would consider starting off commercial ranching with poor-quality cattle purchased cheaply at a backyard sale, and great efforts and high prices are paid for quality founder stock such as stud bulls, disease-resistant seed, and fast-growing hybrids. Likewise, the production of tilapia greatly improved in the Far East with the development of genetically improved farmed tilapia, which was developed in the Philippines in the late 1990s. This is a highly developed strain of the Nile tilapia (*Oreochromis niloticus*) which was selected for its rapid growth, good body form and red colouration.

When buying fish fingerlings, consult your local aquaculture officer to assist you in identifying a hatchery that produces quality fish. It is an unfortunate reality that the freshwater fish stocks offered by many hatcheries in South Africa at present, with the exception of trout, are of worse quality than wild-origin fish!

What are the essentials in identifying good founder stock to breed from?

- The population must have a wide genetic base and not be inbred. Unless the hatchery of origin advertises a program of stock selection, and specializes in quality fingerlings, avoid mass-production hatcheries, especially those who cannot show any quality control. Also avoid obtaining fingerlings from the 'guy next door' who probably also has inbred stock.
- The fish must show good growth characteristics. How can you ascertain this? There have been numerous scientific studies done by universities and other research institutions on wild or other populations of tilapia, barbel and carp. Researching these can lead you to wild stocks of good quality with a wide genetic base.
- In the case of tilapia (*O. mossambicus*), use a founder stock from the cooler parts of the natural geographic range of the species (such as the Eastern Cape), where the fish will have developed a natural tolerance to cooler conditions and will grow at lower temperatures than the local strains. Tilapia from the Eastern Cape are more cold tolerant than those found in Limpopo, Mpumalanga and KwaZulu-Natal. Here temperatures of down to 9.5˚C are tolerated and the fish may grow up 2.4 kg, reaching >400 g in mass during the first year of growth under wild conditions at temperatures in the mid-teens to low 20s˚C.
- Inbred fish (e.g. barbel and carp) often have reduced tolerance to disease. In the case of barbel, the best fish probably come from the lower Vaal and Orange River systems. Carp have been highly developed and selected for improvements by aquaculturalists over the years and deep-body fast-growing forms are available that give better performance than wild strains.
- Trout produced by hatcheries in South Africa are often of good quality, and may have some improved tolerance to higher temperatures than imported strains from Europe or the USA.

Rural farmers in Egypt buying *O. mossambicus* fingerlings from a reputable farm. This is important as fish from good genetic stock will grow faster.

Farmers in Egypt breed tilapia using simple techniques. They net ponds were tilapia have dug 'nests' (far left). The female tilapia swims around the nest with fertilized eggs in her mouth. The eggs are collected from the fish and placed in glass bowls. When the eggs hatch, the larvae swim out of the bowls and into a larger tank where they are collected.

Maintenance of broodstock

One of the essentials of good animal husbandry is the high-quality care taken of broodstock year round. Emaciated or diseased stock can hardly be expected to perform well when called upon to breed, so the conditions under which breeder fish are kept is paramount to their performance. Generally, with the exception of trout which will not breed under culture conditions (but have to be stripped of their eggs and milt), it is best to keep males and females separately to prevent wild-spawning. Tilapia, barbel and carp should be kept in as large a pond as possible, at low density (less than 1 fish per 5 square meters pond area), and be well fed. If year-round spawning is desired then some form of heating will be necessary, such as by enclosing the pond under tunnels to elevate the temperature to 20˚C or more. Ponds should be protected against predators such as birds by using bird-netting and by low walls to keep out otters, leguaans and platanna frogs. Also, wild fish should not be able to gain access to the ponds and all inlets should be screened. The fish should be supplementally fed, and the pond enriched on a regular basis to encourage plankton growth. Broodstock should be replaced at regular intervals and a breeding span of not more than 3-4 years is considered the maximum for most fish from southern Africa (except carp which can be used for up to 10 years). Trout are usually ineffective breeders after 2-3 years as they are a short-lived species.

Breeding techniques:

Barbel (*Clarias gariepinus*)

Barbel are spawned artificially in aquaculture as natural spawning is haphazard and uncontrollable. Ripe fish of 2-4 kg are used and kept under prime conditions until the water temperatures reach the mid 20s˚C. Females will be noticeably swollen in the belly with thousands of ripened eggs, and the ovipositor will look swollen and apparently inflamed. As male barbel do not easily release their milt and females their ripe eggs simultaneously, an injection of pituitary extract is required for both sexes. This can be achieved by injecting either with commercially available hormone treatments or homogenized pituitary glands from another mature catfish. This is a skilled procedure and best left to competent hatchery technicians who will remove the pituitary gland from sacrificed males and inject the pituitary extract into fish of both sexes. The pituitary glands can be stored in ethanol for up to 18 months before being mashed up and mixed with sterile water or pure rainwater before being injected intramuscularly into the fish at a dose of 1.5:1 (donor : recipient weight basis).

Injected females should be separated to eliminate aggression. After approximately 20 hours at 22˚C (sooner for warmer temperatures), the females should be fat and full of eggs and therefore ready for stripping. If the female can be held in a head-up position while the eggs flow freely from the genital pore, the eggs are ready for fertilization. The testis from two to three sacrificed males should be used for fertilisation as it will increase genetic variability and reduce the risk of one male being infertile. The sperm should be diluted in physiological saline (2% NaCl) before being mixed with the eggs. If fertilization is performed by squeezing sperm from the testis directly into the eggs in a bowl, some water should be added (as it activates the sperm) and then mixed in thoroughly.

When added to water, the fertilized eggs become sticky on contact; these can be spread onto screens made from mosquito mesh, using running water to keep them well-oxygenated, and they will hatch after 24 hours. Egg development time is temperature dependent (24 hours at 26˚C; 18 hours at 28˚C). When hatching occurs the free embryos will fall to the bottom of the tank. Once a few larvae have hatched the rest will hatch soon after. The larvae feed on their yolk sac for the first few days but require additional livefood three times a day (such as *Artemia*) from days 3-5 before they are weaned onto an artificial diet. Larval rearing is restricted to a 10-15 day period during which the fish are kept indoors and fed on a dry feed every few hours.

The juveniles should be fed a yeast-based diet and regularly size sorted to prevent cannibalism

of the smaller ones by the frequent 'shoots' which outgrow the rest. High mortalities can be experienced at this stage because the young are fragile. Once they have reached about 50 mm they become far more robust and can be stocked into plankton dams for on-growing, before stocking into grow-out ponds.

Barbel need efficient hatchery conditions to be spawned successfully in large numbers, with large well-covered holding tanks for the adults, and numerous small, clean tanks with filtered water for the fry.

Tilapia (*Oreochromis mossambicus*)
One of the inherent disadvantages of tilapia as an aquaculture species is its tendency to breed at an early age and small size, and thus overpopulate ponds with small fish. However, the availability and quality of tilapia fingerlings is not always certain, so breeding should be done in a controlled manner to produce quality even-sized fingerlings for stocking ponds. Tilapia start growing when water temperatures reach about 18-20˚C (16-17˚C in the Eastern Cape), which is usually during late September in South Africa. At this time fingerlings for onward growth should be available to take full advantage of the growing season of warm summer months. To achieve this, tilapia can be bred during winter in indoor tunnel-covered tanks where the water is kept 4-6 degrees warmer than outdoors. A method used is the 'Baobab Farm' type circular breeding arena (developed at the farm of that name near Mombasa, Kenya) which can be enclosed in a tunnel. Here the natural spawning behaviour of tilapia is exploited whereby the centre of the circular tank becomes the territory of male tilapia, with females attracted to their nests dug in the sandy substrate. Once they have bred, the mouth-brooding females retreat to the tank margins and eventually release their fry into an extremely shallow marginal area that is warmer and has inflowing water, attracting the fry, and from which they are easily collected. The females may then spawn again after a few weeks. The collecting process for the fry does not disturb the adults and relies on the natural instinct of the fry to seek shallow warm water, often of up to 35˚C at the tank margins, from where they can be 'channeled off' into other containments.

INFO BOX: CANNIBALSM IN CATFISH

- One of the essentials in culturing catfish is the need to frequently size-sort the juveniles as they grow, due to the prevalence of cannibalism.
- For example, juvenile *Clarias gariepinus* of 50 mm can eat their smaller siblings of 30 mm and must be removed to containers holding only similar-sized fish. These fish are called 'shoots'.
- Once shoots are removed, others will then become shoots in turn, and these need to be sorted out at daily or at 2-day intervals to reduce cannibalism.

Using such breeding arenas means that selected high-quality males and females can be used for breeding, and fry of a very young age, just post-release can be obtained. This leads to the possibility of using them for all-male production by sex-reversal processes using a feed laced with methyltestosterone for the first 10 days of their life. Use of such all-male stocks will then lead to more even production without all the inherent problems of precocious breeding, reduced growth rates, and over-population of the ponds with juvenile fish.

Sex-reversal in tilapia
The sex of tilapia appears only to be fixed during the first two weeks of exogenous feeding (feeding through the mouth after absorption of the yolk sac). This means that if juvenile tilapia are fed with methyltestosterone-laced feed for the first 21 days of their lives, the sex of the fish will become over 95% males. This has two advantages: first, male tilapia grow faster than females; second, if reproduction is halted in

There are many different ways to grow fish, even of the same species. For example, tilapia can be grown in tunnels or in large earthen ponds. Each system has its advantages and disadvantages.

ponds then all energy is diverted to body growth rather than egg production in the females, and a more evenly sized crop can be harvested instead of the typical stunted crop of undersized and largely juvenile fish so typical of mixed-sex tilapia culture.

To ensure that all the juvenile fish feed only on the hormone-treated feed, a high measure of control is required. Female fish are usually stocked for breeding at a ratio of 5 females per male and kept in small breeding containers like hapas, concrete tanks, small ponds or aquaria. When the females are seen to be mouth-brooding, the hatched eggs are removed and placed into well-oxygenated tanks. Once the yolk sac has been absorbed and the juveniles are ready to feed from the mouth, they swim-up, as a shoal, and can be fed solely on a prepared diet for 21 days. At this stage the tanks will require filtration, as the young fish will need to be fed at least three times per day, and the water quality must be kept at an optimum level. After the 21-day period, the fry may be about 15-18 mm in length, and at this stage the development of the gonads is fixed. Microscopic examination has confirmed that 95-98% of the fish will be sexually male, while the rest may show signs of both male and female gonad development. However, these apparently bisexual fish are usually unable to reproduce.

The actual manufacture of the feed is done by experienced feed-companies to ensure the correct mix of hormone and its stability in the feed. Micro-encapsulation is sometimes used to prevent the hormone from leaching out in the water before being consumed by the juvenile fish.

Tilapia rendalli

Tilapia rendalli are not mouth-brooders, yet are best spawned in the same way, as *O. mossambicus*. This species has much larger individual broods and can be successfully bred in simple earth ponds with a shallow end that can be partitioned off to collect the fry.

Carp (*Cyprinus carpio*)

Female adult carp are kept separately during winter, after which time their eggs will ripen. Once water temperatures rise above 20°C in spring, shallow breeding ponds (<1 m deep) can be prepared; these usually include a crop of grass or other vegetation that the carp can fix their spawn onto when introduced. Males and females are introduced and will often spawn within a few days, during which much activity will be noticed as the males pursue the females into the vegetation onto which they will lay their eggs. The eggs hatch after four days and the larvae are about 5 mm in length. The pond is then partially drained to remove the adults, which would otherwise consume part or all of the hatching eggs. For this to be successful, part of the pond edge must have a deeper channel section to allow for easier catching of the adults without disturbing the eggs on the vegetation. The ponds are then fertilized with manure to produce a plankton bloom that provides the fry with food for the first few weeks of their life. After the juveniles reach about 40 mm in length they can be collected and stocked into grow-out ponds.

Another method of spawning carp is by stripping and artificially incubating the fertilized eggs in large jars with through-flowing clean water in a similar way to the method of spawning barbel. However, male carp do not need to be sacrificed for their milt after injection (or sometimes even without injection) as this is free-flowing when the male is ripe and ready.

Trout (*Oncorhynchus mykiss*)

The spawning of trout is done by artificial methods in a way very similar to that for carp, whereby the males are stripped of their milt and this mixed with stripped eggs from ripe females. Trout eggs are relatively large and robust (in the wild the adults bury them under fine gravel in 'redds') but the eggs need high levels of dissolved oxygen to survive. Fertilized eggs are placed on screens in single layers in tanks, with cool flowing water (13-16˚C). The eyed ova are

Trout ova hatching trays (far left) and tanks with fry (left). Trout hatcheries require very good water quality.

often sold at this stage to other hatcheries, and hatched out elsewhere as they travel well in crushed ice. Trout will grow well from first feeding on artificial diets of finely crushed trout pellets, with a protein content of about 48%. Above all, trout need cool, clean water to prosper and will suffer numerous ailments if the water quality is not high.