CHANNEL CATFISH CULTURE: STATE OF THE ART 1976

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ABSTRACT

The perfection of culture techniques for the channel catfish (Ictalurus punctatus) *has been aided by the commercial demand for fingerlings, by the fact that the catfish is "precocial" by the time the yolk sac is absorbed, is not cannibalistic, and readily utilizes artificial feeds early in life. Several techniques have been developed for producing catfish fingerlings, but the method that appears most acceptable for the production of large numbers of fingerlings is by the pond spawning/trough incubation technique. The principal advantages of this method are that it makes possible a high survival of fingerlings and control of density in the rearing ponds. Where it is desired to mate selected individuals, the aquarium method or the pen method are particularly attractive. There is interest in tank rearing of fingerlings; however, due to the characteristics of the channel catfish, the authors question that this method will have any advantage over the pond method. Most parasitic diseases of catfish fingerlings are well understood, but their control has been adversely affected by legal restrictions on the use of chemotherapeutics. Currently there is need for further investigation, especially in genetics, economics of feeds, and techniques for maintaining desirable environmental conditions.*

A warmwater fish farming industry based on the channel catfish (*Ictalurus punctatus*) commenced to develop in the late 1950's. Inasmuch as the particular requirements of the industry, i.e., a warm climate and large quantities of ground water, are best met in the lower Mississippi River valley, this area is the center of the industry. In addition to being used for food, the channel catfish is produced in a much wider geographic area to support recreational fishing. For this purpose it is stocked in ponds and reservoirs, and in recent years farm-raised fish have become important for use in commercial "put-and-take" operations.

One of the weaknesses of the channel catfish as a species for use in commercial fish farming in the United States is the fact that it grows little, if at all, at temperatures below 21 C. Thus in much of this country the catfish grows for less than six months of the year. However, this does not detract from its importance for use in producing recreational fishing outside the area where it is grown as a food fish. Another undesirable trait of the channel catfish is its requirement for a high protein feed. A less serious negative trait of the species is its low fecundity. Despite these weaknesses, the channel catfish has emerged as the principal commercially produced warmwater food fish in the United States. In addition to its being a high quality food fish, the channel catfish is adapted to pond conditions, readily accepts prepared feeds, and control of its reproduction is feasible.

The development of culture techniques for the channel catfish has been favored by the commercial demand for fingerlings, and by certain attributes of the fish itself. Of particular interest is the fact that, unlike many other warmwater fishes, the egg of the channel catfish contains a large amount of yolk material. As soon as the yolk sac is absorbed, the young fish readily accepts artificial feed. Of particular importance in culture is the fact that the channel catfish is not significantly cannibalistic at any stage.

There is a great deal of variation in the facilities and procedures used in producing channel catfish fingerlings. We will describe facilities and outline procedures that appear to represent a reasonable state of the art. Other general discussions on fingerling production have been given by Crawford (1958), Martin (1967), and Giudice (1972). Another general discussion of the culture of the species is the Second Report to the Fish Farmers (Meyer et al. eds. 1973).

Ponds in which catfish are spawned, as well as those in which fingerlings are raised, should be 0.4 to 0.8 ha in size, with a minimum depth of 1 m and a maximum depth of 1.2 to 1.5 m. They should have a piped water supply and be designed to permit gravity draining.

A satisfactory hatching facility consists of troughs approximately 3 m long, 60 cm wide, and 25 cm deep, with several covered, wire baskets supported 2.5 cm above the bottom. The baskets are 25 cm wide, 41 cm long, and 5 cm deep. Extending the length of the trough is a shaft equipped with paddles that rotate between the baskets in which the eggs are placed. The troughs are supplied with approximately 7.5 liters/min of clean, well aerated water at a temperature of 24 - 27 C. The overflow is covered with a box made of fine-mesh screen.

A water supply of 500 liters/min per surface hectare is desirable for filling and maintaining ponds. The most satisfactory water supply is from a deep well, but surface water can be used. The latter is more likely to contain biological contaminants, other fish, invertebrate predators, and parasites, but they may be removed by a sand filter. Surface water is more likely to be contaminated with various pesticides. Well water is desirable because it makes available cool water that is necessary for handling fish in late spring and early fall. Well water is frequently characterized by being devoid of dissolved oxygen, having high carbon dioxide, containing ferrous iron, and may become supersaturated with nitrogen as it warms. When added in small quantities to maintain water level in ponds, none of these contaminants cause a problem.

The water supply for hatching troughs and holding tanks must be of higher quality than that used for filling and maintaining ponds. Surface water must be filtered to remove silt and plankton, since the troughs and tanks serve as a trap where these materials can accumulate and create an undesirable environment. Well water must be pre-aerated to bring the gases into equilibrium with the atmosphere. If iron is precipitated as a result of oxygenation, it must be removed by filtration. Water that requires heating should be re-aerated before being introduced into the hatching troughs.

There are two intensive methods of obtaining spawn, although not commonly used in commercial operations, they are valuable for mating specific fish; for example, in genetic work. In one of these methods, the fish are spawned in aquaria by the use of hormone injections. In the second, the ripe fish are confined in pens located in the edge of ponds.

Two methods are most commonly used in producing fingerlings on a large scale. The first involves stocking several pairs of brood fish per hectare, supplying cans or other spawning facilities, and permitting the fish to spawn and incubate the eggs. The young fish are left in the pond and harvested as fingerlings. The second method, which results in the highest production and offers the best control over population density, involves stocking 75 to 100 pairs of brood fish per hectare, placing spawning cans in the pond, and periodically removing the egg masses and incubating the eggs in hatching troughs of the type described above. It is also feasible to permit the male to fan the eggs during incubation and remove the larval fish after hatching. Since for most purposes the pond spawning/trough incubation technique is the most satisfactory, it will be discussed in detail.

Channel catfish as small as 0.9 kg will spawn, but this size fish produces only a small number of eggs. On the other hand, fish larger than 4.5 kg are difficult to work with. Fish weighing between 2.0 and 4.5 kg are thus most satisfactory for brood fish. Brood fish 2 kg or larger can readily be sexed by difference in the genital openings. They can also be sexed on the basis of coloration and body conformation, especially as they approach the spawning season.

The sexes may be held together over winter, but should be separated when the water temperature reaches 13 C in the spring. When the water warms to 21 C in the spring, the males and females are placed together in brood ponds. Spawning cans are placed at a water depth of 30 to 60 cm around the periphery of the pond. The cans are staked to prevent them from rolling, but it should be possible to lift them to remove the eggs. Once the cans are in place, they are partially lifted at 3-day intervals and inspected for eggs. For transfer to the hatching troughs, the egg masses are removed from the spawning cans and placed in a covered, flat-bottomed bucket containing about 6 cm of water. The egg masses are broken into clumps 3 to 8 cm in diameter and placed in the wire baskets in the hatching troughs. The flow of water through the troughs and rotation of the paddles are started as soon as the eggs are in the troughs. The pitch of the paddles is adjusted to impart a gentle movement to the eggs each time the paddles pass. The size trough recommended above will accommodate about 50,000 eggs.

In four or five days the eggs hatch and the larvae escape through the wire mesh and aggregate in masses on the bottom of the trough. When hatching is completed, the rotation of the paddles is stopped and the baskets are removed. The young fish subsist on their yolk sac for three or four days. When the larvae are observed to commence leaving the aggregations and searching for food on the bottom and sides of the trough, they are stocked in ponds at a rate of 125,000 to 250,000 per ha. They are fed trout feed formed into moist balls and distributed along the shoreline twice daily. After two weeks this feeding regime is discontinued, and the fish are fed unmodified, pelleted catfish feed once a day. Beginning with the smallest pellet, or crumbles, the pellet size and rate of feeding are adjusted as the fish grow. However, the feeding rate should never exceed 34 kg/ha per day.

Predacious insects, especially notonectids, can cause significant loss of young fingerling catfish. These insects can be controlled with methyl parathion at 0.25 to 0.5 ppm, or a film of oil on the pond surface. Loss of fish due to diseases and parasites may be significant. Fingerling fish held in hatching troughs often develop epizootics of *Trichodina*. This parasite may also occur after the fingerlings are stocked in the ponds. In the hatching troughs or raceways, fingerlings can be treated with 100 ppm formalin for 30 minutes in well aerated water. In the pond, if the temperature is below 18 C, the fish may be treated with 25 ppm formalin; at temperatures above 18 C, 1 to 4 ppm potassium permanganate can be used. As the water cools in the fall there is danger of *Ichthyophthirius*. An effective control for "ich" is a prophylactic treatment of 0.1 ppm malachite green when the water is 16 C in the fall and in the spring. Malachite green can also be used as a therapeutic treatment (Meyer 1967; Leteux and Meyer 1972; Schachte 1974). In warm weather the fingerlings may develop enteritis from aeromonal infections (Snieszko and Bullock 1976). The most effective treatment for this problem is the use of medicated feed containing either Furacin® (145 g activity/50 kg of feed for 10 days), or Terramycin® (91 g activity/50 kg of feed for 10 days) (Meyer 1967). In the winter epizootics of dactylogyrids may occur on the gills of the fingerling fish. The problem can usually be corrected with a pond treatment of 25 ppm formalin, or Dylox® (Masoten®) at 0.5 ppm (Meyer 1967). Additional information on the identification of diseases of catfish, as well as treatment for them, is given by Rogers (1971).

Fingerling catfish are harvested for restocking when they are 10 to 20 cm long. This is a larger "fingerling" than is used for restocking most other species. The use of exceptionally large size catfish fingerlings is related to the desire of commercial producers to start with a fingerling large enough to produce a marketable fish in one growing season. A large fingerling is also required in the management of recreational fisheries. Krummrich and Heidinger (1973) established that at least an 18-cm fingerling is required when stocking catfish in the presence of an existing bass population.

Fingerling catfish are harvested by seining, preferably when the water temperature is 13 to 24 C. At temperatures below 13 C, the fish are likely to be aggregated in deep water and difficult to seine; at temperatures above 24 C they become very excited and aggressive and are difficult to handle.

For marketing, the fish are held at a density of 24 g/liter of water in raceways supplied with enough water to result in an exchange rate of 30 minutes. The fingerlings are transported at 120 g/liter of water, with oxygen maintained by agitation, compressed air, pure oxygen, or a combination of these.

Areas in which one can anticipate significant developments in the immediate future include nutrition, genetics, intensive culture, the problem of chemical contamination, and the registration of fishery chemicals. In nutrition, means of reducing protein cost is a major concern. It has been proposed that synthetic amino acids, along with botanical proteins, may reduce the animal protein requirement in fish feeds (Sneed et al. 1971). However, Lovell (1976) reports that synthetic amino acids may not constitute a satisfactory substitute for animal protein.

Feeds used for open pond culture are not a complete diet for the catfish, thus the natural foods occurring in the pond make an important qualitative contribution. It is reasonable to assume that ponds vary greatly in quantity of natural food they afford, and thus in the qualitative supplement available to the fish. Prather and Lovell (1972) found that the addition of a vitamin package to Auburn No. 2 feed increased production by 19.3% and lowered food conversion from 1.39 to 1.16.

Little has been done on the genetics of channel catfish. Certain genetic problems have been identified; one of the principal problems is marked variation in growth. Meyer (1973) reported that fingerlings from five spawns that were stocked together after being branded exhibited distinct differences in growth between spawns. The growth rate of some averaged 50% better than others. Konikoff and Lewis (1974) have reported on variation in growth. Giudice (1971) suggested that there is evidence of problems resulting from inbreeding. He cites the increased number of deformed individuals and wide variation in individual size. Moav and Wohlfarth (1968) demonstrated that in carp, one generation of inbreeding siblings produced 10 to 20% depression in growth and reduced survival, as well as producing a larger number of deformed individuals. Roberts et al. (1970) published an excellent summary of the benefits to be expected from inbreeding and selection. They expressed the view that inbreeding, coupled with selection, can prove highly beneficial. Rapid progress toward standardization in methods of production and increased predictability of results suggest that the time is right for beginning a program of genetic improvement.

There continues to be an interest in the production of fingerlings in raceways, as opposed to growing them in ponds. Several individuals have succeeded to varying degrees in producing fingerlings under these conditions. An example of such work is reported by Stickney et al. (1972). However, it is questionable that the production of channel catfish fingerlings in raceways will be practical, in comparison to the open pond method. As pointed out above, the channel catfish fingerling is not cannibalistic, and does not require training to accept prepared feeds. As a consequence, it is practical to produce them at high density in ponds. This is not to say that intensive methods will not prove practical for producing edible size fish, but this question is beyond the scope of the present work.

In recent years, chemical contamination of the environment, especially by chlorinated hydrocarbons, has emerged as a major concern in fish culture. Such contaminants not only cause poor hatchability and deformity, but may also lead to fish being declared unacceptable for human consumption. Crockett et al. (1975) report that pesticide residues above FDA "action levels" were detected in 15% of all fish samples taken from 54 commercial catfish farms in Arkansas and Mississippi. They also found that pesticides in catfish were highly correlated with agriculture (especially cotton) and pesticide use. Neither water supply nor runoff appeared to be responsible for pesticide transport. The primary source of contamination appeared to be from the atmosphere.

Under most conditions the use of certain chemicals, particularly for control of parasites and diseases, is essential to success in fish culture. Chemicals suitable for control of practically all important diseases and parasites have been identified. However, the recent interest in environmental contamination, along with the establishment of investigative and regulatory agencies, have resulted in many of the most useful and important chemicals being declared illegal until their status can be re-evaluated. The present status of most of the chemicals in this category is given by Meyer et al. (1976).

In conclusion, the techniques for producing fingerling channel catfish, as compared to the techniques for producing fingerlings of most other warmwater fishes, are well advanced and dependable. Further investigations are especially needed on genetics, economics of feeds, and techniques for maintaining desirable environmental conditions.

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