MILKFISH NURSERY POND AND PEN CULTURE IN THE INDO-PACIFIC REGION

Dan D. Baliao
Aquaculture Department
Southeast Asian Fisheries Development Center
Tigbauan, Iloilo, Philippines

In culturing milkfish to marketable size, the fry (total length = 12-15 mm) are usually reared first in nursery ponds or pens (*hapa* nets) until they become fingerlings (total length = 2 cm or more). The fingerlings are then transferred to the grow-out ponds or pens where they are reared to marketable size. In some countries like the Philippines, fingerling production has become an industry by itself. This paper reviews the state of the art and constraints to and suggests future research directions for milkfish fingerling production in nursery ponds and pens.

INTRODUCTION

The culture of milkfish *Chanos chanos* (Forsskal) in brackishwater ponds is an age-old practice in tropical areas of the Indo-Pacific Region such as the Philippines, Taiwan, Indonesia, and Kiribati. Recently, developments in farming techniques have given rise to milkfish pen culture in the freshwater lakes of Laguna de Bay and Buluan in the northern and southern parts of the Philippines, respectively. Sri Lanka and India have tried to adopt the same techniques, but these are still at the experimental stage.

Milkfish is a well studied species, but much remains unknown about its growth, survival, and production as well as about its reproduction in localities which can be controlled or modified.

Indications are that milkfish production, whether by intensive culture or through expansion of area, is limited by the availability of fry. This depends in turn on how

efficiently the milkfish fry industry exploits the wild fry resource, and on progress in research and development on milkfish broodstock and seed production. On the other hand, production of healthy and/or stunted milkfish fingerlings in nursery ponds or pens depends on the techniques practised by the farmer.

Milkfish production in nursery ponds or pens, be it for fingerlings or for marketable size fish, is still far from realizing its full potential. This review updates and consolidates the state of the art of milkfish nursery in ponds and pens, and highlights relevant information gathered from available reference materials.

BRACKISHWATER CULTURE

Pond Design and Construction

Brackishwater ponds for milkfish in the Indo-Pacific Region historically followed a general design and construction methods developed through long years of experience. For centuries ponds were manufactured by compacting mud and clay around the periphery of an enclosure. The site was drained, and the material excavated from the bottom was used to form the embankment, which was raised to a level above the high water level at spring tide. Thus, the pond could be emptied or filled at any time during the spring tide and neap tide cycles.

Fishpond engineering gradually emerged from the traditional level into the more advanced. Mechanization was introduced to shorten construction time and lessen labor, and, recently, riprap for pouring concrete dikes can be observed at some sites. Construction of coastal fish farms has further emphasized the importance of workable pond elevation in relation to various factors such as size, shore development, and shape of the site. Despite these known technologies, there are some areas that remain underconstructed. The stage of development of milkfish farms varies greatly from one country to another and even within a given country, depending on the availability of suitable sites, the interest of the people, and the far reaching effects of local politics.

Valuable information has been published on fishpond engineering establishing criteria for farm site selection, layout, construction plans, and specifications (Jamandre and Rabanal 1975, Denila 1977, Tang 1975, de la Cruz 1979, Lijauco et al 1979). Kato (1980) discussed basic techniques in coastal aquaculture engineering in detail, presenting attributes of soil quality and quantity. He also recommended construction and installation of water control structures to regulate the exchange of water between the pond system and the tidal stream or sea.

In the Philippines, Rabanal (1974) and Lijauco et al (1979) noted that milkfish farms have been classified according to type of operation into (1) purely nursery system, (2) purely rearing pond system, and (3) combination system having both the nursery and the rearing pond functions. The first type consists mainly of nursery ponds and transition or stunting ponds. Fry are grown to fingerlings, which are sold to other fish farmers. The second system does not provide nursery ponds at all. In the complete system, the farm is apportioned into nurseries (1-2% of total area), stunting ponds (3-5%), and rearing ponds (85-90%) where fry, fingerlings, and marketable size fish are reared independently.

Lin (1968) stated that the layout of milkfish farms in Taiwan (Fig. 1) that are located at the central part of the island follows a scheme which includes (1) nursery

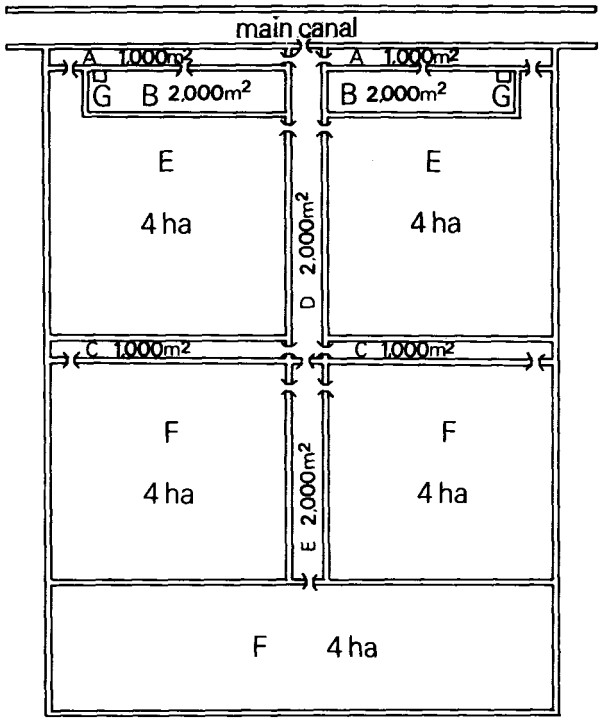

Fig. 1. Schematic sketch of a pond system of 21.2 ha. A, wintering ponds and passageways; B, nursery ponds; C, passageways; D, subcanal; E, subcanal and passageway; F, production ponds; G, acclimation pools.

ponds with small, built-in acclimation ponds; (2) overwintering ponds one-half the size of the nursery ponds, lying beside them and provided with a windbreak to protect the fingerlings from the chilly north wind; and (3) production or rearing ponds.

In the South Pacific, Gopalakhrisnan (1976) reported that nursery ponds are constructed to rear milkfish fry to fingerling size for bait.

Site selection, layout, and construction of brackishwater fishponds in Indonesia follow criteria similar to those in the Philippines (Jamandre and Rabanal 1975, Padlan 1979).

Natural Food Base

Rearing milkfish fry to fingerlings in brackishwater ponds is almost wholly dependent on natural food. The major concern of the fish farmer is establishing, propagating, and maintaining the natural food in the pond until the desired fish size and survival are attained. Concerted efforts are required for (1) the removal or eradication of residual pests and predators, (2) the application of organic and/or inorganic fertilizer to bolster the natural food, and (3) maintenance of good water quality favorable to both the stock and its natural food.

The types of natural food base commonly grown in brackishwater nursery ponds are *lumot, lablab,* and plankton.

Lumot. *Lumot* consists primarily of filamentous green algae such as *Enteromorpha* sp. and *Chaetomorpha* sp. The *lumot* method was common in the Philippines before the 1960s, but at present it is practised in only a few regions. Propagation is either by planting or by the broadcast method, and the algae are dressed with commercial fertilizer. Tang and Hwang (1976) stated that the reported species contain relatively high percentages of protein but have extremely low palatability and digestibility to milkfish, especially during the fry to fingerling stage. *Lumot* also interferes with the process of manipulating the milkfish fingerling population and competes with the stock for living space.

Lablab. This type of natural food complex consists of minute plants and animals which form a yellowish or greenish mat on the pond bottom. *Lablab* is currently used by most fish farmers because it is more nutritious and digestible than *lumot* (Rabanal 1974, Tang and Hwang 1976, Lijauco et al 1979). *Lablab* is grown by using a combination of organic and inorganic fertilizers. In Indonesia, *lablab,* locally called *klekap,* has also been used to rear milkfish fry to fingerlings to ensure rapid growth and a high survival rate (Padlan 1979).

To increase the carrying capacity of the *lablab* pond, Dureza (1977) used nylon screen strips arranged like tennis nets across the pond bottom to increase the surface area for the attachment of the mat. Verification of this method in two 1500 m^2 nursery ponds revealed that 0.005 g milkfish fry stocked at 50/m^2 had an average weight of 3.3 g and a 78% survival rate after 60 culture days (Baliao, unpubl.).

Plankton. This consists of minute plants and animals suspended in the water. Plankton are grown by the application of inorganic fertilizer to deep water (65-100 cm) ponds. The plankton method was developed because of strong indications that milkfish is a plankton feeder (Kafuku and Kuwatani 1976, Poernomo 1976, Tampi 1976, Vicencio 1977). However, Lijauco et al (1979) reported that, for some reason, the plankton method of culturing milkfish has not yielded consistently good results. The common practice is to grow *lablab* and switch to plankton towards the end of the culture period, when *lablab* deteriorates or fails to recover.

Advances have been made recently in supplemental feeding for milkfish fingerling production, but the practice still remains largely an art. The results of a recent study indicated that, at a stocking density of 75 fry/m^2, rice bran given as a supplementary feed to fry at 5% body weight yielded a mean survival rate of 71.5% (Villegas and Bombeo 1981). Lijauco et al (1979) recommended the same feed to fingerlings in transition ponds, where the culture period is prolonged from 6 months to 1 year.

Nursery Pond Management

Fry mortality has been observed to occur mostly between the time of collection and the time of stocking. This is attributed to poor handling techniques, the presence of predators, dirty facilities, and salinity or temperature shock. To minimize loss of fry, the fish farmer should sort out predators and acclimate the fry to temperature and salinity conditions (IFP 1973, PCARR 1976, Lijauco et al 1979). Camacho (1976) also recommended the use of an aeration system during acclimation, sorting, and counting to increase fry survival before stocking.

Milkfish fry are stocked in the nursery pond at the rate of 30-50 fry/m^2, usually in the early morning or late afternoon when the temperature is cool. It is recommended

that, before releasing the fry into the nursery pond proper, they should pass through an acclimation pool (Fig. 1) built within the nursery pond. Schuster (1969) and Huet (1969) mentioned that milkfish fry are first kept for a few days in a small pool or "baby box" built in the middle of the fry pond. This technique ensures that the fry are not subjected abruptly to the harsh conditions of the pond, which would make them more vulnerable to predation. Within 5-7 days they develop some scales and may be able to escape predation upon release into the nursery pond proper.

In the nursery pond, fry are nurtured until they reach fingerling size (2-5 g) after 1-2 months of culture. During this period the water inside the pond is replaced regularly, especially at spring tide cycles.

When the fry reach the fingerling stage (at a normal rate of 0.05 g/day), they are transferred to stunting or transition ponds, then stocked in rearing ponds. Over-wintering ponds in Taiwan, which are similar to stunting ponds in the Philippines and Indonesia, are built to protect the fingerlings from the low temperatures between November and March; water temperature is maintained at 16°C. Stocking density in stunting ponds is 15 fingerlings/m^2 (Lin 1968, Lijauco et al 1979). Supplemental feed (rice bran and/or peanut cake) is given daily.

In the South Pacific, milkfish fry stocked at 10/m^2 in nursery ponds reached bait size in about 8-10 weeks (Gopalakrishnan 1976). Further intensive trials in the region are being planned.

Camacho (1976) reported that, through the use of net enclosures *(hapas)* suspended in fertilized ponds, milkfish fry could attain an average weight of 1.5 g after 60 days of rearing at a density of 500-1000/m^3. Recovery ranged from 30 to 35%. The net enclosure provides a predator-free environment for the still vulnerable fry.

In Sri Lanka, newly arrived fry/fingerlings caught in lagoons in the northern part of the island are emptied into concrete holding compartments (3 × 25 m) where they are acclimated to brackishwater conditions. While in these compartments, they subsist mainly on natural food (plankton). Occasionally, poultry feed is given as a supplement. The fingerlings stay in the pond for a week or two, after which they are distributed for stocking in tanks, dams, and reservoirs (Baliao 1982, Villaluz et al 1982).

FRESHWATER CULTURE

Pond Culture

Not much has been done on the commercial production of milkfish in freshwater ponds in the Indo-Pacific Region, particularly on the production of fingerlings. In India and Sri Lanka, extensive culture of milkfish along with other finfish species like tilapia and carp has been undertaken in freshwater ponds, seasonal or village tanks, dams, and reservoirs with fingerlings coming from lagoons, tidal pools, or streams. Mane (1979) reported milkfish fingerling production in freshwater ponds by one fish farmer in the Philippines where 33-37% recovery was obtained, following the system used in brackishwater nurseries. At the Aquaculture Department of the Southeast Asian Fisheries Development Center, exploratory studies on the development of a seed bank for milkfish in fresh water showed 42% survival of fingerlings stocked in a plastic-lined pool (PCARRD 1982).

Pen Culture

Pen culture has been practised for many years in several countries, but to varying degrees of development (Table 1). Freshwater species being cultured include milkfish, carp, tilapia, and snakehead in the Philippines, and catfish and goby in Thailand. Marine species cultured are snapper, mullet, sea bass, sea bream, grouper, and milkfish (Anonymous 1979).

Fishpen design and construction. Fishpens are constructed in various sizes and shapes: square, circular, and rectangular. A variety of materials ranging from locally available to imported items has been used, including netting material (kuralon and nylon), bamboo, and wooden or palm poles. Depending on the substratum, the poles are staked in the mud at depths of 15-30 cm or more. For more details regarding design and construction of fishpens, refer to Alferez (1977), Marichamy (1979), and Felix (1980).

The milkfish fishpen industry. While culture of milkfish in fishpens has been done on an experimental basis in India (Marichamy 1979) and is at the initial stage in Sri Lanka (Jayamaha 1979), additional research in this industry appears imperative.

In the Philippines, commercial pen culture of milkfish was started in Laguna de Bay in 1971, covering an initial area of 9000 ha. Lately, the technique has been adopted in Buluan Lake in the southern part of the country. In Laguna de Bay alone about 5000 ha of fishpens produce an average of 5000 kg/ha per yr (Baguilat 1979). It is known that culture of milkfish in pens has some advantages, namely: (1) there is an

Table 1. Status of pen (p) and cage (c) culture in various countries, 1979 (Anonymous 1979).

Country	Operational		Initial		Planning	
	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine
Bangladesh					c	
Canada	c	c				
Egypt			c/p			
Hungary and Eastern Europe	c/p					
India	c	c/p				
Indonesia	c		c/p			
Malaysia		c	c			
Nepal			c			
Nigeria					c/p	
Philippines	c/p			c/p		
Siena Leone					c	c
Singapore	c	c				
Sri Lanka					c	c
Sudan					c	c
Thailand	c/p	c/p				c/p
Turkey					c	

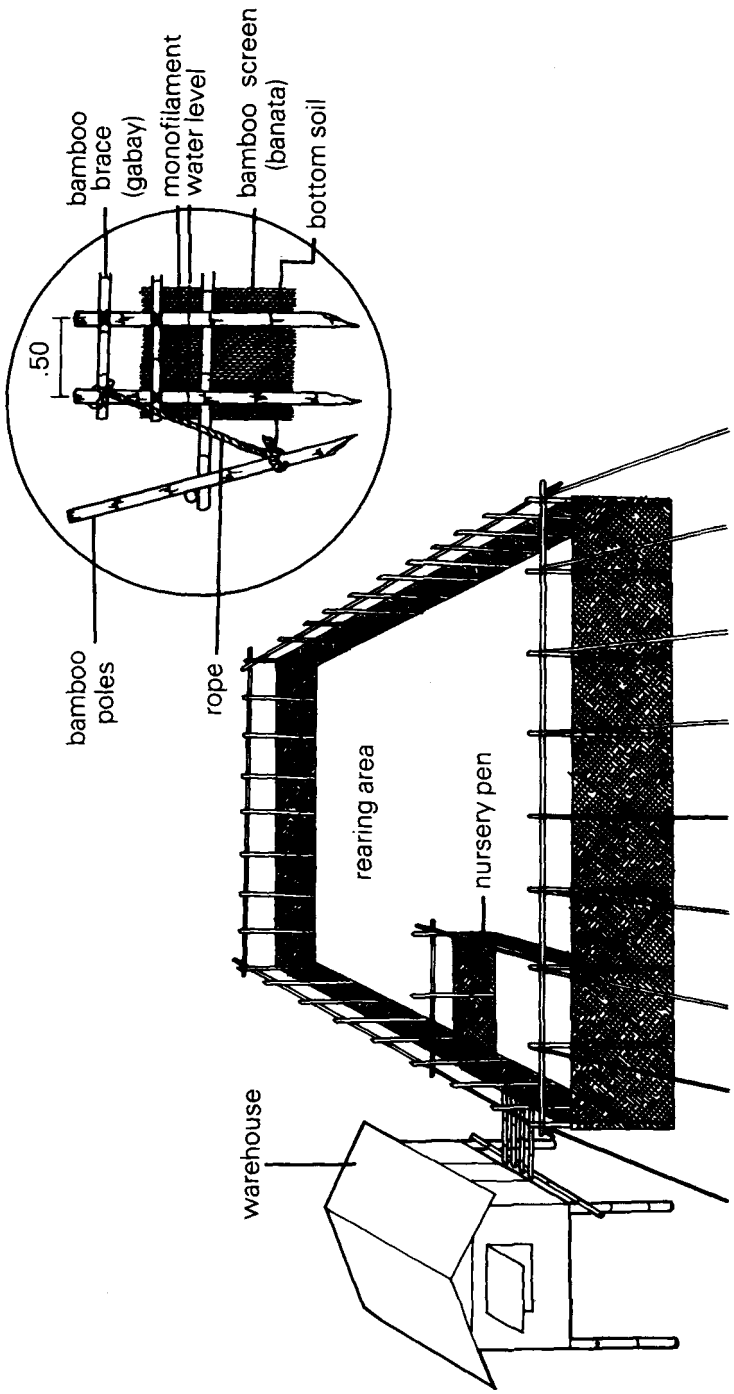

Fig. 2. A typical fishpen with a built-in nursery pen.

annual potential yield of about 5 t/ha, (2) an abundance of natural food in the lake makes supplemental feeding minimal, and (3) vacant areas adjacent to the pens serve as refuge and breeding grounds for other finfish species and thus provide a source of livelihood for lakeshore inhabitants. However, in selecting sites, one should consider a number of factors such as protection from the elements, water circulation, water quality, soil type, access, security, and other legal and social aspects.

Milkfish nursery pen operation. When milkfish production in fishpens was not yet developed in the Philippines, the only buyers of fingerlings were fishpond operators. The establishment of the fishpen industry has also carried along with it a great demand for milkfish fry, thus making the supply inadequate and the price of fry more unstable.

Milkfish fingerlings (1-2 g) stocked in fishpens are usually purchased or produced in nearby brackishwater pond nurseries. In India and Sri Lanka, milkfish fingerlings are caught from lagoons, creeks, and tidal pools. The fingerlings are transported from source to fishpen in oxygenated plastic bags; in the Philippines, "live-boats" (*petuya*) are used (Mane 1979). Mane (1979) also pointed out that fingerlings are first acclimated in nursery pens (Fig. 2) for about 5-6 h to counteract stress after transport.

In the Philippines, nursery pens equivalent to about 1/20 of the rearing pen are prepared of fine mesh nets supported by a bamboo fence *banata* prior to stocking. Unwanted species are removed through seining. The fingerlings are reared for about 1 month. During this period, they subsist on natural food. Supplemental feeds such as rice bran, ground shrimps, and bread crumbs are also given regularly. Mortality rates during this period range from 20 to 40%.

From the nursery pens, the fingerlings are released at 30 000/ha into the rearing pen, where they are grown to marketable size (200 g or more) in 5-6 months (Mane 1979).

SUMMARY AND RECOMMENDATION

The potential of the Indo-Pacific Region for milkfish nursery pond and pen culture in both fresh and brackish water is great. Area expansion and/or culture intensification along with proper pond design and engineering and pond management can surely augment present production. The development and expansion of the milkfish industry, however, is hampered by the scarcity of fry and fingerlings — a very weak link since the industry depends entirely on collection from the wild. Milkfish fry are also not available all year round. Stunting techniques should, therefore, be developed.

Techniques have been developed to rear milkfish fry to fingerlings, particularly those dealing with stocking densities, feeds, and feeding, in order to increase production per unit area of ponds and pens, but survival rates are still erratic. Efforts to stunt milkfish fingerlings for 3-6 months have not been very successful. The development of an economically viable and nutritionally effective diet for fingerlings should be considered a priority in institutions involved in milkfish research.

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