Progress on Artificial Propagation of Milkfish

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ICLARM

Milkfish, *Chanos chanos* Forskal, are widely distributed in tropical and subtropical areas of the Pacific and the Indian oceans. Their geographical distribution ranges from 40°E to about 100°W, and 30-40°N to 30-40°S. They are found in warm offshore waters of the Red Sea; the Indian Ocean from east Africa to the south and west coasts of India, the coasts of Ceylon, Malaya, Thailand, Vietnam and Taiwan; and the Pacific Ocean from southern Japan to Australia in the west and from south of San Francisco to southern Mexico in the east.

Milkfish are herbivorous, euryhaline, hardy, fast-growing and disease-resistant. Culture of milkfish in brackishwater ponds is the oldest fish culture practice in South Asia. It probably originated in Indonesia, where fish farming in saltwater ponds dates back at least to the year 1400. With improvements in farming technology, production has reached 2,000 kg/ha in fishponds, while in Laguna de Bay, Philippines, yields from fish pens range from 5,000 to 10,000 kg/ha. In 1979, the total milkfish production was 133,595 mt and 32,033 mt in the Philippines and Taiwan, respectively.

Milkfish are also known as an important subsistence food fish of the brackishwater coastal ponds of the Philippines, Indonesia and Taiwan. Milkfish fry or fingerlings have also been used extensively as baitfish for the tuna fisheries of many Pacific Ocean islands.

Despite the long history of milkfish farming in the South Asia region, the culture of milkfish in artificial impoundments remains contingent on the availability of wild fry. The fry are collected exclusively from coastal areas during the natural breeding season, and the annual supply of fry for stocking the ponds is naturally inconsistent due to environmental conditions and fluctuations in yearly recruitment. Thus, the most critical problem that faces the milkfish culture industries to date is the inadequate supply of fry to cope with the needs of industrial expansion and development.

The increasing demand for milkfish fry in the last decade has prompted investigations into artificial spawning of broodstock in captivity and mass propagation of the larvae. This article summarizes the progress of such work conducted primarily at the Oceanic Institute in Hawaii and the Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC) in the Philippines.

Collection of Broodstock

At the present time, most of the mature milkfish that have been used for studies in hormone-induced spawning are either captured from the sea or from fishponds which they have entered as juveniles.

Successful capture of the large adults from the sea is dependent on the fishing gear used and the procedure practised. Besides traps (otosiami or corrals in the Philippines), the most effective method of catching is with a 200-m, monofilament, 6.6-cm mesh gill net.

Procedures for handling and transport of captured fish have been established. Fish are handled with either dip net or, preferably with water-filled plastic bags to minimize stress and damage. An 800-l circular tank with cover is used for transporting the milkfish. Best results are achieved by reducing the salinity and providing strong aeration. Although newly captured fish almost always have some injury, holding the fish in a 16,000-l tank and treating them with Furacin greatly decrease the incidence of infection and mortality.

Mature Broodstock in Captivity

HAWAII

Captive milkfish adults in the Hopeaia and Manoku ponds of the Lahuipuaa pond complex, located on the Kona coast of Hawaii, mature naturally. The ponds cover 1.4 ha. Biologically and geologically the ponds are unique, lying exclusively on recent lava flows and harboring both marine and brackishwater biota. They are connected to the subsurface seawater table. Salinity ranges between 8 and 12 ppt and the temperature varies between 25 and 29°C.

The author helping put adult milkfish in polyethylene bag filled with water to minimize stress and damage during handling.

Another mature milkfish population has been located in the Nomilu pond on the island of Kauai. This is a larger (10 ha), highly productive pond. Salinity here ranges from 38 to 42 ppt.

In experimental earthen ponds (0.05 ha) at the Oceanic Institute, seven out of

The lagoons of Christmas Island. Milkfish mature naturally even at salinities in excess of 100 ppt.

twelve adult fish maintained at a salinity of 32 ppt displayed gonadal development in the 1979 season. Others matured in the same ponds in 1980. On the other hand, fish maintained at a salinity range of 15-20 ppt in a 0.05 ha pond were quiescent and irresponsive to the environmental stimulation.

CHRISTMAS ISLAND

Surveys by the Oceanic Institute of the milkfish broodstock availability on Christmas Island indicated an abundant milkfish population and accessibility for induced-breeding trials. Mature adults were captured mostly from two lagoons, which are both hypersaline—76 ppt in Pelican Lagoon and 102 to 106 ppt in Isle Lagoon.

PHILIPPINES

In the 1979 experiments, five female adults were maintained in a 6-m circular canvas tank. They were fed daily with a high-protein diet which was formulated by SEAFDEC. One female showed an early phase of gonadal development with vitellogenic eggs of 0.35-mm diameter, but it did not reach full maturity.

In 1980, spontaneous spawning occurred among 47 milkfish maintained in floating cages 10-m by 3-m deep. Salinity in the area ranged from 28 to 35 ppt.

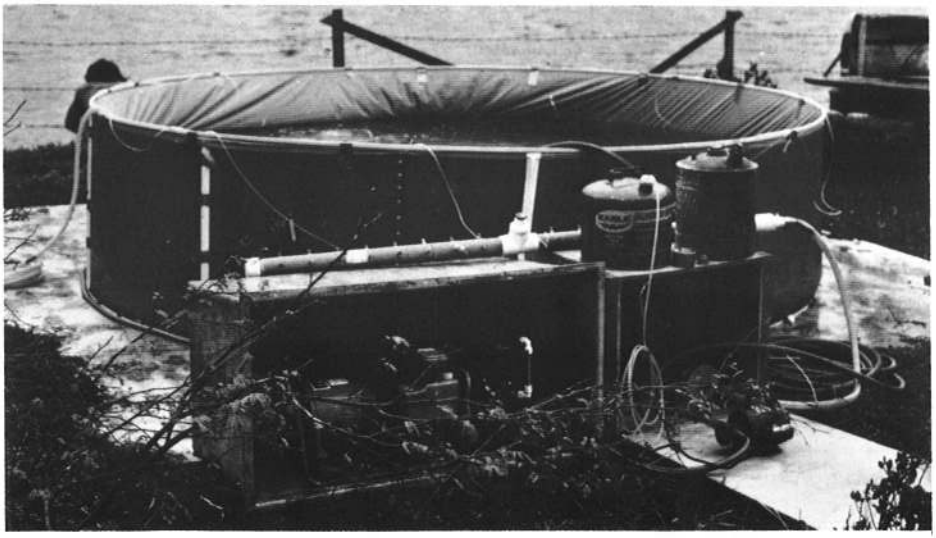
All country results show that adult milkfish can attain sexual maturity in a wide range of salinity (8-106 ppt) and in both natural and artificial environments.

INDUCED SPAWNING BY HORMONE INJECTIONS

The first breakthrough in inducing spawning in wild milkfish by hormone injections [a combination of salmon pituitary homogenate and human chorionic gonadotropin (HCG; APL, Ayerst)], combined with successful hatching of artificially fertilized eggs was achieved by SEAFDEC in 1977. On one occasion, the eggs stripped from one untreated female were also fertilized; however, the number of larvae obtained was very low.

Much progress in inducement of spawning has since been made. In 1978, a total of 48,000 fertilized eggs (38% fertilization) was obtained at the Tigbauan station of SEAFDEC. In another experiment, 36,000 larvae were obtained at a hatching rate of 74%. These larvae were successfully raised through fry stage. In the same year, successful spawnings of wild milkfish were repeated at the Milkfish Research Station, Rangiroa Atoll, by Department of Fisheries scientists of French Polynesia.

With cooperative work between the Oceanic Institute and SEAFDEC Aquaculture Department in 1979, the spawning of wild milkfish was again achieved. The best result was obtained with 35 mg salmon pituitary homogenate plus 3,500 IU HCG/kg of fish given in two injections. The fish responded to the hormone treatment within 24 hours. The hypophysated female was stripped, without sacrifice, yielding 1.4 million hydrated eggs. These eggs were artificially fertilized, and a fertilization rate of 59.4% was achieved, with 40% of the viable eggs hatching



This field unit, consisting of a canvas tank and aerator, was developed at the Oceanic Institute for field experiments in induced breeding of milkfish.

Harvesting technique in the Hopeaia pond, Hawaii: captive milkfish adults here mature naturally. The pond lies on recent lava flows and harbors both marine and brackishwater biota.

after a 25-hour incubation at 28-30°C.

The first spawning of pond-reared milkfish in Taiwan took place in 1979 after a single injection of 3,500 IU HCG plus 100 mg phenobarbital. A total of 120 larvae were hatched.

The use of valium (diazepam) as a tranquilizer and fortatic vitamin B complex to maintain good physical condition was investigated during the Oceanic Institute-SEAFDEC cooperative research in 1979. A dosage of 0.7 mg valium/kg of fish was very successful. This method is now considered a valuable tool for future work on spawning.

Workers checking maturity of adult milkfish. A cannula is inserted into the ovary of a mature milkfish. An egg sample is withdrawn by suction to determine stage of maturity.

Fertilization

Upon the completion of final oocyte maturation induced by hormone injections, artificial fertilization is accomplished following manual stripping. The process often involves sacrifice of the fish. Determination of the proper time of stripping or sacrifice is critical and has proven to be extremely difficult.

Capturing and handling adult milkfish.

Also, difficulty in capturing wild, mature males and females at the same time is often a major obstacle to the goal of artificial spawning through hormone treatments. Short-term sperm preservation is an important step in overcoming this problem. Preliminary studies by the Oceanic Institute and SEAFDEC show milkfish sperm can be kept fertile over a period of two weeks, simply by a reduction of the storage temperature to 4°C. The use of "extenders," media such as blood serum or saline solutions, further enhances sperm longevity.

Difficulty in capturing wild, mature males and females at the same time poses a major problem.

Larval Rearing

The rearing procedure resulting from joint research by SEAFDEC and the Oceanic Institute is as follows: Larvae are suspended throughout the water column in the first two days of life. From the third day after hatching, when the larvae begin to move actively, they are fed with *Chlorella*-fed rotifers at a density of 20/ml. The feeding density of rotifers is then increased to 50/ml from the eighth day. The larvae reach the fry stage in 15 days. They have been found very resistant to environmental fluctuation and relatively easy to raise on a rotifer diet. Healthy fry are further maintained by feeding with newly hatched *Artemia* nauplii or artificially prepared diets.

The Future

Success of mass propagation of milkfish fry is dependent mainly upon methods of mature broodstock maintenance and reliability of induced-breeding procedures. The technologies remain to be refined and standardized.

Efforts were continued in 1981 by several institutions engaged in this work. Spawnings were again achieved. However, progress in the standardization of induced breeding continues to be hampered by lack of broodstock. Intensive efforts are to be concentrated on the establishment of mature broodstock in captivity by defining the optimal environmental and nutritional conditions for gonadal development.

With adequate facilities, the larval rearing of milkfish should be a relatively simple task compared with that of many other marine fish. Mass production of milkfish fry can be anticipated in the near future.o