



Stripping eggs from mullet.

Fish Mariculture Studies in China

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The monograph *Yu Jing (Book of Fish)*, published during the Ming Dynasty 400 years ago, is considered the earliest work on grey mullet rearing. Since then, the fish mariculture situation in China either remained in construction of levees to enclose river mouths, estuaries and mud flats or use of abandoned salt fields and ditches to carry out extensive cultivation.

The collapse of offshore fishery resources in the 1970s stimulated the development of aquaculture. Aside from mullet, *Mugil so-iuy*, other species cultured were grey mullet, *Mugil cephalus*, and milkfish, *Chanos chanos*. Tilapia was also introduced and propagated this decade.

To meet tourism and export needs of recent years, experiments in rearing some species of high-quality food were conducted. These species include black porgy, *Sparus macrocephalus*; sea bream, *Pagrosomus major*; groupers, *Epinephelus* and *Paralichthys olivaceus*. Sea horses, *Hippocampus*, a species of medicinal fish, were also cultured.

Besides pond pisciculture as a way of cultivating the species, net cage culture is also developed progressively.

Main Cultured Species

1. *Mullet*s. In areas north of Changjiang (the Yangtze River), China, *Mugil so-iuy* is chiefly cultured while to the south of the river, *M. cephalus* is cultured. The species are characterized by their adaptation to both saline and freshwater, low food chain trophic level, rapid growth and palatability. Still under

extensive cultivation in a large area, mullet production accounts for the majority of total production of fish mariculture along the coast of Hebei Province. Annual production may be up to 500,000 kg.

As early as 1937 in Guangxi Province, grey mullet was cultured in freshwater ponds with the carps *Mylopharyngodon piceus*, *Ctenopharyngodon idellus*, *Hypophthalmichthys molitrix* and *Aristichthys nobilis*.

One of the key factors to increase production in mullet mariculture in the north is to insure the wintering survival. Experiments conducted in Hebei Province showed that mullets can survive wintering without any problem either in freshwater or seawater ponds provided some simple measures are adopted to keep the mullets from cold and wind; water temperature is kept above 0°C or freshwater is added.

Fry used in culture mostly come from natural collection. To insure fry supply, in 1968, the Institute of Oceanology, Academia Sinica, and other units succeeded for the first time in induced spawning, fertilizing, hatching, nursing and maturing mullets reared in a brackishwater lake (with salinity of more than 5 ppt) in Tianjin. Fry from these experiments were overwintered and by April the following year, their average total length reached 20 cm. It was also a phenomenon that mullet could reproduce naturally in the lake in the years when salinity was higher than 5 ppt.

In recent years, the Institute also succeeded in induced spawning, hatching and nursing hundreds of thousands of fry through the supply of seawater to mature mullets reared in freshwater.

The highest survival rate achieved in rearing mullet fry (54 days after hatch) is 84%. Food is a dominant factor in this. A reasonable food sequence adopted to rear mullet fry is: larvae of oyster (or mussel), rotifer, *Artemia* nauplius, *Artemia* adults or other planktonic animals such as copepods. Mullet fry experience an obvious process of transition from stage to stage and selection in taking food. See article, p. 7.

2. *Tilapias*. Tilapias are characterized by their extremely high reproductive rate. In tropical waters, they can reproduce 6-16 times. They reach sexual maturity 3-5 months after hatching.

The water temperature of the tilapia habitats varies with the species. For known species, the threshold water temperature is 10-45°C and the optimum water temperature is 20-35°C. They can live in freshwater and can also grow well in seawater with a salinity of 35 ppt.

Oreochromis mossambicus, *O. niloticus* and *O. mossambicus* x *O. niloticus* are reared in China. *O. mossambicus* was introduced in Guangdong Province from Thailand and Vietnam in 1956 and 1957, respectively, while *O. niloticus* was introduced from Africa in 1979. Before long, experiments on generalizing the rearing were done in freshwaters of over 20 provinces and cities in the country. During the last three years, experiments in rearing tilapia in seawater increased. It is foreseen that tilapia will help solve the food fish problem of the Chinese.

Experiments also showed that when water temperature is 22-30°C and salinity is below 24 ppt, *O. niloticus* reproduces naturally. The most unfavorable factor in rearing this fish is its poor resistance to cold. However, with the advance in breeding studies, it is expected that *O. niloticus* can be reared in waters with a considerably low temperature.

In July to September 1984, the South China Sea Institute of Oceanology, Academia Sinica, experimented in releasing 800,000 tilapia fry of 3-8 cm into Dayawan Bay waters situated in the eastern part of Guangdong Province.

A resources protection district of Guangdong Province, Dayawan Bay is located in a subtropical zone with an area of 540 km² and with sediments mainly of mud and sand. Its maximum depth is 20 m; monthly mean lowest water temperature occurs in January (13-16°C) and the highest in August (28-31°C). There are about 300 ha of coastal mangroves. Salinity is 30-33 ppt. But as there are more than 10 rivulets flowing into the bay, salinity in the coastal waters is generally 15-25 ppt. These environmental conditions are

Releasing tilapia fry into Dayawan Bay, Guangdong Province.



Status of marine fish culture in China.

Herbivores and omnivores	Type of culture	Developmental status	Carnivores	Type of culture	Developmental status
Mullet <i>Mugil so-iuy</i>	pond	commercial	Porgies <i>Sparus macrocephalus</i>	cage	research and experimental
<i>M. cephalus</i>	pond	commercial	<i>Pagrosomus major</i>	cage	research and experimental
Milkfish <i>Chanos chanos</i>	pond	commercial	Groupers <i>Epinephelus awoara</i> <i>E. akaara</i>	cage cage	research and experimental research and experimental
Tilapia <i>Oreochromis mossambicus</i> <i>O. niloticus</i>	pond or release pond or release	commercial or experimental commercial or experimental	Flounder <i>Paralichthys olivaceus</i>	release	research and experimental
<i>O. niloticus</i> x <i>O. mossambicus</i>	pond or release	commercial or experimental	Sea horse <i>Hippocampus trimaculatus</i> <i>H. kuda</i>	pond pond	commercial commercial

basically suitable to tilapias. If wintering passes without any problem, it is expected that the fish may form natural populations in the bay.

3. *Milkfish (Chanos chanos)*. Milkfish are valuable, euryhaline maricultured species originally found in Indo-Pacific tropics and subtropics. Water temperature of habitats must be above 15°C. They chiefly feed on benthic diatoms and humus, on which they grow rapidly. Every year in May, in the waters near the eastern coast of Hainan Island, natural fry can be caught. It is estimated that there are relatively concentrated spawning grounds along Hainan Island to Xisha Island.

In Hainan Island, milkfish were reared in a large area and mixed with other fish and shrimps so production was very low. Since 1977, experiments were carried out to rear milkfish in small ponds (1 to 5 mu*). Production per mu reached 100 kg or so (about 1,700 kg/ha). Now, milkfish culture is advancing towards a productive scale.

4. *Porgies (Sparidae)*. Porgies are valuable marine food fishes widely distributed along the coasts of China. Black porgy, *Sparus macrocephalus*, and sea bream,

Pagrosomus major, are now in experimental culture in the country.

In 1959-1960, experiments on rearing black porgy culture succeeded. Since 1979, in Shandong, Jiangsu and Fujian Provinces, production of fry in a small scale to supply seed for experiments on net cage culture has been conducted. In the southern part of Shandong Province, results of the experiments on net cage culture showed that after indoor wintering and rearing the juvenile fish for 5-6 months, the weight of each could reach 0.4 kg in net cages. In the southern part of Fujian Province, the growth period appeared longer, but growth rate roughly doubled.

In 1974, experiments on culturing sea bream fry succeeded. Present production of fry and culture of fish to market size are still in the experimental stage.

5. *Groupers (Epinephelus)*. Groupers live on rock and coral reefs along the coasts; most of them hide in rock caves. They are, in general, active at night. Groupers are ferocious carnivores; they can adapt to salinities of 11 to 40 ppt. Optimum water temperature for groupers is 22-28°C. They begin to be sexually mature at the age of two years.

Fry culture is still experimental. In recent years, experiments on net cage

culture were undertaken with *Epinephelus awoara* and *E. akaara* as the major cultured species. Juvenile fish for net cage culture are mostly caught from the sea through line fishing. They feed on small fish and are sold when about 500 g. It is expected that grouper culture will appropriately develop after the success of fry culture.

6. *Flounder (Paralichthys olivaceus)*. These are major commercial fish growing in the western North Pacific. They are delicious and fast growing; large individuals may weigh over 6 kg. In 1959, experiments succeeded in fry culture, but afterwards, no experiments on culture production were undertaken because these fish are extremely ferocious and consume too much food. So production costs are too high. Last year, the Institute began to conduct experiments on releasing them in Jiaozhouwan Bay of Qingdao.

7. *Sea horse (Hippocampus)*. Sea horses are a medicinal commercial fish usually called "the southern ginseng" in China. They are a kind of tonic for recovery from exhaustion and weak kidney function and are especially good in curing nerve system disorders. Every year about 5,000 kg of dry fish are needed as raw material to manufacture medicines.

In 1957, sea horses were for the first time cultured under experimental conditions in Guangdong Province. Before long, the culture was generalized to some regions along the coasts of the country. The cultured species are *Hippocampus trimaculatus* and *H. kuda*. Reproduction of sea horse is very peculiar: the female lays eggs into the nursery bag of the male; the hatched eggs remain in the bag for 8-18 days; then the larval fish come out. Larvae are fed with copepod nauplii and small-sized copepods. A one-year old individual may eat 23 individuals of copepod and digest them in 5-6 hours. Food is given twice a day. Adults are given brine shrimps.

Optimum water temperature for sea horse varies with species. It is generally 14-34°C with an optimum of 19-28°C. Water temperature of 11°C and below is lethal to this fish.

Major problems of sea horse culture are diseases, wintering and developing artificial food for the fish. ●

*1 mu = 670 m².