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Development of Manila Clam Industry in China

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Abstract: Over 2 million tons of Manila clams *Ruditapes philippinarum* (Adams et Reeve) are produced each year on the coast of yellow Sea, Bohai Sea and East China Sea in China. Most of the production occurs in Liaoning, Shandong and Fujian Provinces. Since 1990's, the Manila clam industry has developed rapidly in China prompted by the demand from domestic and abroad. In order to meet the increasing demand of seed from the whole China, the seed production in reclamation areas became the major sources for Manila clam farming in China. Meanwhile, the Manila clam is also one of the major species farmed with shrimp, fish and crab in form of pond integrated multi-trophic aquaculture which is practiced in commercial scale in Zhejiang and Fujian Provinces. The farming areas of the clam has extended from intertidal zone to shallow sea within 10 m depth along the coast of Shandong and Liaoning provinces. Benefiting from longer time immersing in water and abundant phytoplankton supply, the clam cultivated in deeper water has a much higher growth rate and longer suitable harvest time than that of the clam growing in natural inhabits. One of the main problems for such clam farming is the predation from crab, starfish and sea snails.

Key words: Manila clam, seed production, pond farming

China ranks first in mariculture production in the world, and the annual production reached 18,126,481 tons in 2014, with 13,165,511 tons of shellfish production which accounts for about 72.6% of the total production (Fig. 1). Among the shellfish aquaculture, oyster leads all other species with the total annual production of 4.35 million tons in wet weight with shell. Clams rank second with the total annual production of 3.97 million tons in wet weight with shell (Fig. 2).

The production of Manila clam *Ruditapes philippinarum* (Adams et Reeve) was mainly from the capture fishery before 1980's with the natural seeds in China. After 1980's, aquaculture of this

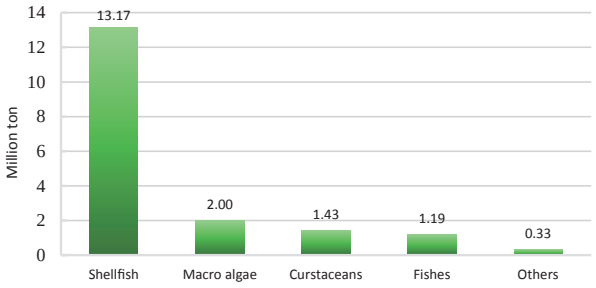

Fig. 1. Annual mariculture production of China in 2014.

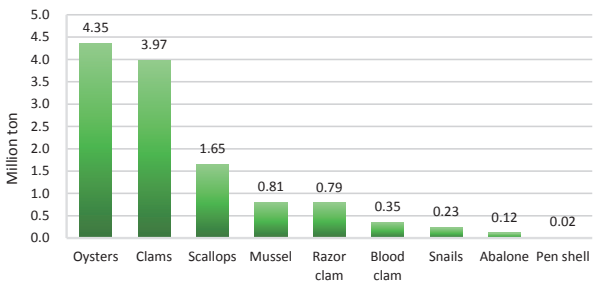

Fig. 2. Annual production of different species of cultured shellfish in 2014.

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species developed rapidly as a result of increasing demand from both domestic and international market. Now, over 2 million tons of Manila clams are produced each year along the coast of Yellow Sea, Bohai Sea and East China Sea in China. Most of the production occurs in Liaoning, Hebei, Shandong, Zhejiang and Fujian Provinces.

Before 1990's, most Manila clam was harvested by manpower from natural muddy flats. Nowadays, in Northern China, the Manila clam farming areas extended from muddy flat to shallow sea within 10 m depth and harvested by dredge boat. In southern China, pond is the major field for Manila clam aquaculture, especially integrated multi-trophic aquaculture with shrimps and fish.

Seed production

Before 1980's, all farmed Manila clams relied on natural seeds. Farmers collected seeds from the natural inhabit and transported to suitable areas for releasing. Since 1980's, the Manila clam industry has developed rapidly in China prompted by the increasing demand domestically and internationally. In order to meet the increasing seed requirement, the seed of Manila clam produced in reclamation areas in Fujian Province became the major sources (Fig. 3).

Seed production in hatchery was started in the mid 1990's in Liaoning Province, northern China, with about 50 billion juveniles in 4 mm shell length annually. But it has declined gradually in both production and scale, mainly due to the higher cost compared to that in reclamation pond in Southern China (Fig. 4). Nowadays, about 80% of Manila clam seeds for aquaculture in China are produced in reclamation areas (big pond with the area of 100 ha) in Fujian Province. The rest is from natural seed habitat

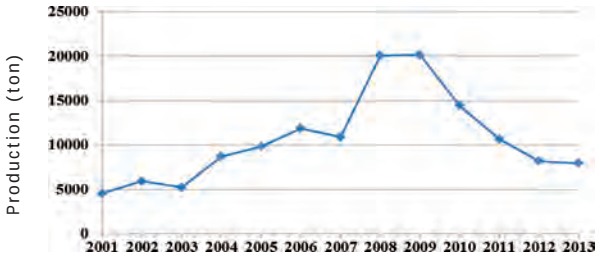

Fig. 3. Seed production of Manila clam in Fujian Province from 2001–2013.
The seeds are cultured in reclamation ponds up to the shell length of 4 mm.

High density culture system for Manila clam seed production was also developed in China around 2010 in Qingdao, Shandong Province. The up-welling system is utilized for larvae culture with the density of 100–150 ind/mL (Fig. 5a). When larvae reach 200 μm, the eye spot larvae are moved from the up-welling system to big tanks for settlement. When spats reach 500 μm, they are collected and moved to spat up-welling or race way nursery sets until commercial seed size in shell length of 5 mm (Fig. 5b).

High density culture system for Manila clam seed production is efficient in laborsaving and space utilization of hatchery; however, the total cost is still much higher than that produced in reclamation ponds. Therefore, the high density culture system has not been practiced in commercial scale for Manila clam seed production in China yet.

Aquaculture

The farming of Manila clam was mainly carried out in tidal zone and subtidal zone before 1980's. A continuous growing domestic and overseas demand pushed the attempts to increase the production of Manila clam in early 1990's. The farming areas of the clam have extended from intertidal zone to shallow sea within the depth of about 10 m along the coast of Shandong and Liaoning Provinces. Benefiting from longer time immersing in water and abundant phytoplankton supplement, the clam cultivated in deeper water has a much higher growth rate and longer suitable harvest time than that of clam in natural inhabits. One of the main problems for such farming is the predation from crab, starfish and sea snails.

Normally, the aquaculture procedures of Manila clam in shallow sea are as follows.

- Removal of the non-alive shells from planned aquaculture area
- Sowing of the seed in spring or autumn at the density of 500–1000 ind/m^2 depended on the

Fig. 4. Clam seed hatchery in Liaoning Province, Northern China.
a: outside view; b: inside view; c: larvae and spat culture tanks; d: indoor tanks at spat nursery facilities.

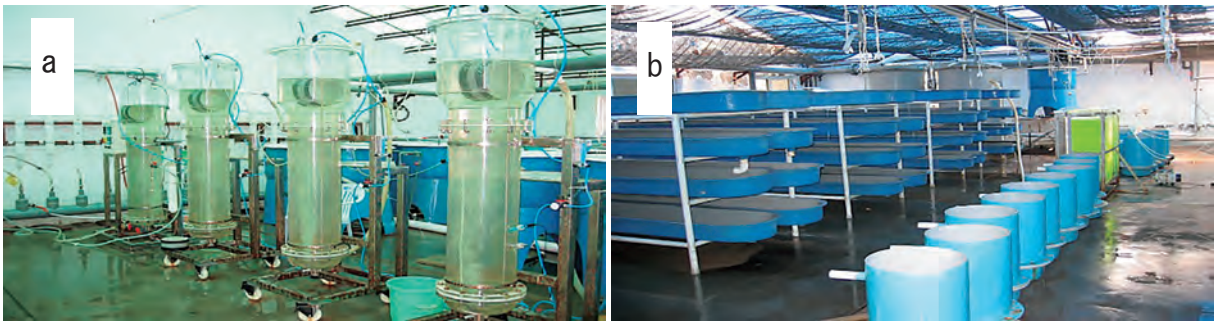

Fig. 5. Photographs of high density culture system for Manila clam seed in Shandong Province, Northern China.
a: high density facilities for larval culture; b: upwelling and race way nursery sets for spat culture.

seed size and bottom conditions

- Farming for about 15 to 20 months from the seed to marketable size
- Regular removal of the predators such as starfish, snail, and crab during the farming periods by trap nets
- Selective harvest depending on the market demand when the shell length reaches 3 cm
- The mean yields of marketable clams can reach 2–3 kg/m^2 in the mudflat, and 3–5 kg/m^2 in deeper waters.

Because of low temperature, the clam stops growing from December to early March. In order to enhance the profit of the clam aquaculture, a

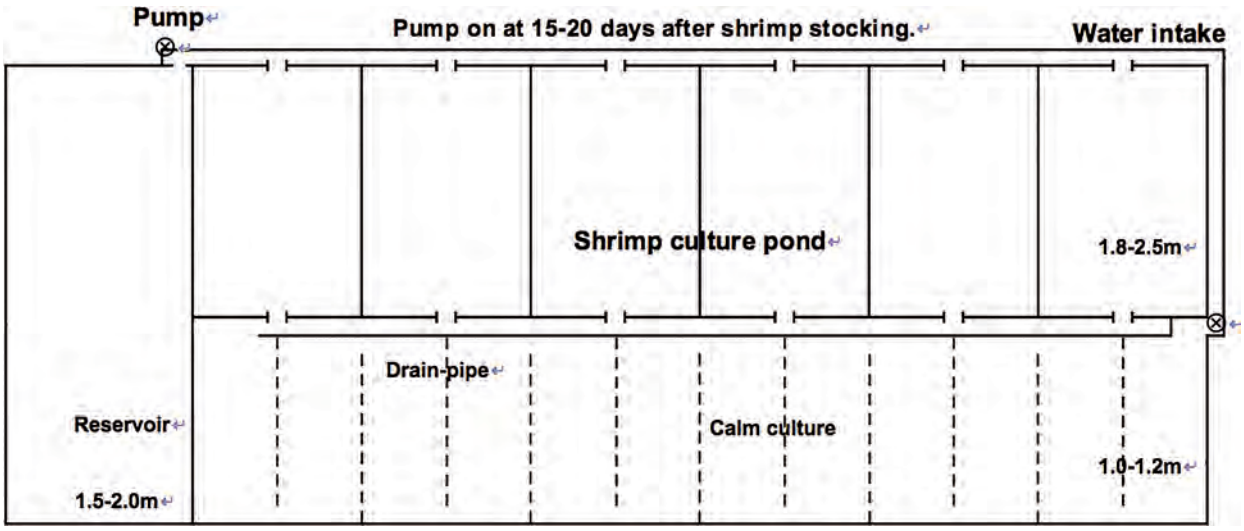

Fig. 6. Schematic diagram of the recirculating system for shrimp and clam culture in Zhejiang Province.

Fig. 7. The photo of integrated aquaculture pond in Zhejiang Province, China.

new method has been practiced by the farmers in northern China as follows.

- Purchase of the seed from Fujian Province in autumn with shell length of 5 mm
- Nursing the seed in indoor or special pond, and over-wintering in green-house for continuous growing of the clam in cold season
- Transfer of the juvenile clam from green-house to the mudflat for intensive grow-out in the following April
- Harvest of the clams with shell length of 3.0 – 3.5 cm within 10 – 14 months from the spawning,

With this method, culturing period can be reduced by about 5 months compared with the traditional method.

In southern China, mainly in Zhejiang and Fujian Provinces, the recirculating culture of the clams with shrimp has been well developed (Fig. 6). In this aquaculture system, the area ratio of shrimp pond to mollusk pond is 10:4. The water recirculation ratio is increased gradually from 10%/d in the early to 40%/d in the late stage.

Recently, the integrated aquaculture system has been well developed in the re-constructed pond in Zhejiang and Fujian Provinces (Fig. 7). In this system, filter-feeding bivalves and predatory animals are separated by a net enclosure in the purpose of preventing predating. In the integrated aquaculture pond, shrimp is stocked at the density of 30 ind/m^2 at the postlarval stage, while clams are normally stocked from March to April at the density of 150 – 200 ind/m^2 with size of 300 ind/kg. Before stocking, the water in the pond is fertilized with well-fermented organic fertilizer for maintaining the water transparency to 30 – 40 cm with yellowish or light brown color during the cultivating period, and exchange the water by 5 – 10 cm/d in the late period. The main species for integrated pond aquaculture and the economic analysis in Zhejiang and Fujian Provinces are listed in Fig. 8 and Table 1.

Problems and challenges for Manila clam aquaculture in China

First of all, environmental pollution from land

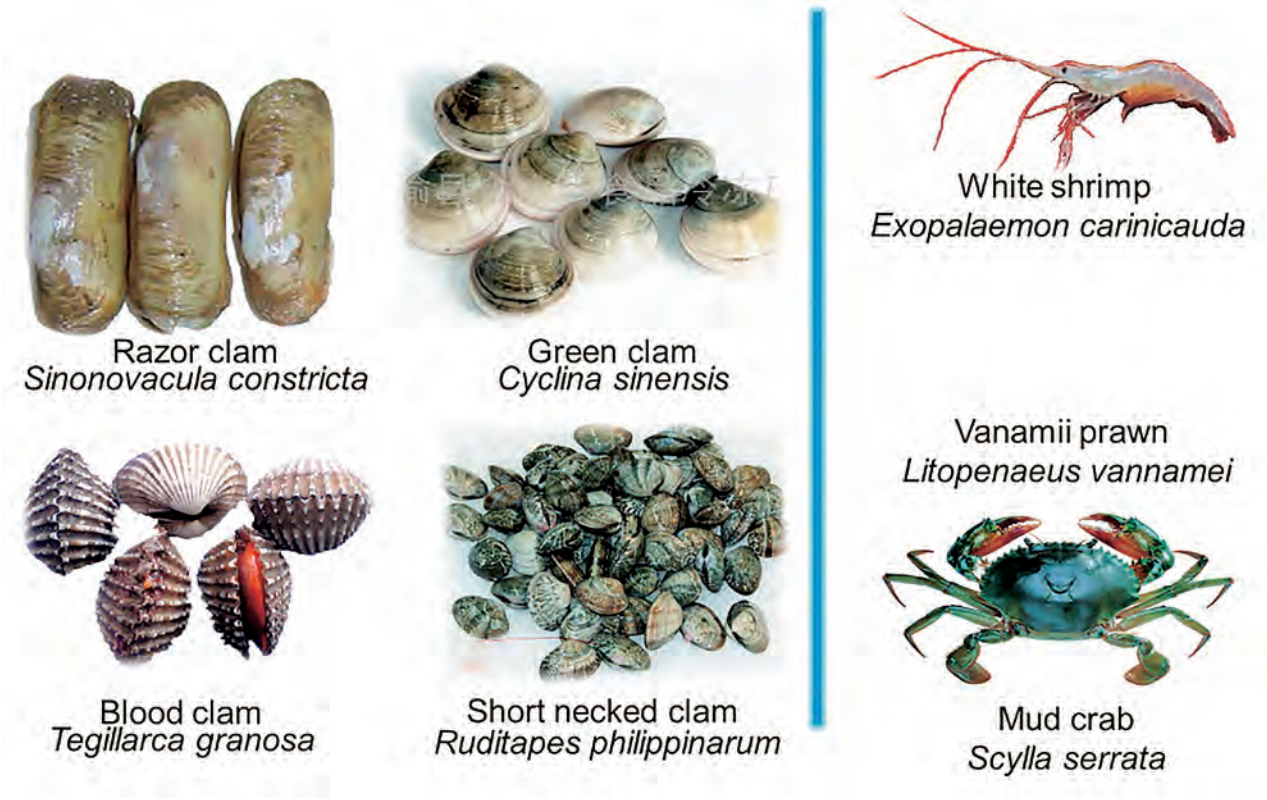

Fig. 8. The main species for integrated pond aquaculture in Zhejiang and Fujian Provinces.

Table 1. Comparison of mono- and integrated aquaculture models in ponds

	Mollusk culture	Shrimp culture	Crab culture	Integrated culture	Recirculating culture
Cost (10^3Yuan/ha)	7.5–10.5	13.5–19.5	16.5–19.5	10.5–15.0	10.5–15.0
Profit (10^3Yuan/ha)	6.0–7.5	10.5–15.0	10.5–13.5	13.5–18.0	12.0–18.0
Risk	Middle	High	Middle	Low	Low
Pollution	Light	Severe	Severe	Light	Light

industry and agriculture is one of the major threats to mariculture, which not only causes the frequent disease outbreaks but also affects the yields and seafood quality.

Secondly, the ecological hazards occur frequently in recent years, such as red tide, green tide and breakout of starfish, which seriously hamper the development of clam aquaculture.

The most serious problem or challenge for the sustainable development of clam aquaculture is the farming space, which has been decreasing mainly due to coastal reclamation. Traditional mariculture areas are encroached by the development of industry.

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