Some Aspects of the Shrimp Farming Industry in China: Constraints and Priorities

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Abstract

Shrimp farming is one of the most important industries in coastal China. During the period from 1988 to 1992, more than one million people were employed in the field and about 200,000 t of shrimp was produced each year. But since 1993, the industry has been frustrated by problems. This paper briefly introduces the developmental history and the current status of shrimp farming in China. Some key constraints to sustainable shrimp culture include disease, impacts on the environment, and seedstock quality. Achievements in scientific research which have been gained in recent years are epizootic pathogen research, diagnostic techniques, comprehensive culture techniques, polyculture and methods of culture in lower salinities. The priority issues for future research are high health seedstock, healthy culture systems, fast diagnosis of shrimp diseases, development of vaccines and immunostimulants, high quality formulated feed and techniques for ecosystem optimisation.

Brief Review

There are about 100 penaeid shrimp species in China's coastal waters, of which a dozen *Penaeus* spp. and *Metapenaeus* spp. have commercial value (Liu 1989a). The main species cultured in China are *Penaeus chinensis*, *P. monodon*, *P. japonicus*, *P. merguinsis* and *P. penicillatus*.

Chinese shrimp farms are distributed along almost 18,000 km of coastline from Hainan Province in the tropics to Liaoning Province in the temperate zone. Farmers usually culture two crops of shrimp per year in southern China, while to the north of Yangzi River farmers can harvest only one crop. More than 80% of shrimp farms use low intensity culture technology. Air blowers or paddlewheel aerators are rare.

The modern shrimp farming industry in China has a history of only about two decades but it has gone through an extraordinary experience which can be roughly divided into four stages: steady increase (1978–1984), rapid increase (1984–1988), prosperity (1988–1992), and recession (1993–1995). There were only 1,300 ha of shrimp ponds in China in 1978, however the area of ponds reached 160,000 ha in 1991. Total shrimp output increased by more than 400 times, from 450 t in 1978 to 200,000 t in 1991, and the average yield increased from 350 kg/ha to 1,500 kg/ha. Since 1988, more than 100 billion shrimp larvae were produced each year (Wang and Cai 1995). About 100,000 t of cultured shrimp were exported annually, earning more than US$500 million (Cen 1993). The development of shrimp culture also promoted related businesses, such as feed manufacture, processing, transportation and marketing. It was estimated that more than one million people were employed in shrimp culture or related businesses in China (Wang and Cai 1995).

China's shrimp farming, however, has suffered from serious disease epidemics since 1993. The total output decreased from 200,000 t in 1992 to 80,000 t in 1993, then to 60,000 t in 1994. Many shrimp farmers have been frustrated and some have changed to new culture species. The recession in shrimp farming

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has generated large socioeconomic impacts in China's coastal areas.

Constraints

Many people, including some researchers, consider viral diseases to be the chief cause of the industry's collapse. Thus, what they eagerly long for are techniques which can control diseases effectively and quickly. However, there are many other factors which contributed to the shrimp culture recession in the past and constrain the sustainable development of the industry in the future.

Disease

In early times, bacteria were the main shrimp pathogens and malnutrition also played an important role in shrimp disease. People were often able to control these diseases relatively easily by applying antibiotics or taking technical measures. However, those measures were not able to control recent epizootics and diseases spread so quickly that, if a few shrimp were found dead or diseased, then a few days later the whole pond would be dead or dying (Cai and Wang 1995). We now know that infectious hypodermal and hematopoietic necrosis virus (IHHNV) was responsible for the disaster.

Environment

The environment around shrimp farming areas was partly responsible for the shrimp farming recession in China. One reason is the pollution from industrial waste water and sewage. According to Jiang (1994a) about 6 billion t of waste water drains into Chinese coastal waters from 43 coastal cities each year, of which 4 billion t is industrial waste water and 2 billion t is domestic sewage. Unfortunately, many shrimp ponds are concentrated near estuaries where polluted water drains directly, and many shrimp farms suffer heavy losses from this pollution. For example, at the estuary of Dagu River near Qingdao, juvenile shrimp cannot survive in summer if water is directly pumped from the estuary. Farmers have to reserve culture water for an appropriate time to avoid or eliminate the pollution. Although the government has been strengthening the protection of the environment, the pollution from industry waste water and sewage is still a big problem for shrimp farming.

Another cause of environmental problems is pollution from the shrimp farming industry itself. A large amount of shrimp faeces and waste feed are drained into coastal waters with the effluent and this results in eutrophication. Also, the composition of phytoplankton in many culture areas has changed dramatically and some microalgae seldom bloom. There are big fluctuations in the micro-environment, especially in indicators such as pH, dissolved oxygen, transparency and some factors which are closely related to algal propagation.

In addition, the abuse or overuse of disinfectants, chemicals and antibiotics disturbs or destroys the natural microbiology, affecting its ability to degrade or convert organic compounds.

Seedstock quality

Unfortunately, little research has been conducted to improve the seedstock of cultured shrimp until now. We should clearly recognise that shrimp culture is still based on the genetics of wild populations. Culturing larvae in hatcheries where good rearing conditions and antibiotics prevent diseases but, at the same time, reduce the ability of the larvae to resist unfavourable environmental conditions.

Current Status

In response to the epizootic in 1993, the China State Science and Technology Commission and the Ministry of Agriculture organised an emergent research program to deal with the difficulties confronting the shrimp culture industry. Demonstration shrimp farms in each shrimp producing province (e.g. Shandong, Liaoning, Hebei, Guangdong and Fujian Provinces), were established to research and teach successful ways of shrimp culturing. Desirable results have been achieved after concerted efforts in the last few years.

Pathogen Studies

The major pathogen of shrimp in China is IHHNV. The size of the virus is 120 × 360 nm, without inclusion. Its main targets are hypodermal tissue, hematopoietic tissue, connective tissue, the antennal gland and blood cells. The virus reproduces slowly when the temperature is below 20°C, however it propagates very quickly as temperature rises above 25°C (Huang and Song 1995). The virus was also found in other crustaceans, e.g. copepods and *Artemia*, which are abundant in natural sea waters or shrimp farming ponds.

After years of research, the Yellow Sea Fisheries Research Institute (YSFRI) and other fisheries-related institutes and universities have developed a series of diagnostic techniques for viral diseases such as gene probes, polymerase chain reaction (PCR), and monoclonal antibody techniques which have been successfully applied in farms.

Culture Techniques

Concerted efforts have been made to explore optimal culture modes for shrimp. Shrimp farmers also actively participated in different experiments to prevent epidemics according to their local ecological conditions. The following are some examples.

Comprehensive culture techniques

The maricultural scientists at YSFRI and other related fisheries institutes and universities have summarised some comprehensive technical measures which have proven to be effective in preventing epizootics in shrimp farming:

- thoroughly disinfecting the farming ponds and removing the sediment from last year's farming before stocking;
- propagating natural feed organisms in ponds and enriching juvenile shrimp' nutrition;
- installing aeration equipment and improving the ecological conditions in ponds;
- improving water quality and treating the water in sedimentation ponds before use in farming;
- supplying high quality formulated feeds;
- controlling water quality in optimum conditions and keeping the micro-ecosystem in balance during grow-out; and
- preventing high temperature larval rearing and overuse of antibiotics in hatcheries.

Polyculture

The main polyculture modes are shrimp–fish (e.g. mullet, tilapia, *Fugu* spp., perch, sea bream etc.), shrimp–algae, and shrimp–crab (Liu 1989b; Wang 1993; Jiang 1994b). The shrimp–fish system is the most successful, according to recent reports. Some experts inferred that there are two factors which keep shrimp growing healthily in the shrimp–fish system. One is that predatory fish eat sick or morbid shrimps, thereby eliminating the spread of disease in shrimp ponds. The other is that there is an improved balance in the mini-ecology of shrimp ponds. The chief drawback is that shrimp survival may be low if the proportion of fish to shrimp is not ideal.

Culture in lower salinity

P. chinensis and *P. monodon* can grow well in a salinity of about 5 ppt. Investigation showed that some shrimp farms located at estuaries or where fresh water was available, cultured their shrimps normally, while their neighbouring farms with higher salinities had suffered severely from disease. In recent years, some farms tried to lower the salinity of the culture water with fresh water (river or well water) and to grow their shrimp in low-salinity waters—most had desirable results.

Priorities for Future Research

The Chinese shrimp farming industry has many problems and the following priorities are suggested for future research.

Establishment of high-health seedstock

Domestication and systematic selection are needed for establishing a high-health seedstock for the industry, just as in agriculture and animal husbandry.

Establishment of healthy culture systems

It is important to develop healthy culture systems for preventing cultured shrimp from being infected by various pathogens and which are harmonious to the local environment. In the long run, different culture systems should be modelled for different locations from south to north along the country's coastline.

Fast diagnosis and checking techniques for shrimp disease

Fast and convenient test-kits are urgently needed for shrimp farmers to diagnose or check for shrimp diseases occurring in their farms, so that the disease may be quickly diagnosed on site and the necessary measures can be taken.

Development of vaccines and immunostimulants

Emphasis should be placed on the development of vaccines for vibrios and immunostimulants for enhancing the health of cultured shrimp.

Development of high quality formulated feeds and additives

Studies are needed to investigate the metabolic physiology of shrimp, with the aim of developing nutritionally-complete feed formulae and special-function additives for feeds.

Ecosystem optimisation in shrimp ponds

Identify appropriate methods to develop a harmonious microbial population in shrimp ponds by micro-organism propagation, water quality control and feeding strategy.

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