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Review

Detection of major penaeid shrimp viruses in Asia, a historical perspective with emphasis on Thailand

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Abstract

Asia leads the world in cultivated shrimp production with export earnings in the order of billions of US dollars per year. Despite this success, annual production decreased in the latter nineties because of widespread epidemics (epizootics) caused by new viral pathogens. Although these viruses were no cause for alarm to human health authorities, they were economically crippling for Asian shrimp farmers. In Thailand, shrimp production trends have mirrored those in the rest of Asia, except that recovery from the viral epidemics has been somewhat better than it has been for most of its close neighbors. Initially, *Penaeus monodon* was the main cultivated species but this has changed markedly since 2002 when *Penaeus vannamei* (also called *Litopenaeus vannamei*) started to be cultivated in many Asian countries. Since 2004, it has been the dominant cultivated species in the world. Research in Thailand has focused on the characterization of shrimp viruses and on the development of rapid diagnostic probes for them. The major viruses of concern (in estimated order of past economic impact for Thailand) are white-spot syndrome virus (WSSV), yellow-head virus (YHV), hepatopancreatic parvovirus (HPV) and monodon baculovirus (MBV). However, with the introduction of *P. vannamei*, Taura syndrome virus (TSV) and infectious hypodermal and hematopoeitic virus (IHHNV) have now become important. Presently, the most rapid and sensitive tests employ polymerase chain reaction (PCR) technology and take approximately 3 h to complete. However, lateral flow chromatographic tests based on nanogold-labeled monoclonal antibodies have recently been introduced. Although they tend to be less sensitive than PCR-based methods, they are highly specific, very inexpensive and so user-friendly that they can be used pond-side by farmers themselves to verify disease outbreaks. This review covers the main Asian shrimp viruses for which PCR tests and some antibody tests are currently available and it emphasizes work that has been done in Thailand.

Keywords: Shrimp; Penaeid; Virus; Detection

Contents

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1. Introduction

Asia has always led world production of cultivated shrimp with a market value of billions of US dollars per year. Thailand alone has been the world's leading producer since 1992 with its export earnings alone reaching more than 1 billion US dollars per year. However, in Thailand in 1995, largely due to the peak in yellow-head virus (YHV) outbreaks, production decreased by about 5000 metric tons (equal to approximately 40 million US dollars in lost export revenue). In 1996 and 1997, peak losses by another virus called white-spot syndrome virus (WSSV) was even more disastrous, with cumulative lost export revenue estimated at approximately 1 billion US dollars. After 1997, Thai production began to recover, reaching the previous highest production of 250,000 metric tons again in 1999 and have since remained more or less at that level or higher. The rest of Asia did not fare so well. For example, WSSV outbreaks in China began in 1993, reducing export production from the 1992 high of 115,000 metric tons to 35,000 metric tons. Recovery was slow, with production reaching only 70,000 metric tons by 1999. However, the subsequent introduction and wide use of domesticated and specific pathogen free (SPF) *P. vannamei* has resulted in the highest production of cultivated shrimp ever recorded there.

The examples above serve to illustrate how serious disease losses can be in the shrimp aquaculture industry. The perilous position of the shrimp farmer and the shrimp industry can be greatly improved by the implementation of relevant strategies that include programs for improved farmer cooperation and technological change. As shown by the success of using domesticated *P. vannamei*, the wider use of domesticated and genetically selected SPF stocks will be an essential element in this change. These strategies could lead to a long term, stable shrimp industry with little negative environmental impact. Biotechnological research can make substantial contributions towards achieving this goal but it is essential that government and industry provide continuous support for the infrastructure and training required to maintain the relevant technical capabilities.

Mostly, this review will cover steps in the development of DNA probes and PCR technology for detection of shrimp pathogens, but will also include a little about lateral flow chromatographic tests using monoclonal antibodies (MAb). The main focus of the review is on work that has been done in Thailand and it has been reviewed in a broader context elsewhere (Flegel, 1997). Where appropriate, I will refer to similar work done outside Thailand. While focusing on these probes, it should be kept in mind that they play only one small part in the overall strategy to control shrimp diseases. They are not an answer in themselves but must be used properly in the overall context of a shrimp health program involving such topics as environmental safety, nutrition and genetics, to name only three. The reader may wish to consult other reviews on shrimp viruses that give more details on work done elsewhere (Lightner and Redman, 1991, 1998; Lightner, 1993, 1999; Loh et al., 1997, 1998; Lo and Kou, 1998).

This review will cover the development of DNA diagnostic probes for shrimp viruses in the order that they were studied in Thailand: monodon baculovirus (MBV), yellow-head virus (YHV), white-spot syndrome virus (WSSV), hepatopancreatic parvovirus (HPV), infectious hypodermal and hematopoeitic virus (IHHNV), Taura syndrome virus (TSV) and Laem Singh virus (LSNV). However, in terms of losses to *P. monodon* in Asian shrimp culture WSSV, YHV and HPV are undoubtedly the most important (in decreasing order of incurred losses). Losses from the viruses MBV and IHHNV are less clearly evident. However, the more recent and widespread cultivation of *P. vannamei* has increased the need to consider losses to IHHNV and TSV more seriously.

2. Monodon baculovirus (MBV)

We were quite alarmed when we saw this virus in Thailand for the first time in 1990 (Fegan et al., 1991),