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WSSV and TSV: Diseases as drivers in the shrimp-farming industry

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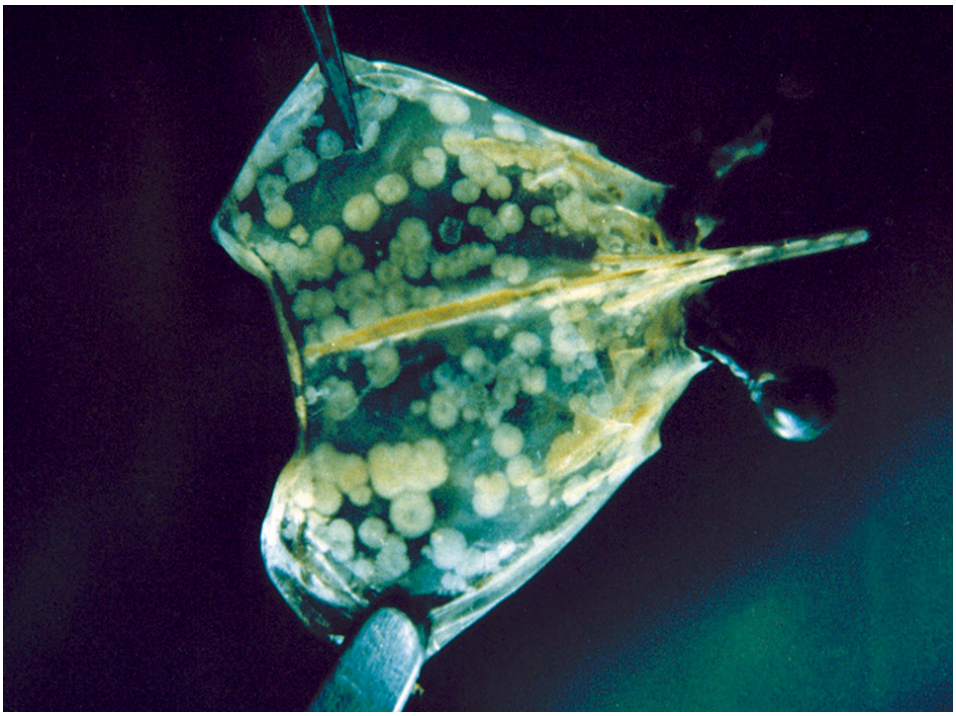
Summarized from 'The Shrimp Book'



This shrimp carapace presents the white spots that typically reflect infection by WSSV. Photo courtesy of Dr. Carlos Pantoja.

Viral diseases have arisen in both Western and Eastern shrimp farms with the consolidation of the shrimp-farming industries in these regions. Two diseases, in particular, have been spread worldwide as shrimp farming has expanded, with the result that Taura syndrome virus (TSV) and white spot syndrome virus (WSSV) are the most serious of the crustacean viruses currently known to the industry.

As the biology of both the viruses and their crustacean hosts became better understood, the impacts of these viruses on production systems have been reduced. In some cases, management has been extremely effective, virtually eliminating these diseases as concerns from production. In other cases, much remains to be done in controlling the impacts of the viruses on production.

Species shift

Of the 10 viral diseases currently recognized by the International Office of Epizootics as negatively affecting penaeid shrimp production, TSV and WSSV are responsible for the majority of financial losses. It has been estimated that TSV accounted for approximately U.S. $1 billion in losses since its discovery in 1991, while WSSV caused as much as $7 billion in losses over the same period.

The history of these two viruses and the steps taken to control them merit careful consideration as reflections of how the shrimp industry has developed across the globe. As a result of the movement of animals for aquaculture and the presence of viral pathogens in the wild, the spread of WSSV and TSV as indicated in Tables 1 and 2 has been swift and worldwide.

Griffith, Chronological summary of the spread of WSS, Table 1

Year	Country/Region

1992	Japan
1994	Thailand/India
1995	United States
1999	Centra lAmerica/Ecuador/Mexico
2004	Hawaii
2005	Middle East

Table 1. Chronological summary of the spread of WSS.

Griffith, Chronological summary of the spread of TSV, Table 2

Year	Country/Region
1992	Ecuador
1994	Colombia/Central America
1998	Taiwan
2000	Venezuela
2001	Belize
2002	Thailand
2009	Colombia

Table 2. Chronological summary of the spread of TSV.

Far from succumbing to these diseases, farmers have in fact been able to increase production. In Asia, this was in great measure due to the change from black tiger shrimp (*Penaeus monodon)* to white shrimp (*Litopenaeus vannamei)*, which now make up approximately 61 percent of the overall farmed harvest exported by the region and are the most important species of shrimp farmed worldwide.

This suggests *L. vannamei* may be more resistant to the pathogens present in Asia than *P. monodon* and supports the switch away from the larger, more demanding *P. monodon*. However, looking at the performance of *L. vannamei* in Latin America, we see continued difficulties with both WSSV and TSV.

Production strategies

Production strategies have always differed considerably between the East and West, and indeed, among countries within regions. There are fundamental differences between both the physicalities and philo-sophies demonstrated regionally toward production. The differences in pond sizes, for example, reflect both the availability and cost of land in the two regions, as well as social aspects of land ownership and small-scale farming inherent to each region.

The long history of small, family-owned and -operated fish farms in the East differs greatly from the situation in Latin America, where shrimp farming was driven by a small number of companies and individuals using large tracts of land operated at low densities. The operation of Western farms thus

tends to be based on low technical inputs with a focus on management of fixed costs (or indirect costs, including, for example, salaries and diesel for pumping water). Eastern operations tend to be high-tech, with a focus on variable or direct costs, such as postlarvae and feeds. These elements are summarized in Table 3.

Griffith, Comparison of disease management tools, Table 3

Criteria	Extensive/Western	Relative Cost	Intensive/Asian	Relative Cost
Pond size	Over 5 ha	Low	Less than 2 ha	High
Stocking density	Low (4-25/m^2)	Low	High (over 50/m^2)	High
PCR screening of postlarvae	No/poor	Low	Yes	High
Specific pathogen-free/-resistant stock	No		Yes	High
Specific pathogen-resistant stock	Yes	Low	No	
Feed-conversion ratio	Less than 1.5:1	Low	Over 1.5:1	High
Direct cost/total cost	Less than 50%	High	Over 50%	High
Indirect cost/total cost	Over 50%	Low	Less than 50%	Low
Genetic programs	Yes, specific pathogen-tolerant	Low	Few, specific pathogen-free/-resistant	High
Disinfection of ponds prior to stocking	No	High	Yes	High
Water exchange during production	Yes	Low	No	Low
Control of disease vectors	No	Low	Yes	High
Production philosophy	Disease coping	Low	Disease avoidance	High
Movement of animals between countries within region	Restricted	High	Well regulated	Low

Table 3. Comparison of disease management tools in Asian and American shrimp farming.

Disease risk

In addition to the dichotomy presented by the two alternative production methods practiced by Asian and American farmers, it is important to recognize the risks presented by small, poorly financed farms to regional production under both systems. Especially in combination, the lax legal framework common to the regions where shrimp is farmed, sometimes poorly educated and inanced farmers, and the simply unscrupulous represent huge risks to the operations that make substantial investments in disease management.

Producer nations and industries must take these smallholder farms into consideration when planning regional disease management programs with a view toward minimizing the risk of introducing diseases to existing systems. As part of the planning, it is key to ensure reasonable access to quality seed at reasonable prices in order to minimize the risk of illicit animal movements that threaten regional production.

Market role in disease management

Disease

The gross signs of Taura syndrome include tail damage. Photo courtesy of Dr. Carlos Pantoja.

outbreaks, particularly major events such as those caused by WSSV in both Asia and the Americas, may be expected to cause sympathetic responses in markets as demand overtakes supply, the latter being perceived to be short due to mortality caused by the disease. This was, in fact, seen in the market for white shrimp from 1999. Interestingly however, not only was this price response from the market short-lived, having dropped to pre-WSSV levels by the end of 2001, but prices continued to drop from that point forward. To date, prices have not recovered to pre-WSSV levels.

The data used was from the main price monitor for the U.S. market, Urner Barry's Comtell, and confined to three size classes for simplicity. However, these three classes (36-40, 41-50 and 51-60) make up a large proportion of U.S. imports of white shrimp, covering sizes from approximately 12 through 19 g. The impacts of these price changes on producers is extremely important, as the overall average price dropped $1.74/lb from an average of $4.66/lb for the period of January 1995 through July 2001 to $2.92/lb for August 2001 through April 2009. This was equivalent to a reduction of 37 percent.

It is possible that markets exhibit controlling features outside the traditional price models typically considered drivers in the market. With the implementation of the Sanitary and Phytosanitary Agreement within Article 20 of the General Agreement on Trade and Tariffs, the World Trade Organization recognized the role that animals destined for market represent to importing nations.

It has been clearly demonstrated that frozen shrimp represent a significant risk for disease transmission both to industry and the wild. Ultimately, this may be one of the deciding factors as to which disease management system is chosen by growers.

Future disease events

It has been demonstrated conclusively that wild stocks of shrimp and other crustaceans act as reservoirs for disease as well as sources of novel diseases, and it is reasonable to assume that we haven't seen the last of novel shrimp diseases. That said, it is also probably fair to assume that as farms intensify and move away from the use of wild animals as seedstock, the risk of a new disease appearing in farms will be reduced. This is the reasoning behind the specific pathogen-free (SPF) concept, aggressive biosecurity and nuclear breeding centers.

It is reasonable to assume that farms well removed from the ocean and operating under tight biosecurity with disease avoidance strategies will be less likely to observe new disease events than farms operating under disease-coping strategies. Of course, this assumes a number of provisos, perhaps most importantly that farmers do not cut corners and succumb to the financial temptations inherent in the marketplace as a result of the commoditization of shrimp and the lower returns caused by oversupply. High stocking densities and stressful environments would prove favorable for another epidemic.

Reports of infectious myonecrosis (IMN) in Indonesia and the subsequent effects of the disease are an example of this scenario occurring in an intensive disease-avoidance environment. It remains to be seen to what point the model and its management are effective in limiting the spread of the disease in Indonesia and adjacent regions, although at least initially it seems to have been successfully limited. It is interesting to note that the same disease in the Americas remains to date limited to Brazil, indicating that it is feasible to control the spread of disease through adequate biosecurity.

Perspectives

The industry has clearly moved from one of supply limitation to demand limitation, a shift that will begin to eliminate the less efficient producers from the industry make-up. The coming years will see dramatic shifts in production schemes and marketing methods as producers attempt to survive in the increasingly complicated commodity market. In addition to the market, there always remains the risk of another pandemic affecting the current stability of the worldwide supply of shrimp.

Key to avoiding the cyclical rise and fall of production and prices is the move toward controlled reproduction of shrimp to perform within the structure chosen, whether that is disease coping or disease avoidance. What cannot be assumed to offer long-term sustainable production is the use of

wild animals of uncertain disease status. Models for production in other animals, both terrestrial and aquatic, have clearly demonstrated that economically viable long-term production requires the use of carefully selected broodstock whose offspring are reared under controlled conditions where disease is not a limitation.

It behooves us to consider what the finding of IMN in Indonesia means to disease control efforts worldwide. As the saying goes, one must learn from one's mistakes or forever be doomed to repeat them. The painful and costly lessons learned from the TSV and WSSV epidemics represent important inflexion points that have clearly been critical to developing the current state of the industry. Let us hope the Indonesia findings do not herald another round of learning experiences for the industry.

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