Monodon Slow Growth Syndrome (MSGS)

A review highlighting the role of *Laem-Singh Virus* (LSNV) in causing the disease

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Focal Points at a Glance: *L.vannamei has gained in importance, particularly because of its export potential. This development may have no doubt pushed the place of monodon to the position next to vannamei, but yet it continues to have its importance although in the second place in the export status. The authors, in this communication tell us about the current research with regards to MSGS which with LSNV (Laem-Singh Virus) as the causative agent of the disease, among other possibilities.*

Among internationally traded fishery products, shrimp is the single largest seafood commodity accounting for 17 % by value. Approximately 75 % of the aquaculture produce out of this is farmed black tiger shrimp (*Penaeus monodon*) and the Pacific white shrimp (*Litopenaeus vannamei*). However, diseases are major constraints in the sustainability of aquaculture. Intensification of aquaculture farming enhances occurrence of new emerging syndromes. Amongst diseases with infectious causes, viruses are the most devastating agents as they cause significant production and economic loss due to mortality or retardation of growth. Besides the major viral diseases in shrimps, an emerging disease characterised by stunted growth and size variation in farmed black tiger shrimp is on the rise in recent past in South and Southeast Asian countries. The term called Monodon Slow Growth Syndrome (MSGS) was coined by Thai shrimp farmers to refer to this unusual retarded growth in cultivated *P. monodon*. MSGS is considered as the most serious problem, probably ranking third next to WSSV and YHV in *P. monodon*. The MSGS condition was first noticed in Thailand in 2001 when farmers found an unusual abnormally slow growth and a large size variation in shrimp. In culture affected by MSGS, shrimp reached an average size of 5–10 g instead of the regular size of 24–40 g after 4 months of culture and very high (30–80 %) coefficient of variation (CV) in weight.

What is the causative agent of MSGS?

Initial studies reported that there was no association of known shrimp viruses with MSGS and the preliminary study by laboratory trials suggested involvement of a filterable infectious agent as injection of 0.45 µm filtered lymphoid extracts from MSGS shrimp caused slow growth condition in normal growing shrimp. Later *Laem-Singh virus* (LSNV) was identified in 2006 while investigating the cause of MSGS in black tiger shrimp reared at Laem-Singh district, Chanthaburi Province, Thailand. LSNV was reported in association with MSGS in both healthy and infected *P. monodon* from Thailand followed by Malaysia, Indonesia, India and Vietnam suggesting its geographical distribution in South and Southeast Asia. LSNV is an unclassified Luteovirus-like, naked, icosahedral virus of approximately 25–27 nm with positive sense RNA. It was reported that LSNV is a necessary but insufficient cause of MSGS. The other cause (s) that lead to LSNV-associated stunting of shrimp in MSGS ponds is still unknown but may involve other pathogens and/or environmental factors. Recently an integrase containing element (ICE) is identified together with LSNV exclusively in stunted shrimp which probably might have an important role in causing MSGS. At present the causes of this slow growth is yet to be determined. More work is required to elucidate possible associations with loose shell, slow growth or other pathologies.

What are the symptoms of MSGS?

Thai researchers adopted a case definition to distinguish ponds exhibiting MSGS from slow growth caused by other problems, for surveillance and epidemiological purposes and suggested following working case definition:

The suspected population should be RT-PCR positive for LSNV and must have a CV of more than 35 % by weight and absence of Hepatopancreatic Parvovirus (HPV) or of other severe hepatopancreatic infections by known agents while also complying with any three of the following gross signs:

(i) Unusually dark colour

(ii) Average daily weight gain of less than 0.1 g day–1 g at 4 months,

(iii)Unusually bright yellow markings,

(iv)''Bamboo-shaped'' abdominal segments, and

(v) Brittle antennae

What is the economic impact of MSGS?

Reports until 2009 indicated MSGS conditions in the farms from both East and West coast of India with the history of extended culture period and growth retardation during past few years. MSGS in farmed *P. monodon* has reduced the farm profitability, caused serious economic loss, damaged export industries during the period based on this species in Thailand and has been responsible for the major switch over to *L. vannamei* farming. The impact of MSGS in tiger shrimp has been substantial on national economies due to significant production losses and poor productivity. Since 2000, economic losses due to MSGS

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became apparent. The most drastic consequence to the farmer was the uncertainty of final harvest yield and value. In a typical case, after 3-4 months of culture, the size variations ranged from 80 to 300 pieces kg-1 in a single pond and at similar stocking density, the average growth rate in MSGS ponds is approximately half that of normally expected growth by shrimp farmers. Shrimp farming in Thailand was reported to have suffered great economic damage as the production value of farmed *P. monodon* dramatically dropped to 40-68 % over a 2 year period. The accumulated damage caused by this phenomenon was estimated at 13 billion Baht (US$ 300 million). In India, White Spot Disease (WSD), Loose Shell Syndrome (LSS) and slow growth have been primarily responsible for economic losses to the shrimp farming sector. The production loss due to slow growth and white gut disease was estimated to be 5,726 MT amounting to Rs.120 crores per year (about US$21.64 million annually) (Kalaimani and Ravishankar, 2009).

How MSGS is transmitted?

LSNV has been reported to be transmitted vertically as well as horizontally. LSNV is widespread and detected in wild and domesticated broodstock and post larval shrimp in Thailand and India. High prevalence of LSNV was also reported in female broodstock shrimp and various developmental stages of shrimp viz., nauplius, zoea, mysis, post larvae 5 (PL5) and PL15. Recent studies showed relatively high prevalence of LSNV in brooders from different locations in States like Tamilnadu, Orissa and Maharashtra and Andaman and Nicobar islands in India. LSNV was reported in brooders and post larvae for the first time in Sri Lanka in 2010.

It has been also reported that the slow growth syndrome in *P. monodon* could be induced by injection of lymphoid organ (LO) extracts of MSGS affected shrimp into healthy *P. monodon*, that result in severe growth retardation and extreme size variation of 20–45 % in experimentally induced and 17–24 % in control groups In another study, Pacific white shrimp, *L. vannamei* that were co-cultured with MSGS affected *P. monodon* were reported to grow normally. However, membrane filtered LO extracts from co-cultured *L. vannamei* caused MSGS when injected into healthy *P. monodon*. These experimental transmission studies suggest *L. vannamei* might act as asymptomatic carrier. Bioassay experiments by oral feeding of MSGS affected shrimp homogenates in healthy tiger shrimp showed 100 % LSNV-positives by 10 weeks along with signs of size variation, dark discolouration, bright yellow markings and 90 % mortalities by end of four and half months of experimental period in infected group. Further, the co-habitation experiments of tiger shrimp showed 100 % positives by 5 weeks along with size variation and 65 % mortalities by end of five and half months of experimental period. In another study on experimental transmission in mud crab *S. serrata* a gradual increase in viral load in 8 days post-injection was reported, which appeared to stabilise after 20 days, post-infection. The ability of LSNV to cause infection when injected into a crustacean species other than shrimp suggests that other species might be potential natural carriers of LSNV infection.

How MSGS is diagnosed?

Nucleic acid-based diagnostic methods like Reverse Transcription **Polymerase Chain Reaction** (RT-PCR), nested RT-PCR, loop-mediated isothermal amplification combined with a lateral flow dipstick (RT-LAMP-LFD)have been used for diagnosis of LSNV with improved sensitivity and specificity . Quantification of LSNV by real-time quantitative RT-PCR (qRT-PCR) has been also developed and tested for determining LSNV loads in shrimp. By histopathology studies it was observed that retinopathy exclusively in the small shrimp from the MSGS ponds suggested that slow growth in the small shrimp from the MSGS ponds may be due to a specific infection of LSNV in the fasciculated zone and onion bodies of organ of Bellonci of the eyestalk. It is thought that progression of infection in the optic nerve may be the cause of slow growth. It is yet unclear whether retinopathy resulting from interaction between LSNV and some other agent or factor(s) like Integrase Containing Element (ICE) or other mechanisms which may predispose their fasciculated zones and organs of Bellonci to infection and damage is causing the shrimp to suffer from growth retardation.

How MSGS can be prevented/ controlled?

Shrimp farmers have been reporting slow growth of black tiger shrimp since 2002. The fifth meeting of the Asia Regional Advisory Group (AG) on Aquatic Animal Health suggested that MSGS seriously affects cultured *P. monodon*. Though its occurrence is strongly associated with infection by LSNV, there is no evidence that LSNV infection alone can cause the syndrome and the specific cause of MSGS is yet to be determined. Since the discovery of LSNV in 2006, it has been added to the list of viruses to be excluded from domesticated SPF stocks of *P. monodon* in Thailand and it has been recommended that shrimp farmers may refrain from stocking LSNV positive post larvae to avoid MSGS.

It is recommended that in countries where *L. vannamei* has been introduced, *L. vannamei* and *P. monodon* should be reared separately, particularly at the maturation and hatchery phases (http://www.biotec.or.th/rdereport/prjbioteceng.asp?Id=882). The reason is to prevent disease spreading. Incidence of MSGS has been reported to be low in farms adopting GMP, GAqP or using SPF PL. It would be practical to limit the potential spread of MSGS by initiating quarantine safeguards in the movement of live shrimp stocks for aquaculture to prevent its spread by live broodstock or PL for aquaculture. which will help to reduce the risk of importing exotic viral pathogens that may damage local aquaculture.

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Further reading

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