JUST AGRICULTURE
multidisciplinary e-Newsletter

LPV – A Newly Reported Parvo-Like Virus in Australian Shrimp

Laishram Soniya Devi[1], David Waikhom[1]*, Angom Baleshwor Singh[1], Sapna Devi Khumukcham[1]
[1]ICAR-Central Institute of Fisheries Education (CIFE), Mumbai-400061, India

ARTICLE ID: 33

Introduction

Shrimp aquaculture has become a commercially crucial primary industry from subsistent farming activity, providing millions of jobs to people across the globe, mainly in countries with substantial coastal boundaries over the past few years. With the expansion of the shrimp industry, it has become imperative to ensure the sustainability and efficiency of shrimp aquaculture. Consequently, this has led to an increasing number of the emergence and dissemination of viral pathogens since the late 1980s (Owens *et al.*, 2015; Dhar *et al.*, 2019). It has brought disaster worldwide to this industry due to the swiftly increasing geographical region and host varieties with an unreasonable prevalence of disease occurrence in aquaculture, including those caused by formerly recognized and unrecognized diseases. Besides, Parvoviruses portray an economically significant virus group that has notably influenced shrimp aquaculture. So far, four single-stranded DNA shrimp parvoviruses are distinguished from infecting shrimp; they comprise infectious hypodermal and hematopoietic necrosis virus (IHHNV), hepatopancreatic parvovirus (HPV), lymphoid parvo-like virus (LPV) and spawner-isolated mortality virus (SMV) (Owens, Beer & Smith, 1991; Lightner and Redman, 1998). The outbreaks of IHHNV and HPV caused huge economic repercussions; therefore, most studies have solely focused only on these two pathogens (Dhar *et al.*, 2019); at the same time, info on SMV and LPV remains little (Dhar *et al.*, 2014). It infects only three wild and captive (farmed) penaeid shrimp species and one of its hybrids is detected randomly by the IHHNV and HPV viruses. It was only first seen in wild fishery shrimp *P. merguiensis* from the Burdekin River in Australia. Almost simultaneously, LPV was found in P. monodon farms near Townsville in 1989 (wild) and shortly afterward in the aquaculture establishments in 1990 - 91 (Owens *et al.*, 1997). It is the relatively prevalent pathogen of wild and farmed penaeid shrimp (Owens, Beer & Smith, 1991; Span *et al.*, 1995 & 1997).

JUST AGRICULTURE
multidisciplinary e-Newsletter

LPV

Lymphoidal parvo-like virus (LPV) is a new parvo-like virus that is also an intranuclear virus and particles discovered by Owens in 1991(Owens *et al.,* 1992). He reported (LPV), which appears to be confined solely to the lymphoid organ of *P. monodon* subadults (Spann *et al.*, 1995). Typically, its virions are small in size, icosahedral, non–enveloped, ranging from 18 to 30 nm in diameter along a linear genome of single-stranded DNA (ssDNA), which consists of intranuclear particles, occasionally in paracrystalline arrays, and are often associated with inclusion bodies (Owens, Beer & Smith, 1991 and Tung *et al.,* 1999; Dhar *et al.,* 2014). Currently, LPV is believed to be a member of the Parvoviridae, but its position in the family remains unsettled. The genome of this virus has not yet been studied.

LPV is somewhat similar to IHHNV with rare Cowdry type A inclusion bodies (Owens, Beer & Smith, 1991) except for infection in a batch of black tiger shrimp/brown tiger shrimp hybrids in which inclusions were prominent (Owens *et al.,* 1992). Moreover, LPV particles exhibit an equivalent dimension to PmergDNV, while the inclusion bodies resemble PC84. In addition, there is a report of considerable closeness between LPV and PstDNV (Bateman *et al.,* 2017)

- **Common name:** Lymphoidal parvo-like virus disease or particles, LPVD,
- **Scientific name:** Lymphoidal parvo-like virus disease of penaeid shrimp
- **Geographical** distribution and spread of the disease

Firstly, LPV was reported in the wild and cultured fishery in Australia only. However, likely, it exists somewhere in the Indo-Pacific or Southeast Asia (Owens *et al.,* 1997)

Clinical signs and symptoms

LPV showed nonspecific gross signs (Dhar *et al.,* 2014 & 2019). Over and above, shrimp infected with LPV showed mild nuclear-hypertrophied nuclei in lymphoid organs, characterized by marginated chromatin and spherical structures encapsulated by fibrocytes similar to the lymphoid organ containing spheroids basophilic intranuclear inclusion bodies in multinucleate giant cells.

Host species of LPV

LPV was first detected from three wild and captive Australian penaeid shrimp species, namely *Penaeus merguiensis* (Banana prawn), *Penaeus monodon* (Black Tiger prawn),

JUST AGRICULTURE
multidisciplinary e-Newsletter

Penaeus esculentus, and hybrid *P. monodon* X *P. esculentus* in Australia (Owens, Beer & Smith, 1991; Owens *et al.*, 1992 & 1997; Munday and Owens, 1997).

Target tissues and histopathology

LPV infection was observed in systemic tissues, including the antennal gland, nerve cord, lymphoid organ (Oka organ), gill, connective tissues of various organs and tissues, and possibly the hematopoietic tissues (Owens, Beer & Smith, 1991; Owens *et al.*, 2015; Dhar *et al.*, 2019). Among these tissue or organs, the lymphoid organ exhibited the heaviest infection.

Histopathological features revealed distinct cellular foci resembling tubules lacking a central hemolymph vessel, hypertrophied nuclei with chromatin marginated, large cytoplasmic vacuoles, and eosinophilic basophilic spherical intranuclear inclusion bodies within the cells of the above-mentioned organ or tissues. Besides, basophilic inclusion caused by LPV stained positively with Feulgen (Owens, Beer & Smith, 1991).

Impact of disease on the host

LPV is associated with moribund wild spawners of *P. merguiensis* and has also been noticed in apparently healthy culture stock samples of all these species. Besides, LPV-infected shrimps showed multinucleated giant cells in their hypertrophied lymphoid organs. In Australia's hybridized species of *P. monodon* and *P. esculentus* prawns exhibit slow chronic mortality, which later became epizootic in that batch was reported when the shrimp attained a body weight of 3-4 g (Munday & Owens, 1997). In heavily affected species, paracrystalline arrays of LPV particles could be visible in lymphoid organ tissues (Dhar *et al.*, 2014). A correlation exists in the *Penaeus monodon* between lymphoidal changes and rounded F-like cells in the hepatopancreas. Due to the intensity of changes in the lymphoid organ compared to the hepatopancreas, lymphoid organs were more accessible and detectable (Owens, Beer & Smith, 1991).

Threat to penaeid shrimp and prawn farming

LPV predominantly attacks juveniles rather than postlarval prawns. However, most of the prawns examined for LPV were over 20 g. To every one infected with LPV, there are approximately thirty cells affected with IHHNV, which show less aggressive virus of LPV. The intensity of LPV infection was low; therefore, it caused fewer mortalities in penaeid shrimps.

Current diagnosis and pathogen detection methods for LPV infection

JUST AGRICULTURE
multidisciplinary e-Newsletter

At present, only two methods are employed for the diagnosis of LPV infection, namely Histology, Light, and electron microscopy (Lightner and Redman, 1998)

- Histopathology:
- Light and Electron Microscopy (Transmission Electron Microscopy)

Prevent and control disease outbreaks

There is a lack of anti-viral therapy to prevent or control viral diseases in shrimp farming. So, prevention measures are the cornerstone in managing this viral disease (Dhar *et al.*, 2019) as a part of health management in aquaculture systems. Some of the preventative approaches to LPV are as follows:

- Use of SPF broodstock (exotic and native) in hatcheries to avoid pathogens
- Pre-screening of wild, farmed-reared broodstock and their eggs/nauplii through the application of PCR
- Development of a disease surveillance system to map the viral hotspot regions
- Utilize genetically resistant lines of LPV
- Proper on-site routine monitoring of disease ponds and nearby adjacent ponds
- Use of probiotics or immunostimulants in shrimp aquaculture to enhance the general well-being of shrimp
- Molecular screening using genetic markers for imported aquaculture products specific to live feeds
- Utilization of therapeutic approach primarily based on ds RNA-mediated gene silencing, RNA interference, and RNAi mechanism to develop anti-viral therapy against LPV infection

Conclusion

In recent years, the development and expansion of the shrimp industry and intensive farming emerged. They spread several viral diseases that cause severe economic loss globally to meet the increasing demand for seafood by the overgrowing human population. Diseases have often propagated well before being fully understood, managed, and controlled. Among the members of parvoviruses, especially LPV, got less acknowledgment instantly. So, to avoid a massive economic loss due to LPV in the aquaculture sector, disease surveillance may be one of the strategies that can be used to point out and prevent the spread of this distinct disease in a specific area.

JUST AGRICULTURE
multidisciplinary e-Newsletter

References

Bateman, K.S. and Stentiford, G.D. (2017). A taxonomic review of viruses infecting crustaceans with an emphasis on wild hosts. Journal of Invertebrate Pathology, 147:86-110.

Dhar, A.K., Cruz-Flores, R., Caro, L.F.A., Siewiora, H.M. and Jory, D. (2019). Diversity of single-stranded DNA containing viruses in shrimp. Virus Disease, 30 (1):43-57.

Dhar, A.K., Robles-Sikisaka, R., Saksmerprome, V. and Lakshman, D.K. (2014). Biology, genome organization, and evolution of parvoviruses in marine shrimp. In *Advances in virus research* (Vol. 89, pp. 85-139). Academic Press.

Lightner, D.V. and Redman, R.M. (1998). Shrimp diseases and current diagnostic methods. Aquaculture, 164 (1-4):201-220.

Munday, B.L. and Owens, L. (1997). Viral Diseases of Fish and Shellfish in Australia. In Intenational Symposium on Diseases in Marine Aquaculture (p. 13).

Owens, L. (1992). Infectious hypodermal and haematopoetic necrosis virus (IHHNV) in an interspecies hybrid penaeid prawn from tropical Australia. Diseases of Aquatic Organisms, 14:219-228.

Owens, L. (1997). The history of the emergence of viruses in Australian prawn aquaculture. World Journal of Microbiology and Biotechnology, 13 (4):427-431.

Owens, L. (2015). Expressed genes in the lymphoid organ of broodstock banana prawn (*Penaeus merguiensis*) using suppression subtractive hybridization. Journal of Aquaculture & Marine Biology, 2:1-9.

Owens, L. (2019). The effect of viral infection on the relationship between the LOS cells and moulting stages of the black tiger prawn (Penaeus monodon). Aquaculture, Aquarium, Conservation and Legislation, 12:1087-1101.

Owens, L., De Beer, S. and Smith, J. (1991). Lymphoidal parvovirus-like particles in Australian penaeid prawns. Diseases of Aquatic Organisms, 11:129-134.

Spann, K.M., Adlard, R.D., Hudson, D.A., Pyecroft, S.B., Jones, T.C. and Voigt, M.O.C. (1997). Hepatopancreatic parvo-like virus (HPV) of *Penaeus japonicus* cultured in Australia. Diseases of Aquatic Organisms, *31*(3):239-241.

Spann, K.M., Vickers, J.E. and Lester, R.J.G. (1995). Lymphoid organ virus of Penaeus monodon from Australia. Diseases of Aquatic Organisms, *23* (2):127-134.

Tung, C.W., Wang, C.S. and Chen, S.N. (1999). Histological and electron microscopic study on Macrobrachium muscle virus (MMV) infection in the giant freshwater prawn, *Macrobrachium rosenbergii* (. de Man), cultured in Taiwan. Journal of Fish Diseases, 22(4):319-323.