Guideline for medical interventions
Veterinary Medicine
Aquatic Animal Medicine

Most common Viral Diseases Affecting Shrimp in Aquaculture Systems

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Aim

The principal objective is to provide concise data regarding main viral infections of shrimp in aquaculture systems. It aims to underscore the diversity of viruses, their epidemiology, pathophysiology, and diagnostic methodologies, while accentuating their economic, ecological, and social ramifications. The evaluation seeks to assess current prevention and control techniques, pinpoint knowledge deficiencies, and suggest future research and management paths to improve aquaculture sustainability.

Scope

- Shrimp biology and farming requirements.
- Epidemiology and transmission mechanisms of viral infections in aquaculture systems.
- Clinical signs and pathological findings related to viral infections in cultured species.
- Diagnostic methodologies, including molecular tools, immunological assays, and innovative technology.
- Prevention and control strategies, including biosecurity protocols, selective breeding for disease resistance and management techniques.

Introduction

Giving a steady supply of protein while also making substantial contributions to economic growth and food security, aquaculture has quickly become one of the world's most dynamic food production industries (Obirikorang et al., 2024). However, infectious diseases, especially those with a viral origin, have been on the rise alongside the fast expansion of aquaculture (Valero and Cuesta, 2023) and considered a significant threat to global shrimp production, causing substantial

economic losses through reducing production, increasing costs and trade restriction. Acute outbreaks, large mortality rates, and substantial economic losses are sometimes caused by viral infections, which pose a significant threat to farmed shrimp and fish (Rahaman et al., 2025). These diseases limit the potential for growth, decrease the likelihood of survival, and impede the global expansion of aquaculture businesses (Maezono et al., 2025). Viruses including White Spot Syndrome Virus (WSSV), Yellow Head Virus (YHV), and Taura Syndrome Virus (TSV) have also had a devastating effect on shrimp farming (Arulmoorthy et al., 2020).

Virus diseases have far-reaching effects that go beyond financial burdens. They threaten biodiversity and environmental stability by allowing it easier for pathogens to spread to wild populations (Sudhagar et al., 2024). Moreover, disease outbreaks have significant societal consequences because they threaten farmers' incomes and local and global market stability (Hounmanou et al., 2018).

Prevention and control procedures are of the greatest significance considering the lack of effective therapeutic measures against viral diseases (Munang'andu et al., 2016). When it comes to disease control, biosecurity protocols, early diagnostic tools, and pathogen-free broodstock are pivotal. Additionally, innovative techniques to improve aquaculture systems' resilience and sustainability necessitate continued research and international cooperation (Aly and Fathi 2024).

Shrimp biology and farming requirements

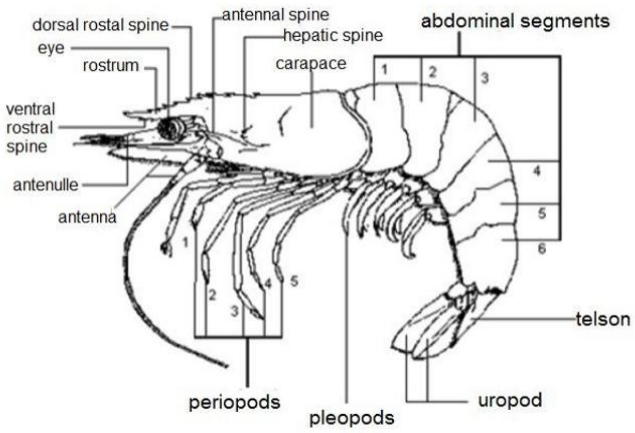
Shrimp production, a significant sector in global aquaculture, plays vital role in food security, employment and economic growth, especially in coastal regions. With increasing demand for seafood, shrimp farming has expanded rapidly making it one of the most traded aquatic products in the world. Shrimps are playing crucial roles in marine and freshwater ecosystems.

Biology: Shrimps belong to the sub-order Pleocyemata which includes most decapod crustaceans like crabs, lobsters, and shrimp. Shrimp body curved as their thorax overlaps their head and abdomen, allowing them to bend their bodies more than prawns, have two pairs of claw-like legs and plate-like gills; Shrimps will carry their fertilized eggs on the undersides of female's abdomen and females brooding eggs on their pleopods known as (berried) females. While, **Prawns** belong to the sub-order Dendrobranchiata; each segment overlaps the one below (head overlaps the thorax, and the thorax overlaps the abdomen) so their bodies are straight and unable to bend as shrimps do. Prawns also have three pairs of claw-like legs, and branching gills. The sexes are separate, and females tend to be larger than males. Prawns release their eggs into the water then leave them to grow on their own.

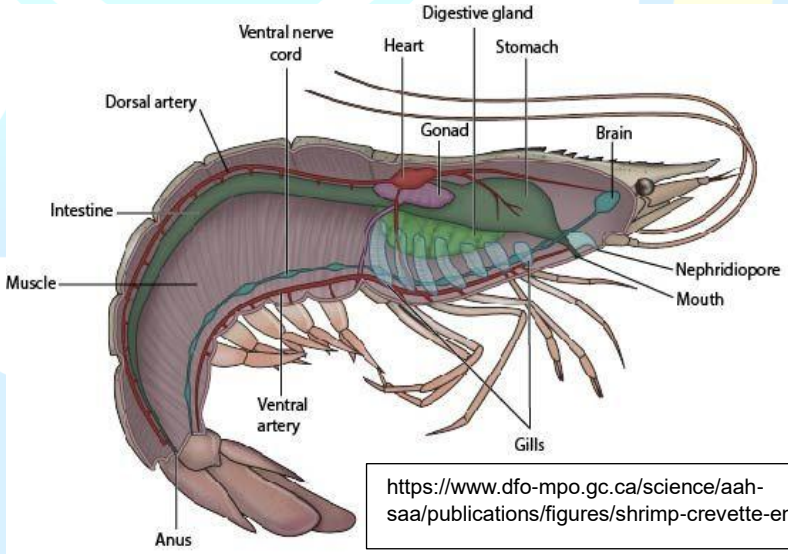
Reproduction biology: Sex is separate, reproduction is hormonally regulated, synthesis and release of hormones occur during season, Reproduction is controlled by hormones released from sinus gland and associated centers in eye stalk. The common technique used to induce reproduction is eyestalk ablation, usually unilateral by cutting off eye stalk to induce spermatogenesis and acceleration vitellogenesis in male and female respectively. In shrimp gonad maturation in female occur very rapidly within 3-4 days after ablation. At mating male

insert spermatophores (sperm) into thelycum (a specialized external structure formed from modified sternal plates on the underside of a female shrimp's thorax that receive and store sperm from male during mating) on the ventral surface of female shrimp. Fertilization occurs externally upon ovulation and passage of the oocyte through the gonadophore, the fertilized eggs are retained on female abdominal appendages (pleopods) until the larvae hatch, the newly hatched larvae each must undergo up to 12 molts to attain final form as a juvenile shrimp.

External anatomy of shrimp: Freshwater and saltwater have two body parts. The cephalothorax is part of the body that contains the head and thorax. It is protected by carapace plating. The cephalothorax has the rostrum, stalked eyes, carapace, first and second antennae, antennules, five sets of pereopods, maxillipeds, and mandibles. The abdomen has both upper and lower parts. Shrimp have swimmerets, which are also called pleopods. Shrimp's tail is made up of three parts. Two are uropods, and the telson is the most pointed part in the middle. When swimming, pleopod tails work like airplane wings to steer. A thin membrane links six parts of the abdomen. The first through fifth segments are connected to five pairs of swimming legs. The sixth segment becomes a tail fan.



Internal anatomy of shrimp: Most shrimps are omnivorous. The intestine appeared as dark line running down the back and along dorsal length of the abdomen; it is sometimes called the "mud vein"



https://www.dfo-mpo.gc.ca/science/aah-saa/publications/figures/shrimp-crevette-eng.html

Difference between shrimp and prawn:

Difference between shrimps and prawns | Martak.com

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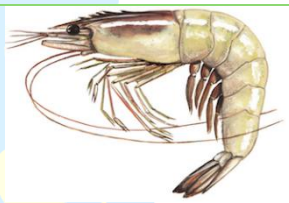
Items	Shrimp	Prawn
Body	Curved body as thorax overlaps their head and abdomen and the second abdominal segment overlaps the first and third segment.	Straight bodies with segments overlapping front-to-back.
Legs	Have two pairs of claw-like legs	Have three pairs of claw-like legs
Gills	Plate-like gills	Branching gills
Reproduction	Females brooding eggs on their pleopods known as (berried) females.	Fertilized eggs release into the water
Habitat	Most are marine	Most are freshwater

Most cultured shrimp worldwide

Species (Scientific Name)	Common Name	Key Features	Culture Regions
 **Penaeus monodon**	Black Tiger Shrimp	Large size, high market value, hardy	Widely farmed in Asia (India, Thailand, Philippines)
 **Penaeus vannamei** ذات الارجل البيضاء (الفانمي)	Whiteleg Shrimp	Fast growth, high survival, dominates global production	Latin America, Asia (China, Vietnam, Indonesia) "Egypt"
 **Penaeus indicus** الهندي الأبيض	Indian White Shrimp	Adaptable to varied salinity, good for semi-intensive farming	India, Middle East "Egypt"
 **Penaeus japonicus**	Kuruma Shrimp	High-value species, prefers sandy bottoms, sensitive to salinity	Japan, Taiwan

 **Penaeus merguiensis**	Banana Shrimp	Short culture period, moderate size	Southeast Asia
 **Penaeus semisulcatus** **الجمبري السويسي**	Green Tiger Shrimp	Hardy, moderate growth	Middle East, South Asia "Egypt"
 **Metapenaeus ensis**	Greasyback Shrimp	Smaller size, local importance	India, Southeast Asia
 **Metapenaeus monoceros**	Speckled Shrimp	Short culture cycle, moderate demand	South Asia
 ***Penaeus pulchricaudatus*** ***الجمبري القزاز*** **https://marinebiodiversity.org.bd/species/penaeus-pulchricaudatus/**	Kuruma Shrimp Tiger prawn	Short culture cycle Market size 30 gm (4 months)	Indo-Pacific, Red Sea, and Mediterranean Wild-caught prawn in Egypt around Bardawil lagoon and the Mediterranean coast.

Freshwater prawn

Macrobrachium rosenbergii

https://pescaflora.com/prawn

جمبري المياة العذبة

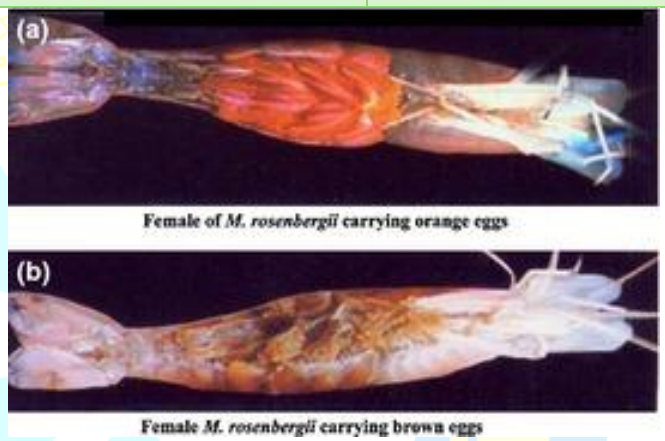
Giant river prawn

Rearing period 6-8 months
Market size 25-60 gm

Farming of Freshwater prawn: Integrated system: it cultured alongside freshwater fish using tilapia wastewater as nutrient source as well as efficient use of freshwater

Male and female *Macrobrachium rosenbergii* (scampi)

Central Institute of Freshwater Aquaculture. TNAU 2009-15



Female of *M. rosenbergii* carrying orange eggs

Female *M. rosenbergii* carrying brown eggs

(a) Female of *Macrobrachium rosenbergii* carrying orange eggs. (b) Female *M. rosenbergii* carrying brown eggs. Madlen (2013)

The Giant freshwater prawn, *Macrobrachium rosenbergii* is a valuable aquaculture species large market size , fast growth, tolerate wide range of environmental conditions, easily breeding under hatchery condition and higher survival from stocking to harvest (New, 2005), it found in freshwater estuarine areas and can culture in rice fields in brackish water with high water depth (0.5– 0.6m) (Lan et al., 2023). Mature males are larger (about 25 cm) than the females (about 15 cm); second chelipeds are much larger and thicker, head is larger, and the abdomen is narrower. The head of the mature female and its second walking legs are much smaller than the adult male. A ripe or 'ovigerous' female can easily be detected because the ovaries can be seen as large, orange-colored masses occupying a large portion of the dorsal and lateral parts of the cephalothorax. Mature prawn easily mates and spawns in captivity throughout the year with berried females (gravid females carrying ripe brown colored eggs) and successful mating can only take place between ripe females, which have just completed their pre-mating moult (usually at night) and are therefore soft-shelled, and hard-shelled males.

Life stages and corresponding feeding		
Stage	**Feeding Type**	**Notes**
Egg	None	Embryo relies on yolk reserves until hatching
Nauplius	None (yolk-dependent)	Non-feeding stage; lasts ~18–24 hours
Protozoea	Microalgae (*Chaetoceros*, *Skeletonema*)	First feeding stage; requires clean water and stable salinity
Mysis	Microalgae + rotifers + Artemia nauplii	Active swimmers need live feed for survival and growth
Postlarva (PL)	Artemia + formulated microdiet	Transition to dry feed; monitor gut fill and hepatopancreas
Juvenile	Formulated pellet feed (40–45% protein)	Feed 3–5 times/day; ensure uniform size and reduce competition
Adult	Pellet feed + supplements	Optimize feed conversion ratio (FCR); avoid overfeeding

Criteria of Good Quality Postlarvae (PL)

Uniformity

Consistent size, suggesting synchronized development anod good hatchery management

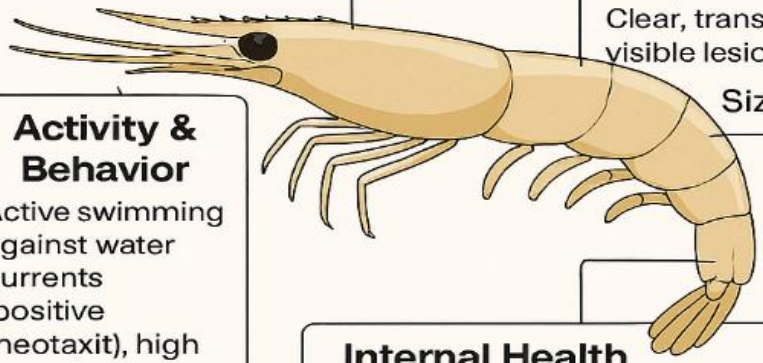
Extemal Morphology

Antennae: open
Antennal scales should be closed together on head

Tall Fan (Uropods):
Widely open, not closed

Body
Clear, translucent, with no visible lesions or deforrmities

Size: Uniform



Activity & Behavior

Active swimming against water currents (positive rheotaxit), high appetite, and quick recovery from stress

Internal Health (Microscopic)

Hepatopancreas: Large, dark, and full of lipid droplets, indicating good nutrition

Gut: Well-filled with feed, suggesting good appetite

Stress Test

Briefly lower the water temperature to see if strong PL survive

Visual Observation Checklist 4:1 in th ablominal segment

- **Observe Activity:** Check for active swimming and positive rehotaxis
- **Check Uniformity:** Visually scan for even size distribution in the tank
- **Inspect External Features:** Look for clear bodies, open uropo ds, and closed antennal scales
- **Microscopic Examination • (Key Indicator):** Use a light microscope to check the hepatopancreas (should be large, dark, lipid-filled) and gut full)

Culturing systems

- Traditional/extensive pond culture: low yield in earthen pond with minimal input.
- Semi-intensive and recirculating system: controlled environment in tanks or pool to reduce water exchange
- Intensive pond culture: use aeration, higher stocking densities and formulated feeds for increased production.
- Closed system: land-based, recirculating system that treats and reuse water, needs high aeration and technology.

Management

- Water quality: maintaining optimal salinity, temperature, Dissolved oxygen and ammonia level.
- Stocking: acclimating post-larvae to pond conditions and adjusting stocking rate (30-50/ m^2 in pond). Ideal stage for stocking is post-larvae 10-12 days old as they are potent enough for pond conditions.
- Feeding: using formulated diet to meet requirements
- Biosecurity: Practices should be applied to prevent introduction and spread of diseases.
- Harvesting: during spring tides to collect hardened-shell shrimp, using nets at pond outlets.

Most common shrimp viral diseases

Viral diseases are very important in global shrimp aquaculture. The most serious viral diseases affecting shrimp include white spot syndrome virus (WSSV) highly lethal causing up to 100% mortality within 2-7 days, Yellow Head Virus (YHV) causing up to 100% mortality within 3-5 days and Taura syndrome Virus (TSV) causes significant economic impact on shrimp production.

The diseases spread through contaminated water, direct contact and movement of infected shrimp so effective biosecurity measures and management practices are crucial to mitigate viral diseases impact on shrimp production. Disinfection of the surface of the eggs by iodophor treatment, a hatchery practice used to reduce the transmission of viral pathogens associated with egg, coelomic fluid or milt (A 10-30 min bath in 50-100 mg/L iodine solution as standard procedure performed both on recently fertilizes eggs during the water hardening step (Wood, 1979). Moreover, stocking of tilapia with shrimp in the pond culture can lower Infectious myonecrosis virus. As low-density tilapia into the pond can reduce cannibalism, consumes organic waste, control vectors as small crustacean, improve water quality and change water bacterial community.

Disease management strategies include:

- **Specific pathogen free (SPF) shrimp post-larvae stocks**: use SPF broodstock and post-larvae to reduce disease
- **Vaccinations:** explore vaccination to enhance shrimp immune response.
- Using RNA interference technology, it works by introducing double strand RNA (dsRNA) that trigger the suppression of virus replication and has potential to boost the shrimp innate immune response. Despite its promise, challenges like cost-effective dsRNA production and efficient delivery methods for large-scale farms still need to be overcome.
- **Immunostimulation:** Use immunostimulants to enhance innate immunity and provide viral resistance.
- **Early viral detection**: use PCR diagnostics for early detection and rapid response.
- **Integrated disease management**: combine biosecurity, management practices and treatment strategies.
- **Regulating water quality parameters**: monitoring water quality parameters such as oxygen, salinity, ammonia, and temperature.
- **Selection of the resistant strains of shrimp.**

Biosecurity measures include:

- **Quarantine:** quarantine for new shrimp before introducing to production system
- **Sanitation:** disinfected equipment, vehicles and personnel.
- **Pathogen screening:** regularly screen for pathogens using PCR or other diagnostic tools.
- **Access control:** restrict access to production areas**.**

Prevention and control

1. Developing domesticated SPF stocks, free of prevalent pathogens, as critical for predictable production stability. Significant efforts in breeding programs have already yielded stocks of *Penaeus vannamei* that demonstrate tolerance to TSV and IHHNV, despite lacking clarity on the underlying tolerance mechanisms, highlighting the need for persistent research in shrimp immunology.

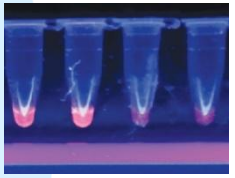
2. The efficacy of shrimp vaccinations, traditional vaccination methods based on adaptive immunity are noted as inapplicable to invertebrates, leading to proposals for “immune priming” or “trained immunity.” Despite initial successes in protecting shrimp using killed pathogens and other immune response activators, no commercial products are presently available.

3. Additional research avenues include harnessing AMPs produced by shrimp in response to infections, which could provide targeted responses against specific pathogens.

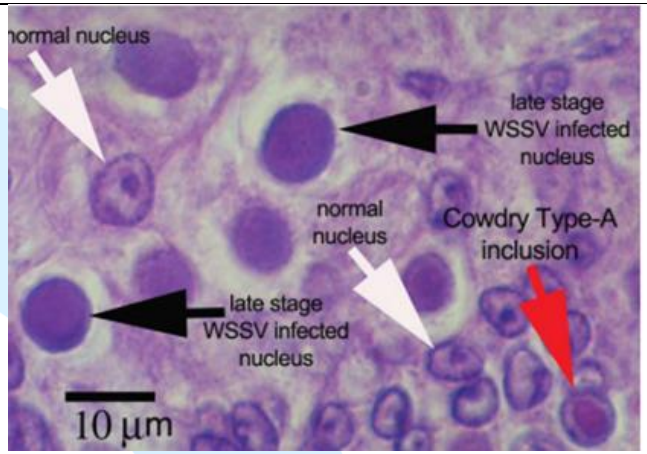
4. Emerging techniques involve using heterologous proteins—either viral or host-derived—to impede virus attachment to shrimp cells. However, practical delivery methods for these proteins remain a barrier to commercialization.

5. Using dsRNA has shown promise in combating viral infections and could pave the way for large-scale implementation, pending reductions in production costs and advancements in delivery methods.

Most common shrimp viral diseases

Most common shrimp viral diseases						
Disease	**Causative agent**	**Susceptible hosts**	**Mode of transmission**	**Clinical signs**	**Histopathological alterations**	**laboratory diagnosis**
1-White spot syndrome disease (WSSD)	White spot syndrome virus (WSSV) belongs to genus Whispovirus of the family Nimaviridae with a rod-shaped double-stranded DNA (dsDNA)	It infects penaeid shrimp, crabs, lobsters, prawns, cray-fishes, all life stages are susceptible	Horizontal transmissions occur by cannibalism / contact with infected shrimp or water, or spread of viral particles. Vertically from the spawner to offspring by viral particles shed during spawning.	Signs: • Within 3-7 or 10 days, disease mortality can reach 100%. • Infected shrimp exhibit lethargy, reduced feed consumption, reduced activity, anorexia, surface swimming. • Soft shell cuticle, and reddish to pink body discoloration. • In severe infections, WSSV signs may not be visible, with only lethargy and lack of feed consumption.	The WSD infect various tissues, including the cuticular epithelium, stomach epithelium, connective tissue, antennal gland, gills, heart, and hematopoietic tissue, with enlarged nuclei and eosinophilic to basophilic inclusions. Significant decrease in the total hemocyte count.	A broad range of commercial kits using in situ hybridization. PCR, and immunodetection techniques are available for the detection of WSSV Real time PCR. Loop-mediated isothermal amplification (LAMP).  https://www.globalseafood.org/advocate/on-site-diagnostic-kit-identifies-wssv-in-shrimp/

Lesions: A characteristic white patches (0.5-2mm diameter disks) on the inner exoskeleton layer, particularly on the carapace and abdominal segments



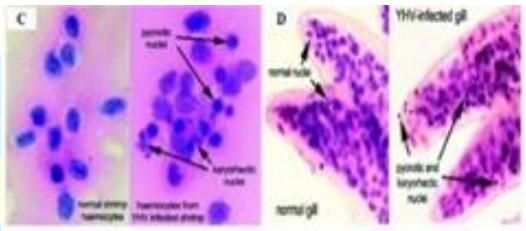
Histopathological characteristics of white spot disease: normal nucleus (white arrows); infected cells will have hypertrophied nuclei, which are stained red in the first stage, called Cowdry type A inclusions (red arrow); in the later stages they stain dark blue (black arrows) (H&E stain). https://tas2go.acfs.go.th/upload_standard/6_en.pdf%20

Prevention and control

- Biosecurity measures in shrimp farms include virus prevention, control, and eradication, as well as pond preparation, disinfection, water filtering, and treatment.
- Specific pathogen free (SPF) shrimp post-larvae stocking in ponds.
- Monitoring water quality parameters such as oxygen, salinity, ammonia, and temperature.
- Use immune stimulants to enhance innate immunity and provide viral resistance.
- Vaccinations, and RNA interference (RNAi)

Disease	Causative agent	Susceptible hosts	Mode of transmission	Clinical signs	Histopathological alterations	laboratory diagnosis
2- Yellow head disease (YHD)	Okavirus, family Roniviridae Yellow head virus single-stranded RNA	juvenile to subadult *Peneaus monodon* 50–70 days, Pacific whiteleg shrimp (*Litopenaeus van namei)*	Horizontal transmissions occur by Cannibalization of diseased shrimp, Co-habitation with infected shrimp, exposure to waterborne shedding virus particles, Imported frozen shrimp could be a source for infection. Vertical transmission was also confirmed	Signs: • Rapid but unusual rise in feed consumption, followed by an equally quick stop in feeding two to four days later. • Moribund Shrimp gather at the borders of ponds and die within 3–5 days. The name YHD was given because the bodies of many infected shrimps had a faded frequently with yellowed cephalothorax due to the gills having a brownish color and the hepatopancreas being enlarged and yellowed rather than dark brown.	Severe necrosis is characterized by prominent nuclear pyknosis and karyorrhexis. Intense basophilic perinuclear inclusion bodies are observed in the cytoplasm	Commercial kits, ISH using digoxigenin (DIG)-labeled probes, provide reagents to synthesize DIG-labeled DNA or RNA probes, which used to detect virus nucleic acid in tissues or cells Using RT-PCR assays, multiplex RT-nested PCR

Gross signs of yellow-head infection are seen here in the 3 shrimp on the right. They are generally bleached in color with a yellowish discoloration of the cephalothorax ("head") region when compared to shrimp of normal appearance on the left.
https://files01.core.ac.uk/download/20323870.pdf



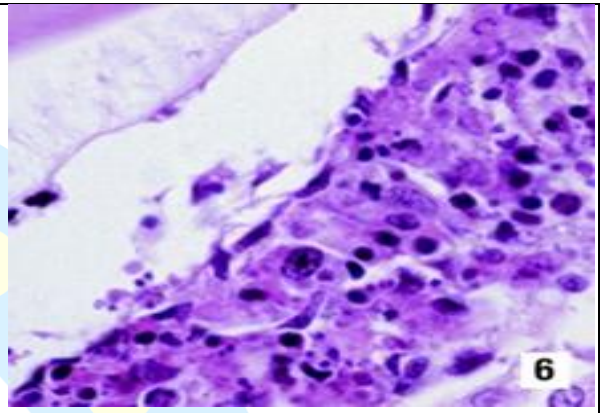
Hemolymph from normal and YHV infected shrimp identified by staining hemolymph smears; (D) Gills of YHV infected shrimp stained with H&E in rapidly fixed and stained (3 h) whole mounts. Lee et. Al., 2022

Prevention and control

- Employing biosecurity for the water and culture systems alongside SPF broodstock to generate YHV-free postlarvae.
- The use of mosquito netting to cover culture ponds and prevent the use of live or fresh feeds.
- Regulating water quality parameters.
- RNA interference technology, it works by introducing double strand RNA (dsRNA) that trigger the suppression of virus replication and has potential to boost the shrimp innate immune response. Despite its promise, challenges like cost-effective dsRNA production and efficient delivery methods for large-scale farms still need to be overcome.

Disease	Causative agent	Susceptible hosts	Mode of transmission	Clinical signs	Histopathological alterations	laboratory diagnosis
3- Taura syndrome (Red tail disease)	Family Dicistroviridae genus Aparavirus Taura Syndrome Virus (TSV) Single-stranded RNA  Transmission electron micrograph of TSV particles. Srisuvan, T. (2006)	Post larvae (PL), juveniles and adults' stages of *Penaeus vannamei*	Horizontal transmissions occur by contact with infected shrimp or water, or spread of viral particles. Vertically from the spawner to offspring by viral particles shed during spawning	Signs: Acute stage Shrimp turns pale red due to cuticular red chromophore cell proliferation, turning the pleopods and tail fan red and mortalities during molting ecdysis. Soft shell in the late stages and an empty gut. Chronic stage: Shrimp has multifocal, melanized cuticular lesions.	Necrosis in cuticular epithelium including the body surface, appendages, gills, hindgut, esophagus, and stomach, as well as subcuticular connective tissue and muscle Lacking hemocytic infiltration with the presence of Eosinophilic cytoplasm, nuclear pyknosis, and karyorrhexis Cytoplasmic spherical inclusions eosinophilic to pale basophilic staining.	In situ hybridization, RT-PCR. Taqman probe, Real time RT-PCR. RT-PCR.

The pleopods and tail fan are turning red

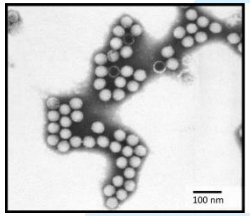


Cytoplasmic spherical inclusions eosinophilic to pale basophilic staining Characteristic lesion in peracute phase of Taura syndrome. 900x magnification

http://www.agriculture.gov.au/pests-diseases-weeds/aquatic

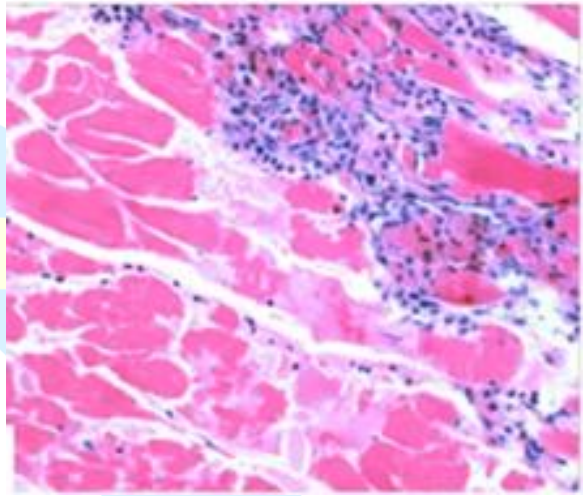
Prevention and control

- Prescreen broodstocks and spawned eggs/nauplii and eliminate TSV positive
- Stocking with TSV-SPF stocks.
- Biosecurity measures application and disinfection of eggs and larvae, and the selection of TSV-resistant P. vannamei (OIE, 2017).

Disease	Causative agent	Susceptible hosts	Mode of transmission	Clinical signs	Histopathological alterations	laboratory diagnosis
4- Infectious myonecrosis	Infectious myonecrosis virus, a non-enveloped virion double-stranded dsRNA  Transmission electron micrograph of purified infectious myonecrosis virions. Tang, et.al.,. 2019.	All stages of shrimp can be affected by IMNV disease. It is particularly common in juvenile and adult stages,	Horizontal transmissions occur by contact with infected shrimp or water or spread of viral particles. Vertically from the spawner to offspring by viral particles shed during spawning	Signs: including focal to extensive whitish necrotic areas in the abdominal muscles. Reddish coloration of the tail fan, which resembles the appearance of cooked shrimp. Hypertrophy of the lymphoid organ Mortalities varying between 40% and 70% in infected pond	Muscle sections exhibit coagulative or multifocal necrosis of striated (skeletal) muscle fibers accompanied by hemocytic infiltration. Fibrocytic inflammations, and phagocytosis, are frequently associated with edema in the lesion. In the most severe lesions, hemocytes and inflamed muscle fibers are substituted by a loose matrix of fibrocytes and connective tissue fibers.	In-situ hybridization along with 993 bp digoxigenin-labeled probe Western blot PCR

Naturally (A) and experimentally (B) IMNV-infected shrimp

Sahul Hameed, et.al., (2017)



Sahul Hameed et al., (2017).

Prevention and control

- Good management practices, application of biosecurity measures and prescreen broodstocks for presence of virus
- Stocking of tilapia with shrimp in the pond culture can lower IMNV. As low-density tilapia into the pond can reduce cannibalism, consumes organic waste, control vectors as small crustacean, improve water quality and change water bacterial community.
- Use of immune-stimulants and probiotics to enhance immune responses

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