



INFECTION WITH COVERT MORTALITY NODAVIRUS (CMNV)

PATHOGEN INFORMATION

1. CAUSATIVE AGENT

1.1. Pathogen type

Virus.

1.2. Disease name and synonyms

Infection with covert mortality nodavirus (CMNV), viral covert mortality disease (VCMD), running mortality syndrome.

1.3. Pathogen common names and synonyms

Covert mortality nodavirus (CMNV).

1.4. Taxonomic affiliation

CMNV is a related but unclassified virus of the Family *Nodaviridae* (Sahul Hameed *et al.*, 2019).

1.5. Authority (first scientific description, reference)

CMNV was first described in China (Zhang *et al.*, 2014).

1.6. Pathogen environment (fresh, brackish, marine waters)

Fresh, brackish and marine waters. Infection with CMNV can occur in a wide range of salinities from fresh water to 30 ppt (Wang *et al.*, 2022; Wang *et al.*, 2021b; Liu *et al.*, 2017).

2. MODES OF TRANSMISSION

2.1. Routes of transmission (horizontal, vertical, indirect)

The presence of CMNV viral particles in the gonad suggests vertical transmission is a possible route of infection. Experimental studies have found that fertilised eggs and nauplii from artificially infected parents were positive for CMNV (Liu *et al.*, 2017).

CMNV can be transmitted horizontally among shrimp through cannibalism and co-habitation in rearing ponds (Zhang *et al.*, 2014).

CMNV can be transmitted via effluent water or through close habitation of different species (Xu *et al.*, 2022; Wang *et al.*, 2019).

Infected feed or bait (e.g. *Artemia*) can transmit the disease and poses an introduction risk (Yao *et al.*, 2022).

2.2. Reservoir

Infected populations of aquatic animals, both farmed and wild, may act as reservoirs of infection.

Five species that typically co-exist in shrimp ponds have had positive detections on RT-PCR and ISH [*Sinocorophium sinense*, Edward's hermit crab (*Diogenes edwardsii*), Ghost crab (*Ocypode Cordimanus*), Amphipod (*Parathemisto Gaudichaudii*) and Fiddler crab (*Tubuca arcuate*)]. These species may act as vector species or act as viral reservoirs (Liu *et al.*, 2018).

Six other invertebrate species (*Artemia sinica*, *Balanus sp.*, *Brachionus urceus*, *Magallana* (Syn. *Crassostrea*) *gigas*, Gammarid amphipod, *Meretrix lusoria*) were positive for CMNV on RT-PCR (Liu *et al.*, 2018) and may also act as a reservoir.

2.3. Risk factors (temperature, salinity, etc.)

In shrimp, high mortality rates (80%) may occur at water temperatures above 28°C (Zhang *et al.*, 2014) and with any sudden changes in weather (Liu *et al.*, 2022) or increased NO₂-N levels in the water (Yao *et al.*, 2022).

3. HOST RANGE

3.1. Susceptible species

Crustaceans

Chinese white shrimp (*Penaeus chinensis*), Kuruma prawn (*Penaeus japonicus*), giant tiger prawn (*Penaeus monodon*), giant river prawn (*Macrobrachium rosenbergii*) (Xia *et al.*, 2022; Zhang *et al.*, 2017), ridgetail prawn (*Palaemon carinicauda*) (Liu *et al.*, 2017), white leg shrimp (*Penaeus vannamei*) (Liu *et al.*, 2021).

Fish

Japanese flounder (*Paralichthys olivaceus*) (Wang *et al.*, 2019), large yellow croaker (*Larimichthys crocea*) (Xu *et al.*, 2022), zebrafish (*Danio rerio*) (Wang *et al.*, 2021a), *Mugilogobius abei* (Zhang *et al.*, 2018).

Other species

Sea cucumber (*Apostichopus japonicus*) (Wang *et al.*, 2021b).

3.2. Affected life stage

Crustaceans

All life stages are affected. Experimental studies have found that fertilised eggs and nauplii from artificially infected parents were positive for CMNV (Liu *et al.*, 2017).

4. GEOGRAPHICAL DISTRIBUTION

Infection with CMNV has been reported in China (People's Republic of) (Zhang *et al.*, 2014) and Thailand (Pooljun *et al.*, 2016; Thitamadee *et al.*, 2016).

Additional reports of detections can be found in literature but without supporting data (Varela-Mejias, 2018; Zhang *et al.*, 2017; Huang *et al.*, 2015).

5. CLINICAL SIGNS AND CASE DESCRIPTION

5.1. Host tissues and infected organs

Crustaceans

The main organs where pathology is observed are the nervous tissues, hepatopancreas, muscle and ovary (Liu *et al.*, 2022; Liu *et al.*, 2017; Zhang *et al.*, 2017).

Fish

The main organs where pathology is observed is the brain, eyes, muscle, gill and intestine (Wang *et al.*, 2022).

5.2. Gross observations and macroscopic lesions

Crustaceans

Moribund shrimp sink to the bottom and are typically found in deep water rather than at the surface or edges. Affected animals often exhibit pale bodies with soft shells (Zhang *et al.*, 2014).

Internally there is evidence of hepatopancreatic atrophy with a faded colour, empty stomachs and uneven whitish muscular lesions in the abdominal sections (Zhang *et al.*, 2014).

Fish

Anorexia and abnormal swimming behaviours (vertical or horizontal spiralling) (Xu *et al.*, 2022, Zhang *et al.*, 2018).

Visual examination was normal but with stunted growth (Wang *et al.*, 2019). Zebrafish have shown exophthalmus and red-brown discolouration of the tail (Wang *et al.*, 2022).

5.3. Microscopic lesions and tissue abnormality

Crustaceans

White muscle lesions show muscle fragmentation leading to coagulative, muscular lysis and myonecrosis. Multifocal myonecrosis in striated muscle included haemocytic infiltration and karyopyknosis of hemocytes. Vacuolation in the cytoplasm of hepatopancreocytes and eosinophilic inclusions in the tubular epithelium of the hepatopancreas.

Fish

Cytoplasmic vacuolation in the nervous tissue of the eye and brain and in hepatocytes. Muscular lysis, myonecrosis and haemocytic infiltration of the cardiac muscle and fibromuscular stroma. Cell necrosis, degeneration and karyopyknosis of the spleen and kidney tissues (Wang *et al.*, 2019). Haemocytic infiltration along the enterocytes of intestine folds (Zhang *et al.*, 2014b).

5.4. WOA status

Infection with CMNV is considered to meet the WOA definition of an 'emerging disease' and, as such, should be reported to WOA in accordance with Article 1.1.4. of the *Aquatic Code*.

6. SOCIAL AND ECONOMIC SIGNIFICANCE

Infection with CMNV can under certain conditions result in high rates of mortality (up to 80%) (Zhang *et al.*, 2014). The sinking of shrimp in the ponds potentially masks the infection for farmers as the moribund animals are not visible to farmers.

The ability of CMNV to cross host species has greater implications for spread and impacts of the disease. In fish species, infection with CMNV can affect production through stunted growth (Wang *et al.*, 2019).

7. ZONOTIC IMPORTANCE

None.

8. DIAGNOSTIC METHODS

8.1. Definition of suspect cases

Crustaceans

Infection may be suspected when animals sink to the bottom of the pond with stunted growth and soft shells.

Fish

Infection may be suspected in populations with direct or indirect contact with shrimp populations and that show abnormal swimming behaviours.

8.2. Presumptive test methods

Several molecular techniques such as one-step RT-PCR, nested RT-PCR, LAMP, real time RT-PCR, ISH are available (Wang *et al.*, 2021a; Li *et al.*, 2018; Liu *et al.*, 2018; Pooljun *et al.*, 2016; Zhang *et al.*, 2014).

8.3. Confirmatory test methods

Infection with CMNV can be confirmed by molecular methods combined with sequencing.

9. CONTROL METHODS

Appropriate biosecurity measures in aquaculture establishments before and after stocking are important to prevent introduction of CMNV. These should include the use of CMNV-free broodstock and post-larvae (PLs), and feeds that do not present a risk of CMNV introduction.

As multiple vertebrate and invertebrate species are susceptible to CMNV and may act as reservoirs of infection, exclusion of potential reservoir species from ponds should occur in areas where the disease is endemic.

To prevent the translocation of CMNV from endemic to disease free areas, targeted surveillance for infection with CMNV should be completed prior to movements of animals.

10. TRANSMISSION RISK

There are no reports on the stability of CMNV however closely related *Macrobrachium rosenbergii* nodavirus can survive freezing at -20°C and is inactivated by heat treatment at 50°C for 5 mins (Ravi & Sahul Hameed *et al.*, 2014).

11. ADDITIONAL USEFUL INFORMATION

The disease has been notifiable to NACA since 2017 (in crustaceans) as 'viral covert mortality disease'.

Network of Aquaculture Centres in Asia-Pacific (NACA). CMNV Disease card: <https://enaca.org/?id=1108>

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