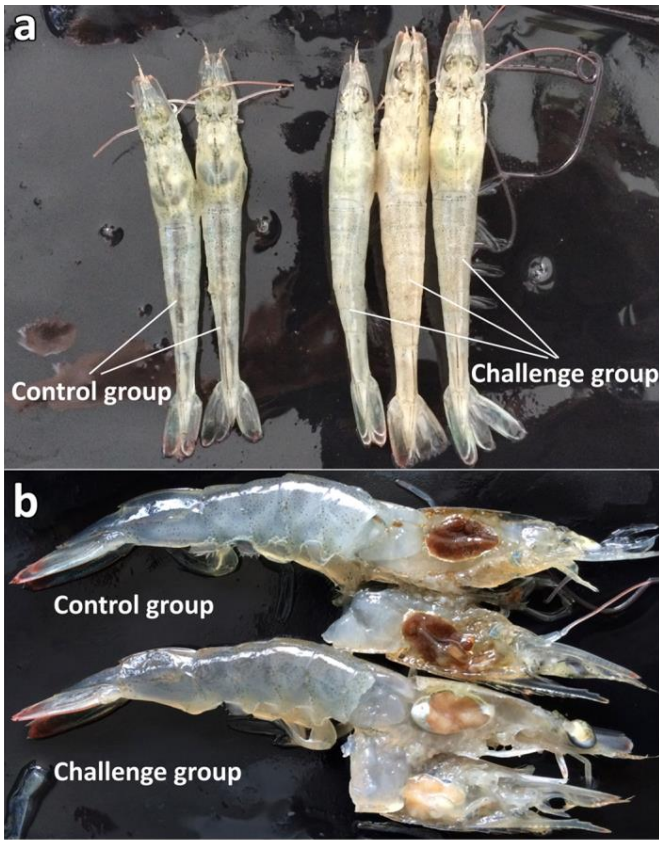
Shrimp hemocyte iridescent virus (SHIV) or Decapod iridescent virus (DIV-1) of Shrimp

Infection with *Shrimp hemocyte iridescent virus* (SHIV) or *Decapod iridescent virus* (DIV-1) is a highly fatal emerging disease reported recently from China. This infection was first identified in mortalities of crayfish in 2014 (Xu et al, 2016). Since then, it has been reported in several crustaceans, for example: oriental prawn, *Exopalaemon carinicauda* (Chen et al, 2019) and freshwater prawns (Qiu et al, 2019). Recently, SHIV was detected in diseased Pacific white shrimp, *Penaeus vannamei*, farmed in Zhejiang Province, China, and caused huge economic losses (Qiu et al, 2017). Since 2014, DIV-1 has been causing extensive mortalities as high as 80 % in farmed *P. vannamei* and *Macrobrachium rosenbergii* in China. Soaring shrimp mortalities due to SHIV, lead to significant economic losses to the shrimp farming industry in China. According to the China Fishery Statistical Yearbook 2019 estimate, the disease contributed to the drop in China's annual output of Pacific white shrimp, from 1.5m metric tons in 2013 to 1.2 million metric tons in 2018. Further, it was reported that two thirds of ponds across shrimp farms in Guangdong province, China infected with SHIV were drained immediately during the spring of 2019. Some reports also suggest the existence of this virus in shrimp farms in Thailand. Currently the name, *Decapod iridescent virus*- 1 (DIV-1) is accepted, and the disease is being reviewed by the OIE.

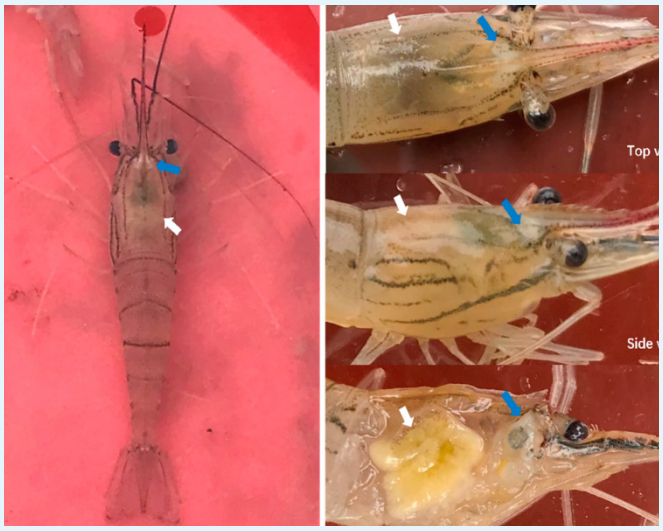
What are the symptoms of DIV-1?

- Gross signs include empty stomach and guts, soft shell, mutilated antennae, fading colour and slightly reddish body colour in around one third of affected shrimp. Whitish to yellowish coloured head due to pale atrophied hepatopancreas.



Gross signs of SHIV infection in shrimp: Shrimp infected with SHIV have a whitish to yellowish head (a) due to pale necrotic hepatopancreas (b) and a slightly iridescent appearance of the carapace.

Source: Qiu et al. 2017



Gross clinical signs of DIV-1 infection in freshwater prawn, *M. rosenbergii* (A); cephalothorax showing whitish area under the cuticle at the base of rostrum (B). White arrows indicate hepatopancreas atrophy, colour fading and yellowing. Source: Qiu et al. 2019

- The affected shrimp become lethargic, cease to feed, followed by mass mortalities. Moribund and dead shrimps could be found every day in the affected pond. Unusually high cumulative mortality reaching 80% occur within one to two weeks after the onset of infection in farmed shrimp; diseased shrimp sink to the bottom of the pond.
- This disease in *M. rosenbergii* called as "white head", in China as infected prawns exhibit a typical white triangle under the carapace at the base of rostrum and yellow gills.

Which species of crustaceans are susceptible to DIV-1?

As per the literature published so far, several decapod crustaceans such as the Pacific white shrimp *P. vannamei*, freshwater prawns *M. rosenbergii* and *M. nipponense* , Chinese white shrimp *P. chinensis*, ridge tail white shrimp *Exopalaemon carinicauda*, red swamp crawfish *Procambarus clarkii*, and red claw crayfish *Cherax quadricarinatus* are found to be susceptible to this virus. Natural infection of DIV-1 has also been reported in polychaete worm *Nereis succinea.* The two crab species, mitten crab *Eriocheir sinensis* and striped shore crab *Pachygrapsus crassipes,* have been reported to be susceptible to DIV-1 through experimental challenge.

How DIV-1 is transmitted?

Transmission of SHIV infection is possible horizontally via cannibalism of infected shrimp or through contact with infected faeces. Oral, reverse gavage and inter-muscular injection modes of experimental transmission have been demonstrated in *P. vannamei, C. quadricarinatus,* and *Procambarus clarkii.* Chinese white shrimp (*Penaeus chinensis), Macrobrachium superbum* and Cladocerans (water fleas, Order Cladocera) might serve as potential carriers of SHIV.

Decapod iridescent virus 1 has wide range of hosts, and can be transmitted between cultured and wild crustaceans. Therefore, polyculture of close species such as *P. vannamei*, *M. rosenbergii* and *P. clarkii* poses a serious risk of pathogen transmission.

It is likely that the international spread of this pathogenic agent via trade of aquatic animals, aquatic animal products, vectors or fomites is possible.

What is the causative agent of DIV-1 infection?

Decapod iridoviruses are large viruses that infect penaeid shrimp and crayfish. Among the viruses reported for crustaceans, two isolates of the species have been reported, one from shrimp (*P. vannamei*, shrimp hemocyte iridescent virus, SHIV) and the other from the redclaw crayfish (*Cherax quadricarinatus*, *Cherax quadricarinatus iridovirus*, CQIV). In 2019, the Executive Committee of the International Committee on Taxonomy of Viruses (ICTV) approved addition of the new species of *Decapod iridescent virus 1* (with two isolates SHIV 2014 and 2015), and CQIV CN01, and they are grouped under a new genus *Decapod*

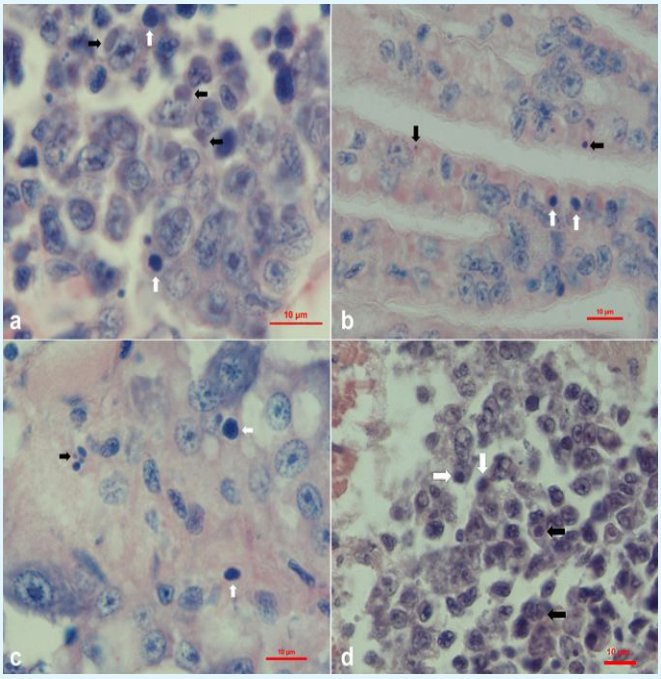


Figure showing SHIV induced histopathological features in *P. vannamei*. Presence of basophilic inclusions (black arrows) and karyopyknotic nuclei (white arrows) in the Haematoxylin and Eosin (H&E) stained hematopoietic tissue (a), gills (b) sinus of the hepatopancreas (c) and periopods. Bar - 10 μm. Source: Qiu et al. 2017

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iridovirus a member of the sub-family *Beta-iridovirinae* under *iridoviridae*. The SHIV or *Decapod iridescent virus 1 is* a large (158 nm), dsDNA non-enveloped, icosahedral virus, with genome size of about 166 Kbp.

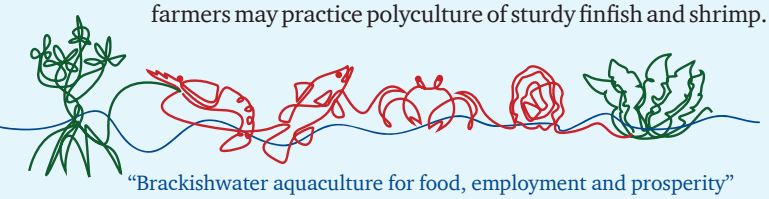
How to diagnose DIV-1 infection in shrimp?

DIV infection is systemic, and the principal target tissues for detection of DIV-1 includes hemopoietic tissue (located above the stomach and at the base of antennae), gills, hepatopancreas, pereiopods and other appendages. Haematopoietic tissues and haemocytes are the best samples for disease diagnosis. Apart from clinical signs, the disease can be diagnosed by histopathological lesions, *viz.*, dark eosinophilic inclusions and karyopyknosis in haematopoietic tissue, presence of several necrotic cells with pyknotic nuclei in the haematopoietic tissue and circulating haemocytes in the gills, hepatopancreas and haemolymph sinuses and basophilic intracytoplasmic inclusions in haemocytes and other infected cells. DIV-1 can be also detected by transmission electron microscopy (TEM) of infected animals, indicates by the presence of a number of icosahedral non-enveloped virions within cytoplasm many tissues such as haemocytes, hepatopancreas and muscle. Currently, nested PCR, and Taqman probe based qPCR methods are also available for confirmatory diagnosis of DIV-1 or SHIV infection.

How to Prevent DIV-1?

There is no treatment for SHIV infection, and therefore, prevention is the only way to circumvent the disease. Strict biosecurity measures to prevent introduction of disease into the country should be ensured. Besides, best management practices (BMP) should be adopted to maintain good water quality, proper feed usage and good health of shrimps. The following measures are very important in the prevention of SHIV.

1. Follow strict principles of pond preparation (drying, spraying lime, ploughing, etc.). This will help to kill all the bacterial and viral pathogens from previous culture.
2. Stock only disease free seeds produced from specific pathogen free (SPF) hatcheries, further ensured by PCR tests for DIV-1, white spot disease (WSD) and *Enteropcytozooan hepatopenaei* (EHP).
3. Closed re-circulatory systems or zero water exchange practice will help in avoiding contamination
4. Monitor the ponds regularly for any abnormalities and get shrimp tested time to time.
5. Avoid use of water from common water body. Reservoirs should be provided in the farm to treat the water prior to use.
6. The affected pond should be strictly disinfected using hypochlorite.
7. Avoid polyculture with diverse species of crustacean, especially with DIV 1 susceptible species. Small holding farmers may practice polyculture of sturdy finfish and shrimp.



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What ICAR-CIBA has done?

Although disease is currently confined or restricted to China, considering its catastrophic nature, ICAR-CIBA has been testing for SHIV or DIV-1 pathogen by nested PCR since January 2020 in farmed shrimp samples. However this pathogen has not been detected so far.

What we need to do?

Import of broodstock and aquaculture inputs such as Artemia and polychaetes must be avoided from China, Taiwan and possibly Southeast Asian region. Further, take proactive measures at International borders especially with Bangladesh, for prevention of entry of exotic diseases through possible cross border fisheries trade

Intensive passive and active surveillance is of paramount to detect and contain the spread of this emerging disease in shrimp farming. Widespread awareness campaigns should be conducted in major shrimp farming regions using print and other media.

What stakeholders need to do?

Since DIV-1 or SHIV is not reported in India so far, it is necessary that such cases are required to be investigated thoroughly. ICAR-CIBA is a referral laboratory for Aquatic Animal Diseases in the country and its services may be availed by the stakeholders if any mass mortality of farmed shrimp is noticed in their farms for confirmation of the disease. Other stakeholders, including farm consultants, feed representatives must ensure that tested seeds are stocked by the farmers. Freshly collected samples with signs of disease preserved in 95% ethanol (for molecular diagnostics), Davidson's fixative or Neutral buffered formalin (for histology) can be submitted to CIBA for investigation. On confirmation as positive DIV-1, the pond water should be disinfected by chlorination within the pond. The treated water should be discharged after only proper deactivation of the disinfectant.

Stakeholders may contact any of the following phone numbers or email given for collection, preservation and transport of samples testing for DIV-1 or SHIV; and farm disinfection protocols.

1. +91 94447 49519
2. +91 98408 46110
3. +91 94453 57126
4. +91 99414 08949;
   Email: aahed.ciba@gmail.com

This technical fact sheet has been prepared based on the scientific literature available till April 2020 on DIV-1 for creating awareness among the stakeholders in the aquaculture sector on the emergence and possible threat of DIV-1 to Indian Aquaculture

भाकृअनुप ICAR
CIBA

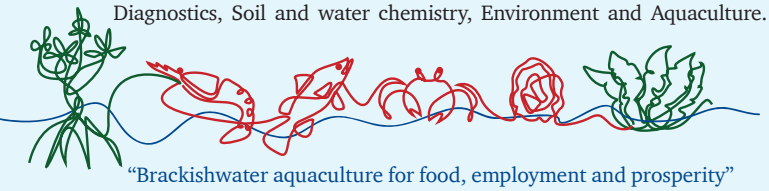
Aquatic Animal Health and Environment Division

Further Reading

1. Chen, X., Qiu, L., Wang, H.L., Zou, P.Z., Dong X., Li, F.H., Huang J., 2019a. Susceptibility of *Exopalaemon carinicauda* to the infection with Shrimp hemocyte iridescent virus (SHIV 20141215), a strain of Decapod iridescent virus 1 (DIV1). *Viruses* 11(4), 387. doi: 10.3390/v11040387
2. Chen, Z. W., Huang, J., Zhang, F., Zhou, Y., Huang, H. J., 2019b. Detection of shrimp hemocyte iridescent virus by recombinase polymerase amplification assay. *Molecular and Cellular Probes*. doi: 10.1016/j.mcp.2019.101475.
3. ICTV, 2019. One New Genus with One New Species in the Subfamily *Betairidovirinae*. https://talk.ictvonline.org/files/ictv_official_taxonomy_updates_since_the_8th_report/
4. Li, F., Xu, L., Yang, F., 2017. Genomic characterization of a novel iridovirus from redclaw crayfish *Cherax quadricarinatus*: evidence for a new genus within the family *Iridoviridae*. *Journal of General Virology*, 98(10), 2589-2595. doi: 10.1099/jgv.0.000904.
5. Pan, C. K., Yuan, H. F., Wang, T. T., Yang, F., Chen, J. M., 2017. Study of *Cherax quadricarinatus* iridovirus in two crab. *Journal of Applied Oceanography*, 36(1), 82-86 (in Chinese).
6. Qiu, L., Chen, M.M., Wan, X.Y., Li, C., Zhang, Q.L., Wang, R.Y., Cheng, D.Y., Dong, X., Yang, B., Wang, X.H. and Xiang, J.H., 2017. Characterization of a new member of Iridoviridae, Shrimp hemocyte iridescent virus (SHIV), found in white leg shrimp (*Litopenaeus vannamei*). *Scientific Reports*, 7 (1), 1-13.
7. Qiu, L., Chen, M.M., Wan, X.Y., Zhang, Q.L., Li, C., Dong, X., Yang, B. and Huang, J., 2018. Detection and quantification of shrimp hemocyte iridescent virus by TaqMan probe based real-time PCR. *Journal of Invertebrate Pathology*, 154, 95-101.
8. Qiu, L., Chen, M.M., Wang, R.Y., Wan, X.Y., Li, C., Zhang, Q.L., Dong, X., Yang, B., Xiang, J.H. and Huang, J., 2018. Complete genome sequence of shrimp hemocyte iridescent virus (SHIV) isolated from white leg shrimp, *Litopenaeus vannamei*. *Archivesof Virology*, 163(3), 781-785.
9. Qiu, L., Chen, X., Guo, X.M., Gao, W., Zhao, R.H., Zhang, Q.L., Yang, B. and Huang, J., 2020. A TaqMan probe based real-time PCR for the detection of Decapod iridescent virus 1. *Journal of Invertebrate Pathology*, p.107367.
10. Qiu, L., Chen, X., Zhao, R.H., Li, C., Gao, W., Zhang, Q.L. and Huang, J., 2019. Description of a natural infection with decapod iridescent virus 1 in farmed giant freshwater prawn, *Macrobrachium rosenbergii*. *Viruses*, 11 (4), 354.
11. Xu, L., Wang, T., Li, F. and Yang, F., 2016. Isolation and preliminary characterization of a new pathogenic iridovirus from redclaw crayfish *Cherax quadricarinatus*. *Diseases of aquatic organisms*, 120 (1), 17-26.

Aquatic Animal Health and Environment Division

Research programmes on aquatic animal health were initiated at the Central Institute of Brackishwater Aquaculture since 1990. Since then it has grown considerably in terms of expertise, manpower and laboratory facilities. Presently, the Aquatic Animal Health and Environment Division or the AAHED in short, has scientists of relevant disciplines, such as Microbiology, Pathology, Parasitology, Biotechnology and Molecular Diagnostics, Soil and water chemistry, Environment and Aquaculture.



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The AAHED has well established laboratory facilities for carrying out hi-tech research in molecular biology in addition to aquatic animal health and environment management including diagnostics, prophylactics and health management in brackishwater aquaculture. The advanced facilities have been developed with funding support from ICAR, National Agricultural Research Project (NARP), World Bank, National Agricultural Technology Project (NATP), All India Network Project on Fish health (AINI), Consortia Research Platform on Diagnostics and Vaccanies (CRPD & V), Department of Biotechnology and National Fisheries Development Board with dedicated efforts of scientists. A well designed wet lab oratory is also in place for carrying out live aquatic animal experiments and evaluating Koch's and River's postulates.

The AAHED, CIBA has the mandate to carry out research on (a) economically impacting diseases of brackishwater culture species and develop technologies for rapid diagnosis, prophylaxis and control; (b) brackishwater environment and develop mitigatory measures as required; and (c) provide technical and policy support to the Government on matters pertaining to aquatic animal health and environment management to improve aquaculture productivity.

The AAHED of CIBA was the first to commercialsise a white spot syndrome diagnostic kit to a premier Biotechnology company in the year 2002. The AAHED also produced kit for diagnosis of white tail disease in scampi (2004). Recently, highly sensitive diagnostic kits have been developed for hepatic pancreatic microsporidosis and white spot disease. AAHED has the expertise and capacity to carry out proposed levels of Diagnostics of all the OIE listed Brackishwater pathogens.

The environmental section has the laboratory and expertise to look into all aspects of abiotic parameters. Novel methods have been developed for the bioremediation and environmental monitoring of the brackishwater rearing systems, including hatchery and farms. The unit also has expertise in climate related studies, and has developed climate smart solutions for brackishwater farming systems. Environment section has the expertise for the environmental impact assessment and monitoring studies, carrying capacity assessment of source waters for optimisation of Brackishwater aquaculture development.

AAHED, CIBA has published over 80 research publications in peer reviewed national and international journals, produced 15 Ph.Ds, who are currently employed in key positions in various Institutions in India and abroad.

Microbiology & Virology:

Dr S.V. Alavandi, Dr M. Poornima, Dr P. K. Patil, Dr Sanjoy Das, Dr T. Bhuvaneshwari, Dr N. Lalitha, Dr Sujeet Kumar

Biotechnology, Molecular Diagnostics & Aquaculture:

Dr. K.K. Vijayan; Dr S.K. Otta; Dr Satheesha Avunje

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