Disease issues in Indian brackishwater aquaculture and management strategies

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Introduction

The Indian fisheries sector has constantly been contributing to the nutritional security to the people by providing affordable source of protein. According to FAO (2012), globally, 16.5% of total animal protein source and 6.5% of total protein consumption is supplied through fisheries products. World over, overexploitation of stocks has almost brought a stagnant growth to the production of fish from the capture fisheries. On the other hand, the growth from the aquaculture sector has consistently been on the increase and it is predicted that by 2030 the production will almost match with that of capture fisheries. Evolving from its traditional form and equipped with the modern infrastructure, the aquaculture sector is thus moving at a rapid pace to meet the growing demand of ever increasing population. Global fish production touched 158 million tons out of which aquaculture production contributed to 66.6 million tons of food fish in 2012 (FAO, 2014). Indian fisheries sector has also witnessed a growing trend particularly during the last several years. In 2012, India's total fish production was 14.6 lakh tons, more than double, compared to a 7.6 lakh tons in 2003. During 2013-14, the production from the shrimp culture alone was 3 lakh plus tons and the total export value from marine and brackishwater sector reached an all-time high of over US $ 5000 million.

Rapid expansion of aquaculture sector in terms of the area under cultivation, increased stocking densities and aquaculture inputs have contributed to the emergence and spread of diseases. The disease problems show an increasing trend almost parallel with the aquaculture development and intensification. During the days of traditional farming with low stocking density, prevalence of non-infectious (nutritional / toxin) or less dangerously endemic pathogen (bacteria or parasites) related diseases were common. In the present day of farming, it has been estimated that up to 40% of shrimp production, with a value of ~ >$3bn is lost annually, mainly due to disease incidence caused by viral pathogens. Starting from 1994, the annual crop loss to shrimp culture industry of India has been estimated to be about rupees 300 crores per annum and this is largely due to a single causative agent, the white spot syndrome virus (WSSV). Disease has always been a limiting factor and their management plays a crucial role on the sustainability and economic viability of any aquaculture enterprise.

Diseases in brackishwater aquaculture

Issues in finfish grow-out culture

Presently, the Indian brackishwater aquaculture sector is dominated by shrimp culture due to its high export value. India has a great potential for brackishwater finfish culture and with the support of the aquaculture promoting agencies and R&D institutions, hatchery and farm rearing technologies of new finfish species are already being demonstrated by the farming sector for economic viability. Expansion of brackish / marine finfish aquaculture has been taking place along the coastal states of India especially, Andhra Pradesh, Tamil Nadu, West Bengal, Odisha and Gujarat. As with the case of any live animal rearing issues, disease has been an issue in finfish culture sector also. Although a number of viral and bacterial pathogens have been reported from other finfish farming nations, only viral nervous necrosis (VNN) has been reported to be present in India, mainly causing mortalities in the larval stages of seabass.

Among the bacterial pathogens, *Vibrio anguillarum* has been reported to be associated with diseases in brackishwater finfish by some investigators.

Issues in crustacean grow-out culture

Viral Diseases

Among the listed viruses of the farmed crustaceans, the white spot syndrome virus (WSSV) and infectious hypodermal hemotopoetic necrosis virus (IHHNV) have been frequently reported from Indian subcontinent and, at present both these pathogens can be considered as endemic pathogens to India. Other viral pathogens such as infectious myonecrosis virus (IMNV), Taura syndrome virus (TSV), yellow head virus (YHV) which have been responsible for causing losses to aquaculture in the Americas and the Southeast Asian countries have so far not been scientifically confirmed from India. IHHNV is known to be associated with runt deformity syndrome in the Pacific white shrimp. However, its negative impact on Indian shrimp culture yet needs to be quantified.

For the global aquaculture sector, WSSV pandemic served as a "wake up" call and the catastrophic losses had serious impacts on the economies of some countries in Southeast Asia including India, and also some of the Latin American countries. Following emergence of WSD pandemic, a number of diagnostic techniques were developed, and molecular diagnostics has become part of present aquaculture industry. Prevention and control of WSD has been a serious challenge to the shrimp farming sector and the scientific community at large. In the hope of finding new strategies for the disease control especially against WSD, novel approaches using viral accommodation, a process that has evolved from host viral interaction, put forward by Flegel (2007). Research on the molecular mechanisms of tolerance of shrimp to viral infections has been showing promise, but the understanding is still in infancy.

Fig 1. Growth variation in vannamei shrimp

Bacterial diseases

Bacterial diseases in shrimp until recently were considered less significant upon emergence of viral diseases since 1994. Starting from early 2010, the early mortality syndrome (EMS) specifically designated as acute hepatopancreatic necrosis disease (AHPND) has caused significant losses in many of the Southeast Asian countries and Mexico. A specific strain of *Vibrio parahaemolyticus* was found to be the causative agent. Through quorum sensing, these bacteria produce a toxin that affects hepatopancreas, the digestive gland of shrimp. In the advanced stages of infection, the shrimp health is worsened due to secondary infection by other bacteria. While molecular diagnostic tools are developed for the detection of specific strains of

these bacteria, it would be a daunting task to prevent AHPND since these species are native to coastal and marine waters. Biofloc

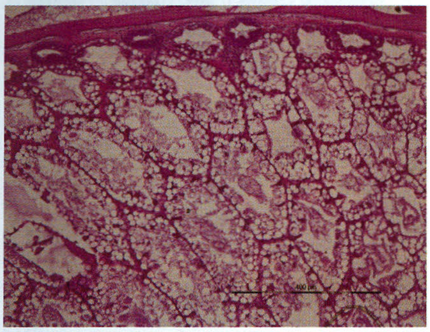

Fig 2. Histopathology of shrimp heatopancreas showing vacuolation of cells and haemocytic infiltration in the peripheral intertubular spaces indicating bacterial infection

technology and green water technology appear to be promising in overcoming AHPND, however, more research in this direction is necessary.

Although AHPND has not been reported from Indian aquaculture sector, issues often related with WSD and secondary bacterial infection, mostly related to the water quality and poor health status of the grow-out rearing system has been observed. In addition to such mortalities, a number of farmers have been reporting continuous low-level mortality, popularly known as running mortality syndrome (RMS). In the RMS affected ponds, starting from about 45 or more days of culture (DOC), a portion of the biomass (about 50-100 shrimp per day) succumbs to slow mortality, and by 90 DOC, the mortality of shrimp rapidly increase and farmers are forced to harvest. Farmers record poor survival (50-60%) along with high FCR and thereby suffer loss. So, far no definite causative agents have been reported to be associated with such mortalities. The incidence has been reported to occur more frequently in ponds with higher stocking density and in those using bore well water. As per the investigation of CIBA, poor water quality associated with higher stocking density could be related to this shrimp mortality, where association of different pathogenic bacteria including *V. parahaemolyticus* have been noticed. Poor quality of the seeds due to inbreeding, and physiological dysfunction related to poor defence system of the host and metabolic dysfunction also been speculated as the reasons for this condition and mortality.

Recently, a microsporidian *Enterocytozoon hepatopenaei* (EHP) infection affecting the hepatopancreas of shrimp has been reported to be responsible for considerable growth reduction and size variation in vannamei shrimp. Considering its prevalence in Southeast Asia, NACA has recently published an advisory as a caution and requiring attention. Another issue facing shrimp farming sector is the white faeces syndrome of shrimp, often reported by farmers in India, and the same condition is reported to be associated with AHPND in Thailand and China. Shrimps affected by this produce white faecal strings and show reduced growth rate. Affected shrimps show a typical hepatopancreas pathology and presence of gregarine-like parasites. Although vibrios have been suspected to be involved, scientific evidence needs to be generated.

Apart from penaeid shrimp culture, crab farming and fattening have been emerging as viable ventures in India. These activities are likely to expand considering the reports that crab fattening / culture is more profitable than other coastal aquaculture operations currently in practice. In the event of expansion of crab farming and fattening activities, it is possible that new viral infections such as those reported from China would possibly emerge. Crab reovirus infections causing significant economic losses in cultured mud crabs have been reported from China with mortalities reaching 70%. Since the crab culture practice has not developed to full capacity, information on the diseases in India is very scanty, and hence proactive research for surveillance is very much required.

Like finfish and crab culture, bivalve mollusc culture is also in the early stages of development in India. Considering their export value, these species have a great potential for culture in brackishwater bodies. Studies on the disease problems in bivalves have indicated high prevalence of *Perkinsus olseni*, an OIE listed parasite of molluscs. It is believed to have contributed to the


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depletion of the pearl oyster beds at Tuticorin, in South India. Initial studies on the bivalve population have showed that the pearl oyster, *Pinctada fucata* from the southwest coast of India are infected with the OIE listed pathogen, *Perkinsus olseni*. Different species of vibrios have been detected from bivalves in India indicating the potential threat requiring attention when these species are cultured in large scale.

Issues in hatcheries

For the past several years, zoea-2 syndrome has been a major concern for shrimp hatchery operators in India and other parts of the world. Affected hatcheries report problems of conversion of shrimp larvae from zoea-2 stage followed by significant mass mortality, causing serious economic loss. So far it has not been possible to determine the exact cause of this disease. Some studies indicate association of zoea syndrome with *Vibrio alginolyticus*. Hatchery operators believe that it is a management issue since nauplii stocked in the same hatchery facility in a staggered manner suffer with zoea syndrome, whereas the same batch of nauplii stocked in a different hatchery do not show issues of zoea syndrome.

In the shrimp hatcheries, the luminescent *Vibrio* species such as *V. harveyi* and *V. splendidus* are known to cause significant mortalities in both tiger and vannamei shrimp globally. These bacteria cause mortalities due to septicaemia, localized infections in different organs such as hepatopancreas, epidermis and gut. Luminescent bacterial disease (LBD) is often observed in hatcheries deficient in BMPs that lead to increased organic matter in the tanks. Egg washing is a crucial stage and plays an important role in the outbreak of LBD since gut of the spawners is the major source of luminescent bacteria.

Aquatic animal health management in brackishwater aquaculture in India

Efficient management of disease problems in aquaculture can be possible by two ways, one by the regulatory process at international and national level and the most importantly at the farm level management. The regulatory aspects such as transboundary movement of aquatic animals, aquatic animal quarantine and registration of aquaculturists is now fairly well placed system in India, being regulated by the Ministry of Agriculture and the Coastal Aquaculture Authority (CAA). An aquatic animal disease surveillance programme has been also initiated through a network of fisheries research institutions active in aquatic animal health with National Bureau of Fish Genetic Resources (NBFGR) and National Fisheries Development Board (NFDB) is an important way forward in the aquaculture disease monitoring in India. This initiative will help in scientific and a functional disease reporting system at regional national and international levels. However, India needs to gear up to put in place the contingency plan in preventing emerging disease issues in the farming sector. With regard to research and development in India, the ICAR Institutions and allied fisheries Universities have the capacity to undertake R & D related to aquatic animal health management. Thrust needs to be laid on basic research encompassing detection of emerging infectious agents, origin and nature of pathogens, geographic and host range of pathogens, biology of hosts, virulence mechanisms of pathogens, and knowledge on the host – pathogen – environment interactions, which will provide directions for prevention and control of diseases in aquaculture. Application of modern scientific tools such as genomics, proteomics and next gen sequencing would help in understanding these aspects and further the cause of improving farm productivity.

At the farm level, adoption of BMPs and implementation of biosecurity is absolutely essential avoid the cross contamination and spread of diseases. Farmers also need to be continuously educated on benefits / performance of use of seed only from approved SPF hatcheries in maximising farm productivities. In the current market driven era, concern of unregulated use of drugs and antimicrobials in aquaculture has often affected smooth international trade due to issues of residues in the produce.

Adoption of "Good Aquaculture Practices" would be the best way to address the environmental and sustainability concerns of aquaculture. Hence it is essential that audit and certification system has to be set up in India. It would be worthwhile to develop an India centric health certification programme. China, Vietnam and Thailand have their own national certification schemes to facilitate international trade and food safety issues. A national Aquaculture Certification Standards for India and compliance by the farming sector will boost India's attempt towards sustainable aquaculture.

Conclusion

India's brackishwater aquaculture has become synonymous with shrimp, dominated by domesticated lines of Pacific white shrimp, which has been improved by genetic selection for growth rate and other desirable traits like being free of most significant pathogens. Such stocks are highly successful when reared with good management practices. Diagnostic methods / kits are currently available for the most significant shrimp diseases. However, development of multiplex tests and their use by the farmers during the grow-out period at the pond-side is the need of the hour. Awareness programmes for the farming sector should be increased to provide them knowledge on practices and causes that lead to disease outbreaks in farms, importance of adoption best management practices and overall responsible aquaculture. The national aquatic animal disease surveillance programme hopefully would act as a sentinel in preventing emergence of any new disease threats, while providing valuable service to the shrimp farming sector in the country. Research institutions such as CIBA, along with other agencies working for the sector such as MPEDA, RGCA and other university centres need to take a collective role. The core task force of aquatic animal disease surveillance programme should be expanded by including members from all stakeholders to chalk out contingency plans and tackling disease emergencies in aquaculture in India. A unified approach by the regulatory and promoting bodies, responsible aquaculture by farming sector and cooperation among all the stake holders is necessary to achieve the common goal of enhancing aquaculture productivity in India. ■