CMFRI

Course Manual

Winter School on

Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish

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HEALTH MANAGEMENT ISSUES IN THE DEVELOPMENT OF MARICULTURE: AN INDIAN PERSPECTIVE

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Introduction

Achieving food safety in terms of valuable protein for the ever growing population of Indian subcontinent is a major challenge in the 21st century. In this endeavour 'Aquafarming' is to play a major role, as agriculture and animal husbandry has been slowing down in growth. The strength of Indian aquaculture lies in (a) large water bodies suitable for aquaculture, (b) tropical Climate, (c) species diversity and (d) availability of cheap labour. While the weakness include (a) unregulated development, (b) disease problems and (c) lack of scientific approaches. It is estimated that about 5 million tones of aquatic animal products can be produced annually through aquaculture in India.

As aquaculture production expands, diversifies, and becomes more intensive, the risk and effects associated with pathogen introduction, transfer, disease outbreaks and pathogen spread are enhanced. The growth, economic viability and sustainability of aquaculture primarily depend on the successful prevention or control of disease outbreaks. Unlike the land based farming, disease problems in aquafarming are complicated due to the three-dimensional nature of culture system where the dynamic interaction of biotic fauna comprising the host and opportunistic pathogens and the environmental factors exists.

Mariculture – Indian scenario

Shrimp farming dominates Indian aquaculture scene. Importance and need of finfish and shellfish mariculture is coming into lime light, mainly due to the viral disease problem and related crop losses prevailing in the shrimp farming areas of coastal India. The accumulated losses due to white spot syndrome virus (WSSV) alone in India during the past decade is about Rs. 3000 crores. The importance of finfish and shellfish mariculture is growing as an alternative for the diseases gripped inshore shrimp farming. The research efforts by CMFRI in the development of maricuture technologies of the candidate species such as bivalves, swimming crabs, sand lobsters, finfishes and marine ornamentals have shown initial success. Farming of the green mussel and edible oyster has become a popular livelihood activity by the self-help groups along the costal belt of Kerala, and the farming area is growing every year. CMFRI has succeeded in the hatchery rearing of swimming crabs, sand lobsters and marine ornamentals.

When the rearing activities are in the experimental and demonstrative level, which are at a lower level of intensity, the problem of microbial diseases may not be significant. The absence of clinical or obvious disease problems does not indicate that there are no disease causing pathogens or possibilities of epizootics. Along with domestication and the intense rearing comes an increase in the incidence of infection and potential for disease. One of the most important factors in dealing with the disease is INFORMATION. Knowledge is required on the potential disease causing pathogens, role of environmental factors, health status of the host, diagnostics and therapeutic options. These information forms the key elements in deciding upon the best means of dealing with a disease or formulating a health management strategy. Hence the best approach in collecting the information should be proactive, rather than waiting for a disease outbreak. The ready knowledge would be handy in disease situations, enabling to understand the incidence, its spread, impact, diagnosis and control. One single piece of information, that the disease is caused by a viral pathogen and there is no cure, would desist the farmer from spending large amount of money for 'bogus' cure, and also from additional losses due to delay in harvesting.

The Genesis of Disease in Aquaculture/Mariculture

Any impairment that interferes with the performance of normal functions of an animal can be termed a disease. Diseases can be caused by a variety of factors, the most important being pathogens. Other factors contributing towards the development of disease conditions include stress, environmental/water quality, physical agents, nutritional imbalance, toxins, etc. or a combination of these. Disease condition what we see is thus a complex situation resulting from the interaction/modification of the primary disease condition by these biotic and abiotic factors. In culture conditions the health status of the animal can become weak due to different stress factors such as chemical stressors, biological stressors, physical stressors and procedural stressors.

In such situations, opportunistic pathogens such as parasites, bacteria, fungi, and virus surrounding the animal invades the animal body, resulting in an infection. All infections need not result in disease manifestation. Only when the pathogen build-up disrupts the threshold of animal resistance, the animal succumbs to disease. The situation is a complex one where different factors such as the environment, the animal and the pathogen interacts continuously, making the health management a difficult proposition. This can be further complicated with the involvement of more than one pathogen resulting in a mixed infection which can lead to faulty diagnosis. This entails the need for an integrated management approach to tackle the disease problems with respect to the animal, environment and pathogen using diagnostics as a functional tool.

Unlike the land-based animal rearing systems, where the diseased animals can be identified and treated individually, the scope for disease control in aquaculture through detection and treatment is only of limited value, mainly due to the co-existence of the pathogen and host in the aquatic rearing system. In the case of mariculture, where the extent of the water bodies are without boundaries, the scope of control over the host, pathogen and environment is all the more difficult than in the case of inshore/inland aquaculture. The fish is constantly bathed in potential pathogens, viz., parasites, bacteria, fungi and viruses. Separating the infected or diseased animals from the population and subjecting them to a treatment regime is impractical. Hence, disease treatment becomes a difficult proposition in aquaculture, and disease prevention remains the only natural choice.

The management practices that are designed to prevent the occurrence of disease in a fish grow out system is termed as the AQUACULTURE HEALTH MANAGEMENT. Disease prevention in aquaculture is not merely a case of dealing with the pathogen and its elimination. It is a holistic approach where the focus is given to the health of the animal rather than disease treatment, with suitable integration of quarantine principles, good nutrition and pathogen watch.

Aquaculture Health Management

Aquaculture health management primarily constitutes two aspects, the *farm health management* and the *fish health management.* In mariculture/sea farming, water quality of the selected site in the sea determines the rearing condition of the fish. Successful integration of these two factors only can deliver a disease free environment. Hence routine monitoring of health of the host and environment should form a part of regular activities in the practice of Aquaculture /Mariculture / Aquariculture.

Fish health management constitutes

Effective implementation of fish health management depends entirely on the early and accurate diagnosis of the disease causing agents. The failure of accurate diagnosis of pathogens can lead to faulty treatment resulting in multiple problems like indiscriminate use of chemicals and drugs, drug resistance, large-scale mortality causing crop failure and economic loss. The occurrence of disease can be prevented by the detection and avoidance of the pathogen. Timely and early use of proper diagnostics can be used as an effective tool for health care management.

Disease Outbreak and Diagnostic Procedure

With the onset of a disease, there is a gradual degeneration of fish's/shellfish's ability to maintain its normal physiological state. Various abiotic and biotic factors play important roles in aggravating/modifying the primary disease condition.

The incidence of disease occurs in:

• Aquaculture/Mariculture facilities where fishes and shell fishes are commercially reared

• Ornamental fish rearing systems

• Game fishes in captivity and fish holding centres

• Wild fishes

Once the infection or disease is suspected, the next step is to draw a diagnostic procedure, to fix the root cause of the problem. The diagnostic procedure may include a single diagnostic test or a combination of tests. In the case of routine pathogen watch or health monitoring, a set of selected diagnostic tests are performed to cover the potential pathogens. The approach generally followed is location specific and problem specific, where the first consideration is the availability of the diagnostic facility and expertise. There is no hard and fast method which can be applied for all cases.

Considerable progress has been made towards developing improved diagnostic methods for serious aquatic animal pathogens, particularly those affecting shrimp and marine fish especially in the field of molecular diagnosis. But, traditional diagnostic methods like gross signs, wet mounts of tissues, histopathology, immuno-diagnostic techniques and culture techniques still have their own importance.

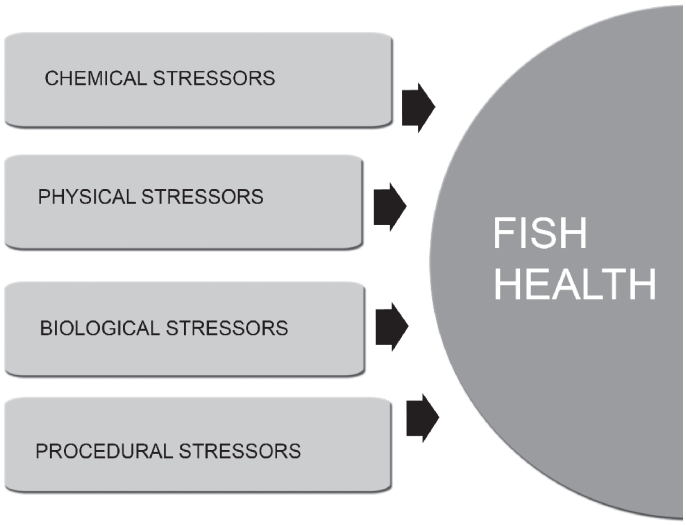
Histopathology is one of the classical methods of disease diagnosis where in the diagnosis is made based on the interpretation of histopathological findings. As such it is a non-specific diagnostic tool and has many limitations including its slow nature. Still in many cases, especially in the diagnosis of new or emerging diseases it has great importance.

Immuno-diagnosis can play an important role in aquatic disease diagnosis and various immunodiagnostic tests are available. Though most of these tests are reasonably rapid, problems of cross-reactions have limited their use. When compared to the polyclonal antibody based techniques, monoclonal antibodies offer high levels of specificity. Monoclonal antibodies to several viral and bacterial pathogens of fish and shellfish have been developed and MAb based immunodiagnostic kits for several microbial pathogens are available commercially.

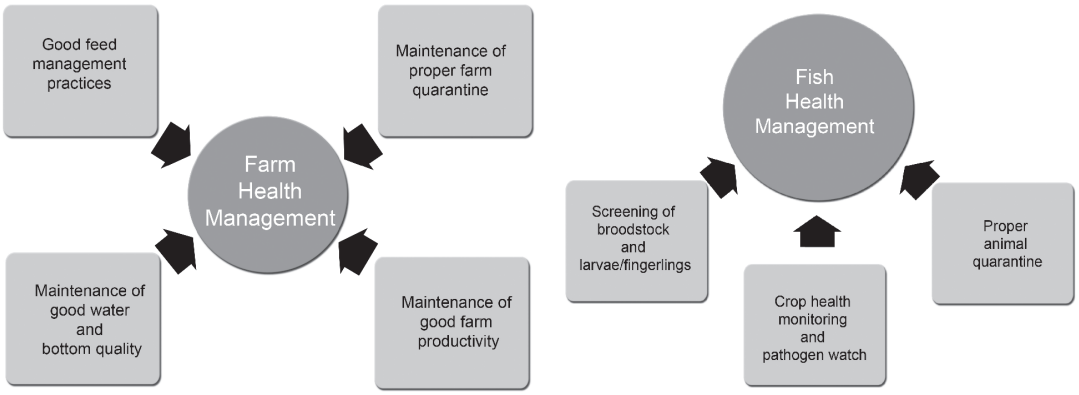
Polymerase chain reaction (PCR) technology is increasingly used in the rapid diagnosis of many disease agents. PCR has simplified and accelerated the *in vitro* process of nucleic acid amplification and at the same time increase the sensitivity dramatically while still retaining a high specificity. PCR is based on the ability of DNA polymerase to copy a strand of DNA by elongation of complementary strands initiated from a pair of closely spaced chemically synthesised oligonucleotide primers. The basic technique of PCR includes repeated cycles of amplifying selected nucleic acid sequences. At the end of each cycle the quantities of PCR products are theoretically doubled. Normally this cycle is repeated 30 to 50 times and the entire process is carried out in an automated thermal cycler. Numerous modifications of the standard PCR procedure have been developed and these include Reverse Transcriptase PCR (RT-PCR), Nested PCR, Multiplex PCR, Broad range PCR, Real time PCR etc which have effectively expanded the diagnostic capabilities and utility.

Use of PCR assisted diagnosis has many advantages over the conventional methods. Since PCR can amplify even a single strand of DNA into millions of copies within hours, even a single pathogen collected from the infected fish could be used directly for the identification. Thus, considerable time can be saved. The drawback of this technique is that it can be utilized only for the diagnosis of known pathogens.

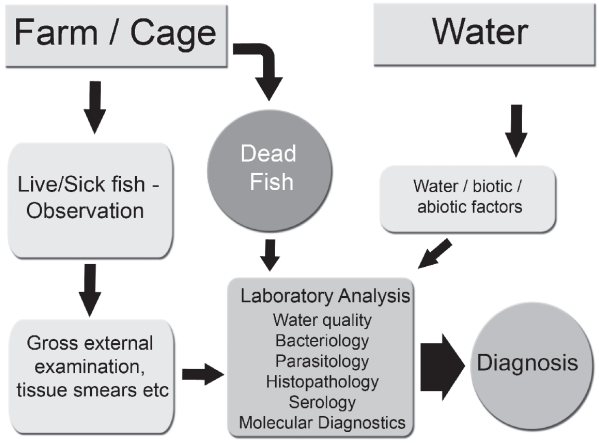
Factors affecting fish health



Farm health management constitutes



Disease outbreak



Methods available for disease diagnosis and pathogen detection

History	**History of disease at facility or region , facility design, source of seed, type of feed used, environmental conditions etc.**
Gross, clinical signs	Lesions visible, behavior, abnormal growth, feeding or food conversion efficiency, etc.
Direct microscopy	Bright-field, phase contrast, or dark field examination of stained or unstained tissue smears, whole-mounts, etc. of diseased or abnormal specimens
Histopathology	Routine histological or histochemical analysis of tissue sections
Electron microscopy	Ultrastructural examination of tissue sections, negatively stained virus preparations, or sample surfaces
Culture and bio chemical studies	Routine culture and isolation of bacterial isolates and identification using biochemical reactions
Enhancement	Rearing samples of the appropriate life stages under controlled conditions to enhance expression of latent or low level infections
Bioassay	Exposure to potential pathogens
Serological methods	Use of specific antibodies as diagnostic reagents in immunoblot, agglutination, ELISA, IFAT, or other tests.
Tissue culture	In vitro culture of pathogens in cell lines
DNA based Diagnostics	PCR, nested PCR, Multiplex, real time PCR

Once the right diagnostic picture along with the water, soil and other biotic parameters are available, the health management measures with respect to the causative factor can be initiated. However, the diagnosis often gets complicated in the cases of mixed infections, with the involvement of primary, secondary and even tertiary pathogens.

Emerging disease problems, particularly in developing countries, are often slow to be recognized. Thus pathogens become widely spread, often globally, before the seriousness of their nature is recognized and reliable methods of detection, treatment and prevention are developed. Methods for detecting, reporting and responding much more quickly to such emerging diseases should be developed. The recent epizootic of koi herpes virus (KHV) affecting koi and common carps (*Cyprinus carpio*) in Indonesia is a typical example. The design and implementation of effective disease surveillance programs, early warning and reporting systems and contingency plans for dealing with serious disease outbreaks will help in reducing the social, economic and biological impacts of disease.

The integrated approach using diagnostics with farm management, outlined above can avoid the introduction of the virus via vertical and horizontal route, thereby preventing the disease causing pathogen. The success of this approach mostly depends on the right choice and use of diagnostics along with other farm management measures, to keep both the animal and its environment in a healthy condition.

The key elements of an ideal health management system can be summarized as:

- Control over the fish/animal stocks at hatchery / farm levels
- Identify excludable disease/pathogens of concern
- Vaccination
- Diagnostics for the detection of pathogens of concern
- Adequate environmental control to prevent the introduction of pathogens of concern (specific pathogen free stock)

- Routine management/husbandry practices to ensure pathogen exclusion (sterilization of influent water, pathogen free feed, prevention of pathogen transfer through men, material and vectors)
- Disinfection, treatment and pathogen eradication methods to contain and eradicate disease outbreaks due to pathogens of concern

In mariculture, development of species specific and location specific health management models with broader management approach for the control of farm/cage level environmental deterioration, pathogen (Virus, bacteria, parasites and fungi) introduction and disease outbreaks is imperative to ensure the sustainability and economic viability of the enterprise.

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