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# Disease Management in Aquaculture

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Aquaculture is one of the fastest growing industries worldwide. When the ability of traditional food production systems such as agriculture and animal husbandry has shown stagnation, an alternative source has to be found out. In this endeavour, `aqua farming' is to play a major role in our country, considering the vast water bodies of India, where aquaculture can be practised.

Shrimp and Carp farming has been the mainstay of Aquaculture in India. But by 1993, diseases, especially those of viral etiology have emerged as the major constraint to the sustainability and growth of shrimp aquaculture. The growth and economic viability of any aquaculture venture primarily depend on the successful prevention/control of disease outbreaks. Unlike the land based farming, the disease problems in aqua farming are complicated and more difficult to control/ treat due to the three-dimensional nature of culture system where the dynamic interaction of various factors comprising the host, opportunistic pathogens and abiotic factors takes place. Disease prevention in aquaculture is not merely a case of dealing with the pathogen and its elimination, but it has to be dealt with a broader perspective, popularly termed as "aquaculture health management". Disease problems were not a major deterrent when the aquaculture activities were of extensive in nature. Intensive systems lead to higher stocking densities and increasing stress which often leads to disease outbreaks. Creation of Intensive rearing systems aiming for more and more production and profits, without proper planning and management, invite problems of infection and disease.

Any impairment that interferes with the performance of normal functions including responses to environmental factors, toxicants, climate, nutrition, infectious agents etc 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 outbreak is thus a complex situation resulting from the interaction/modification of the primary disease condition by these biotic and abiotic factors. The effect of disease on animals range from morbidity/reduced production in some cases to mass mortalities. In nature we are less aware of fish disease problems because sick animals are quickly removed from the population by predators. In addition, fish are much less crowded in natural systems than in captivity. In aquatic ecosystems pathogens are always present and a delicate balance exists between the host, pathogen and environment. Any changes in any of these factors may disturb the equilibrium and may lead to increase or decrease in the disease condition. The most obvious sign of disease in any system is the presence of weak, dead or dying animals. However, the careful observation can usually tell that fish are sick before they start dying because sick fish often stop feeding and may appear lethargic. Fish that are gasping at the surface, abnormalities in the feeding pattern (poor feeding or overfeeding) or rubbing against objects indicate something may be wrong. These behavioral abnormalities indicate that the fish are not feeling well. In addition to behavioral changes, there could be physical signs also that indicate potential disease problems in fish.

There are two broad categories of diseases that affect fish, infectious and non-infectious diseases. Infectious diseases are caused by pathogenic organisms present in the environment or

carried by other fish. Majority of diseases affecting fishes are infectious, caused by opportunist viruses, bacteria, and parasites.

These pathogens multiply in vast numbers in the fish, causing massive damage to the organism by depriving it of life-essential substances and/or by producing ichthyotoxic substances. In both cases the health of the fish is affected and results in diseases, unless appropriate treatment is given. In contrast, non-infectious diseases are caused by environmental problems, nutritional deficiencies, or genetic anomalies; they are not contagious and usually cannot be cured by medications.

**The Genesis of Disease in Aquaculture:** There exist a delicate balance between the host, pathogen and the environment. When this delicate balance gets upset, diseases can result. In an aquaculture pond, the health status of the animal can become weak due to different stress factors. These include (a) chemical stressors (b) biological stressors (c) physical stressors and (d) procedural stressors.

**Role of Stress in Disease Development:** the role of stress in predisposing the fish/shrimp to infections is widely recognized and many of the routine aquaculture practices are known to induce stress. Stress is a non-specific response and it involves series of changes in the animal in trying to adapt to the changed situation. The adaptive responses of the animal when extended beyond the normal range, disturbs the normal functions. The series of changes termed "stress response" in fact tries to help the animal restore the normal homeostasis. This process has both advantages and disadvantages. During stress, hypothalamus- pituitary-interrenal axis (hpi axis) gets stimulated and increases the output of stress hormones called corticosteroids. These stress hormones help to mobilize additional energy during the response to regain the internal homeostasis. At the same time, these stress hormones are

zooplankton which could be easily cultured on a large scale. Different varieties of rotifer sp., copepods and cladoceran are used for the culture. All these organisms which have high reproductive rate, short generation time, and the ability to live and grow in crowded culture conditions have been found to be useful as live feed organism for larval rearing of cultivable species of fishes. Among them *Brachionus plicatilis, B. rotundiformis, Pseudodiaptomus annendeli, P. serricaudatus and Moina* sp. have been the most successfully cultured in small and large scale in the mariculture hatchery of the Central Marine Fisheries Research Institute, Kochi, and given as feed for fish larvae.

**Importance**

Zooplanktons play an important role in the pelagic food web by controlling phytoplankton production and shaping of pelagic ecosystem. It plays critical role as food source for larval and juvenile fishes. The zooplankton population dynamics, reproduction and survival rate etc. are important factors for recruitment to fish stock. Zooplankton occupies a key position in the pelagic food web as it transfers organic energy produced by unicellular algae through photosynthesis to higher trophic levels. It is regarded as the most important environmental factor controlling the year class strength of a large number of commercial fish stock. The ecological significance of zooplankton communities depends on the diversity, behavior and interaction of their species, which play the main role in channeling energy up the food web and exercising top-down control through grazing or predation. Natural (variation in current) and man-made factors can strongly affect zooplankton density and distribution. Zooplankton contributes to the removal of surplus anthropogenic carbon dioxide from the atmosphere through sedimentation and burial of organic and inorganic carbon compounds.

basically immuno-suppressive in nature, reducing the efficiency of both non-specific and specific immune systems of fish significantly, rendering the animal susceptible to diseases. Common husbandry practices like handling, netting, transportation and the normal features of an intensive culture system like suspended solids, low oxygen, high organic matter, overcrowding, high ammonia, etc. can elevate the level of corticosteroids in the blood. Similarly, many of the pollutants even at very low levels can also stress the fish and make them relatively more susceptible to infection. Most of the stressors encountered in intensive culture systems are of chronic nature and can keep the level of corticosteroids above basal levels for longer duration. In such stressful situations opportunistic pathogens including parasites, bacteria, fungi, and virus in the surrounding medium invades the animal body, resulting in an infection.

**Disease process:**

A pathogen can cause a clinical disease only when it can establish on or in the host, proliferate, overcome the non-specific and/or specific defense barriers of the host, produce the pathogenic factors, cause cellular and tissue damage, produce significant pathological changes, impair the function of the target tissue and cause mortality. 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 condition. The sequence of events in an acute infection is as follows.

- Contact with the pathogen
- Infiltration into the body
- Development / proliferation - incubation (usually short in fishes)
- Spreads throughout the body
- Symptoms appear
- Pathogen restricts itself to specific target organ (mortality)

The sequence of disease development will to a large extent depend on the nature of the pathogen (parasite, bacteria, fungi, virus), environmental factors, size of the host, pathogen load or intensity per unit area or unit weight of the host. The situation is a complex one 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. A mixed infection can lead to faulty diagnosis. This spells the need for an integrated management approach to tackle the disease problems with respect to the animal, environment and pathogen using diagnostics a functional tool.

**Bacterial Diseases:** Fish are susceptible to a wide variety of bacterial pathogens. Many of these bacteria become pathogens when fishes are physiologically unbalanced, nutritionally deficient, or there are other stressors, which allow opportunistic bacterial infections to proceed. Important bacterial diseases in fishes include Bacterial Hemorrhagic Septicemia caused by *Aeromonas hydrophila* and *A. sobria*, Furunculous caused by *Aeromonas salmonicida*, Enteric septicemia of catfish caused by *Edwardsiella ictaluri*, Bacterial gill disease caused by *Flavobacterium branchiophilum*, Columnaris caused by *Flavobacterium columnare*, Fish Mycobacteriosis caused by *Mycobacterium marinum*, Emphasematous Putrefactive Disease of Catfish or "Fish Gangrene" caused by *Edwardsiella tarda*, Vibriosis caused by *Vibrio anguillarum*, & *V. alginolyticus*, Enteric Redmouth Disease caused by *Yersinia ruckeri*, Bacterial Kidney Disease caused by *Renibacterium salmoninarum*, Coldwater Disease caused by *Flavobacterium psychrophilum*, Streptococcus Infection caused by *Streptococcus iniae.* Bacteria are known to cause infections / diseases in shellfish farming also.

**Viral Diseases:** Viruses are obligatory intracellular parasites requiring a living cell to replicate. Outcome of diseases due to virus infection is complex and depends on several factors including the immune status of individuals and infectious dose of virus.

Mortality need not always be 100%. In some cases, virus remains at a low level of infection establishing a delicate balance with the host. In addition, there are carriers, which are survivors of a mass scale infection and mortality. Usually it is difficult to detect virus in carrier or latent infection stage. Important diseases of viral etiology in fish include Channel Catfish Virus Disease a herpes virus infection of fry and fingerling channel catfish, Lymphocystis, a disease caused by an iridovirus, Infectious Hematopoietic Necrosis, a rhabdoviral disease of salmonid fishes, Infectious Pancreatic Necrosis, a birnavirus infection of salmonids and Viral Hemorrhagic Septicemia a rhabdovirus infection of salmonids. Viral diseases are known to cause havoc in shrimp culture. Some of the prominent viruses causing disease and mortality in shrimp culture farms include white spot syndrome virus (WSSV), Monodon baculovirus (MBV), *Baculovirus penaei* (BP), Baculoviral midgut gland necrosis virus (BMNV), Infectious hypodermal and hematopoietic necrosis virus (IHHNV), Hepatopancreatic parvo-like virus (HPV), Yellow head virus (YHV) and taura syndrome virus (TSV). Specific drugs for viral disease treatment are not available or difficult to develop since virus is host cell dependent for all its metabolic machinery and vaccines in general are not found to be effective in fish viral disease management. In the absence of a successful drug or vaccine, avoidance of the virus in culture system is the best strategy. Crop holiday is one of the best strategies to prevent viral disease in aquaculture and is still practised in salmonid culture to prevent IPN disease.

**Fungal Diseases:** Generally fungal diseases can be external or systemic and are difficult to cure. Important fungal pathogens infecting fishes include *Aphanomyces* sp. causing the Epizootic Ulcerative Syndrome (EUS), *Saprolegnia, Achlya, Dermocystidium*, *Branchiomyces*, *Aspergillus, Ichthyophonus* and those infecting shrimps include *Enterocytozoon Hepatopenaei* (EHP).

**Parasitic Diseases:** Parasitic diseases in fishes range from extremely pathogenic ones to those, which are practically harmless. Important protozoan diseases of fishes include Velvet Disease, Cryptobiasis, Ichthyobodosis (Coastiasis), Coccidiosis, Microsporidiosis, Myxosporidiosis, Ichthyophthiriasis (white spot disease), Chilodonellosis, Trichodina infection and diseases caused by surface fouling organisms. Generally metazoan parasites are less pathogenic in fishes and include various monogeneans, trematodes, cestodes, acanthocepahalans, nematodes and crustaceans.

**Non-infectious Diseases:** Feed-derived wastes also affect the culture environment through direct pollution, which in turn affects the culture organisms. Uneaten feeds, faeces and metabolic wastes contribute to nutrient and particulate loading of the water and substrate which in turn induce stress, depress the growth of cultured organisms and increase their vulnerability to diseases. Improper diets can negatively influence the health of a fish by inducing nutrient deficiencies, imbalances or toxicoses. An impaired nutritional status contributes to defective host resistance. Malnourished fish may harbor latent infections, and certain physiological conditions and environmental stress may predispose them to infection.

**Disease Diagnosis in Aquaculture:**

Diagnosis forms the first step in any disease control programme, which determines the ultimate success or failure of the programme.

**Diagnostic Procedure:** Once an 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.

A general approach in disease diagnosis is given below:

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| Records/History on | Water source and Pond, Water parameters<br>Stocking, feeding, growth performance, handling,<br>Recent pathologies and treatments<br>Epizootiology<br>The more precise and consistent the farm records are the more likely it is for the pathologist to reach a sound diagnosis |
| On site observation of | Water conditions / soil / benthos and plankton samples<br>Live / sick fish for shoaling behaviour, reactions to stimuli and feeding. Presence of dead and moribund fish. External lesions (ulcers, exophthalmus, reddening, fin erosion) |
| Examination | Gross external examination for parasites<br>Preparation of smears |
| Sampling for | Laboratory examination (whole fish, organs) for Bacteriological, fungal examinations<br>Blood tests / Rapid diagnostic tests<br>Electron Microscopy |
| On site necropsy | Skin, fins, gills, internal organs<br>Sampling for histopathology / virology |
| Laboratory analysis | Bacteriology, Parasitology, Histopathology, Serology, PCR / DNA Probes |

Once the right diagnostic picture along with the water and soil parameters are available, control measures with respect to the causative factor(s), 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.

**Treatment:** Treatment or therapy is intended to restore the normal health of the diseased or infected animal. Based on the nature of the etiological agent, suitable chemicals/drugs are administered in the required doses for their control. Drugs can be given orally, intramuscularly, intraperitoneally, intravenously or topically as baths or dips. Selection of the proper route depends on the environmental situation, the species and condition of the animal, and the drug being delivered. Failure to consider any of these factors can result in unsatisfactory treatment. 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 of limited value. Aquatic animals are constantly exposed to potential pathogens and separating the infected or diseased animals from the population and subjecting them for a treatment regime is impractical and is not economically viable. Chemotherapy is not advised in culture systems and should be used only as a last resort since the use of antibiotics can lead to residues in tissues as well as development of antibiotic resistant microbes in the environment, which in turn can create other public health issues. So chemotherapy, if at all required, should be practised judiciously and restricted to broodstock alone. Hence disease prevention is the only natural choice available.

**Prevention:** The cornerstone of disease prevention is the creation and maintenance of excellent water and soil quality conditions in the rearing systems. Good sanitation practices are also important to reduce the load of potential pathogens. Quarantine is another extremely important concept since it helps to prevent the entry of

disease causing pathogens and thereby avoid serious problems, mainly related to infectious diseases. The term quarantine originally indicated an isolation period of 40 days, and generally it can be defined as a six weeks period of segregation away from the final destination tank. Quarantine helps in the (a) evaluation of the health condition of the new fish (b) reduction of disease transmission risk to pre-existing fish (c) gradual acclimatization of the new fish and (d) convenient administration of drugs. Avoidance or at least minimizing the introduction of known infectious pathogens is also important. Preventative treatments ("prophylactic" treatments) can be helpful in removing initial loads of external parasites.

**Aquaculture Health Management:** The management practices that are designed to prevent the occurrence of disease in a grow out system is termed as the AQUACULTURE HEALTH MANAGEMENT. It is a holistic approach where the focus is given to the health of the animal rather than treatment. Therefore different components viz., animal quarantine, screening of broodstock and larvae/fingerlings, Specific Pathogen Free (SPF) animals, pond and water quality management etc. are involved. Aquaculture health management primarily constitutes two aspects, the **farm health management** and the **fish health management**. Successful integration of these two aspects only can deliver a disease free environment.

**Farm health management:** It constitutes the maintenance of (a) good soil quality (b) good water quality (c) good farm productivity (d) feed management and (e) maintenance of proper farm quarantine to prevent horizontal transmission of disease causing pathogens.

**Fish health management:** It constitutes (a) proper animal quarantine b) screening of Broodstock and larvae/fingerlings and (c) crop health monitoring and pathogen watch. Effective

implementation of all the above three aspects of fish health management depends entirely on the early and accurate diagnosis of the disease causing agents. The failure of which 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. Timely and early use of proper diagnostics can be used as an effective tool for health care management.

Individual health management models with broader management approaches to control farm level environmental deterioration and preventive measures against pathogen introduction, depending on the availability of sensitive and specific diagnostics can be adopted for specific diseases caused by the pathogens such as bacteria, parasites, fungi, considering the economic aspects.