Diseases of seabass in cage culture and control measures

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The cage culture of finfish, especially marine cage farming is becoming more popular because of the many economic advantages associated with it. Though, operationally this has a number of advantages, the practice is vulnerable to natural hazards and can be affected by occurrence of diseases. Disease outbreaks can occur more often when fish are raised under intensive culture conditions and can pose problems in cage culture. Increased production under high density can create conditions conducive to outbreaks of infectious diseases and an increase in prevalence of parasites. Infectious diseases in fish culture are not only augmented by waste pollution, but exacerbated by crowding, handling, temperature and biofouling. The most common fish disease in cages is vibriosis caused by *Vibrio* spp. Furthermore, abrasions cause fin and skin damage to cultured stocks. Occurrence of infection/disease may be minimized by selecting good sites, proper mooring and observance of optimal stocking densities and careful handling of stocks.

Disease monitoring

Monitoring of fish stock health is essential and early indications can often be surmised from changes in behaviour, especially during feeding. Some indication of disease status can be gained from examination of moribund fish netted from the cage surface. Rapid detection and removal of dead fish helps to prevent the spread of disease.

Diseases in Cage fish farming

The disease types and severity are greatly influenced by the species of fish, the conditions in which the animals are cultured and the husbandry management. Fish cultured in floating cages become particularly susceptible to disease when various environmental parameters such as temperature, salinity, dissolved oxygen and suspended particles fluctuate suddenly or widely, or following rough, although often unavoidable, handling operations. Once conditions suitable for pathological changes develop, progress to disease in the warm water environment is rapid. Early detection of behavioral changes and clinical signs in the cultured animals are critical for proper diagnosis of the disease. In addition to diseases caused by infectious agents, diseases and abnormalities due to environmental stresses and nutritional deficiencies have also been recognized, which can lead to secondary infections. Certain types of physical injury are specific to caged fish, *e.g.*, if over-stocked they may suffer from fin and skin damage caused by net abrasion and are susceptible to pathogenic organisms if handled without due care. Caged marine fish are vulnerable to "red boil disease" (*Vibrio anguillarum*) following routine handling operations at polluted sites (Chua and Teng, 1980).

Caged fish established in coastal environments may be exposed to a wide range of pathogens. From this perspective, the worst sites are those in which pathogenic or potentially pathogenic organisms exist prior to establishment of the farm and those in which disease organisms thrive following the installation of cages. Facultative pathogenic organisms are often associated with water bodies where a source of infection, such as untreated sewage, is present. There exists a link between trophic state and bacterial/fungal infections in fish. Chua (1979) observed that the ectoparasitic isopod *Nerocilia* sp. that attacked caged rabbit fish (*Siganus rivulatus*) was more prevalent in organically enriched waters.

Both wild fish populations and intermediate hosts in the life cycle of a fish parasite represent a risk for the fish farmer. Cages of salmon attract scavenging sathe (*Pollachius virens*) that often harbour the sea lice *Lepeophtheirus salmonis* and *Caligus elongatus,* and laboratory trials have clearly shown that lice can transfer between host species (Bruno and Stone, 1990). In the UK, caged fish were found severely infested with the cestodes, *Triaenophorus nodulosus* and *Diphyllobothrium* spp. resulting in heavy mortalities and the closure of at least one farm (Wootten, 1979; Jarrams *et al.*, 1980). The source of infection was subsequently traced to the wild fish populations.

Disease risks can be minimized by avoiding sites where a pre-development survey reveals parasites or disease agents to be present in the wild fish or intermediary hosts. However, problems may still occur through the introduction of diseased stock to the farm or the attraction of birds and other opportunistic predators. Epidemiological studies have revealed the importance of management in reducing the incidence of disease and mortality. A four year study of disease outbreaks in 11 Irish salmon farms showed that interruption of parasite life cycles through fallowing, the separation of year classes of fish to different sites and the practice of basic hygiene methods could significantly reduce the severity of disease outbreaks (Wheatley *et al.*, 1995).

Infectious diseases of cage cultured fish

Generally, infectious diseases of fish are caused by virus, bacteria, fungi and parasites.

Diseases caused by viruses

Viral diseases have not been considered to be a significant factor in marine and brackishwater culture. However, such disease as lymphocystis has recently become one of the problems in seabass culture. Viral diseases in cage cultured fish have been on the increase since the 1980's in East Asia and the 1990's on south-east Asia (Nakai, 1995). Virological research received a new impetus following the high mortality in hatchery-bred juvenile fish soon after being placed in sea cages. With the increasing awareness of virus-related diseases and with new species of fish being selected for culture, more reports of known and new viral diseases are to be expected.

Viral nervous necrosis (VNN)

VNN disease has been found in all warm water marine environments where marine fish have been cultured in cage environments, particularly in juvenile stages. The viral particles are packed in the cytoplasm of retinal and brain cells of affected fish. Infected fish exhibit whirling movements, lethargy, dark body colouration, loss of balance and hyper-excitability in response to noise and light. Mortalities are usually high and occur within a week of the onset of first signs. Extensive spongiosis is typically observed in the retina, brain and central nervous system. VNNV is an RNA virus and can be detected by RT-PCR. A PCR method based on the sequence of the virus coat protein genome (RNA2) was used to diagnose the virus in spawners, suggesting vertical transmission of the infection.

At present there is no known method of therapy, but vaccination using recombinant coat protein of live piscine nodavirus in sevenband grouper, *Epinephelus septemfasciatus*, resulted in significantly lower mortality in the virus challenge tests, indicating great potential for protection against the virus.

Iridoviral disease

Iridoviral disease has been reported in more than 20 marine species, from south-east and east Asia. Affected fish become lethargic and severely anaemic. The gills are hemorrhagic, the spleen is heypertrophic and the iridovirus appears in a crystalline array in the enlarged, basophilic splenic cells. Presumptive diagnosis based on Giemsa staining of histological sections can be confirmed by immunoflorescence or by PCR assay.

An experimental vaccine prepared by Nakajima *et al*. (1997) produced a higher survival in treated red seabream than in control group, suggesting the possibility of controlling the disease through vaccination.

Lymphocystis disease

Lymphocystis disease is commonly found in seabass raised in cages especially among juveniles. It has been observed at all temperatures in rather high salinity. Lymphocystis is a highly contagious infection and the disease follows a chronic course and, in general mortalities are limited. The infected fishes recover within a few weeks of the onset of the outbreak displaying little or no scar tissue. Although known to infect 30 families of marine fish, in south-east Asia, only Asian sea bass has been reported to be affected by this disease.

The disease is characterized by tumour-like masses of tissue on the body surface. These growths are clusters of extremely hypertrophic fibroblastic dermal cells. Occasionally internal organs can become infected. Diagnosis of lymphocystis disease is confirmed through histological sections and appropriate staining of the tissue lesions. The observation of the typical icosahedral virions by electron microscopy offers further confirmation. Horizontal transmission is the most probable route, facilitated by high stocking density and unfavorable environmental conditions. In south-east Asia, trash fish used as feed may be another source of infection. A decrease in stocking density and culling of visibly infected individuals are the only known measures that can be adopted to reduce the impact of the disease.

Diseases caused by bacteria

Many clinical signs of bacterial diseases of cultured marine fish are similar. Definitive diagnosis requires the isolation and *in vitro* culture of the organisms involved. A great number of aquatic bacteria are opportunistic and under normal environmental conditions do not cause disease, becoming pathogenic only when the balance of the host/ environment is changed by elevated stocking densities, inadequate nutrition, deteriorating water quality, rough handling (*e.g.*, net changing, grading) and other stress factors.

Gram-negative bacteria

Vibriosis is the disease caused by a group of bacteria belonging to the family Vibrionaceae. Vibrios are ubiquitous in all marine environments and most are facultative pathogens. The infectious disease they cause is one of the most significant in mariculture. Diseases caused by *Vibrio* sp. typically appear as ulcerative haemorrhagic septecaemia. It occurs frequently during periods of fluctuations in salinity, increased organic load, or stress brought on by net changing and grading of fish. The period following initial stocking is particularly critical. The clinical signs are congestion and red boils appearing on the body surface and gradual darkening of the body. The petechial haemorrhages usually enlarge into irregular and deep lesions, which disintegrate the skin, exposing the underlying muscle, which becomes necrotic. The tissues surrounding the infected vent are usually reddened and inflamed. The body is completely covered by a thick layer of mucus. Internally, there is congestion and hemorrhage of the liver, spleen and kidney, frequently accompanied by the presence of necrotic lesions. The gut and particularly the rectum may be distended and filled with a clear viscous fluid.

The pathogenic vibrios which have been isolated from seabass include *Vibrio parahaemolyticus, V. anguillarum* and *V. alginolyticus*. Good husbandry practices and adequate nutrition are essential to prevent the development of vibriosis. Though in the initial stages the disease can be effectively treated with antibiotics, the use is not recommended due to the risk of development of resistant strains. Prophylactic measures such as vaccines are recommended.

Pasteurellosis – Photobacterium damsela

Pasteurellosis is an most important bacterial disease of cultured maine fish which is caused by the Gram-negative non-motile bacterium, *Photobacterium damsela*. This is a septicaemic disease with no external signs except occasional darkened spots on the body surface. A large number of white spots corresponding to foci of bacterial colonization engulfed by phagocytes are found in the spleen and kidney, and to a lesser extent in the liver. The diseased fish rapidly lose their vigour, sink to the bottom of the cage and die. Ampicillin and florfenicol have been reported to be effective when administered in feed. However, this bacterium is known to become resistant to antibiotics. Vaccine preparations also give satisfactory results.

Gliding bacterial disease/tail rot disease (Flexibacter sp.):

Tail rot disease caused by gliding bacteria of the genus *Flexibacter,* is one of the diseases commonly found in Asian seabass in cages. The bacteria first gain entry through damaged caudal fin, where the tissues are gradually eroded away by the bacteria. The bacteria then invade the muscular region, the muscles disintegrate and typical tail rot occurs. No pathological changes are normally observed in the internal organs. The disease usually affects seabass fry, 2 -3 weeks after their introduction sea cages.

It is difficult to prevent and control the disease in the cage environment. The standard treatment is feed medicated with oxytetracycline or a bath in sodium nifurstyrinate. However, the results are usually unsatisfactory. A combination of freshwater treatment and reduction of stocking density helps to reduce mortality in affected seabass.

Tenacibaculum maritimum (formerly *Flexibacter maritimus*) is reported as the etiological agent of flexibacteriosis disease in red seabream (*Pargus major*), European seabass, *Dicentrarchus labrax etc.*

Gram-positive bacteria

Streptococcosis

Streptococcosis caused by non-motile, gram-positive bacteria, *Streptococcus* sp. is most severe when farmed fish are stressed and water temperature is high. The onset of the disease is related to the rapid growth of the bacterium in the intestine where both extracellular and intracellular toxins are produced. The common clinical signs are darkening of the body, erratic swimming, hemorrhage in the intestine, liver, spleen, and kidney and abdominal distention. Necroses of the heart, gill, skin and eye have also been reported.

Confirmation of the diagnosis requires culturing of the pathogen, preferably on a blood-enriched medium. Control is mainly by chemotherapy. Antibiotic treatment with erythromycin and spiramycin has proved effective.

Mycobacteriosis

The etiological agents of mycobacteriosis, *Mycobacterium marinum* cause systemic, chronic infections in fish. The disease follows a chronic course and remains asymptomatic for a long time. Superficial ulcers and exophthalmia are often the only external signs. Spleen and kidney however are severely affected and are enlarged with granulomatous lesions that appear macroscopically as whitish nodules. In advanced cases these lesions spread to liver, heart, mesentery *etc.*

Nocardiosis

Nocardiosis is a chronic bacterial disease that affects both freshwater and marine fish. Many clinical characteristics of nocardiosis are similar to mycobacteriosis. Early signs of infection include anorexia, inactivity, skin discolouration and emaciation. In the late stages, nodular skin lesions may ulcerate or extend to skeletal muscle and visceral organs, causing abdominal distension. There is no effective therapy for this disease. The route of infection in fish is not known, but is probably through direct contact or contaminated food. Clean environment is an important factor in preventing the occurrence of the disease.

In addition to these more established pathogens, upcoming bacterial diseases potentially harmful for aquaculture species are being identified. A previously unrecognized disease namely "pot belly or big belly" disease caused by a facultative intracellular Gram-negative bacterium has been identified. Infections with this previously uncharacterized pathogen causes severe visceral granulomatous lesions in Asian sea bass fry < 5 g with an associated mortality rates of 70-80%.

Parasitic diseases

Parasitic protozoa

Protozoans are probably the most important group of animal parasites affecting fish. Many reports from all over the world indicate great losses in cage culture caused by protozoans. Environmental factors affect the susceptibility of fish to certain protozoa. Oxygen concentration and temperature are the factors affecting both hosts and parasites. Since many protozoans transfer from fish to fish through the water, fish population density is an important factor. Tremendous infestation of protozoans can occur in a relatively short time where fish populations are dense. Other factors such as host size, age, host specificity, immunity and the influences of host condition also play an important part in the host reaction to invasion by protozoa.

Protozoans cause harm to fish mainly by mechanical damage, secretion of toxic substance, occlusion of the blood vessels, depriving the host of nutrition and rendering the host more susceptible to secondary infections. Some of the most common clinical signs are changes in swimming habits such as loss of equilibrium, flushing or scraping, loss of appetite, abnormal colouration, tissue erosion, excess mucus production, haemorrhages and swollen body or distended eyes.

Cryptocaryon sp.

Cryptocaryon sp. is the marine counterpart of the freshwater *Ichthyophthirius* species and similarly cause the white spot diseases in marine fish. Its morphology and life cycle is quite similar to that of the "Ich". The surface of invaded fish reveals white pustules or numerous minute, greyish vesicles which are nests of cilliates burrowing under the epidermis. They feed on the host's cells underneath the epithelium and cause heavy irritation resulting in excessive production of mucus and finally completely destroying the fine respiratory platelets of the gill filaments. On the skin, this parasitic protozoan causes considerable lesions resulting in destruction of large areas of the epidermis. Secondary infection may complicate the situation and the host dies. The incidence of *Cryptocaryon* sp. in seabass showed a distinct peak during low water temperature period.

The presence of *C. irritans* in cage-cultured fish means that the cages are kept in too shallow waters. If logistically feasible, the cages should be moved in to an area where sufficient depth and currents prevent the theronts (free swimming infective stages) from re-infecting the fish.

Other important protozoan parazines affecting marine fish cultured in cages are *Trichodina* sp., *Brooklynella* sp., *Henneguya* sp. *etc.*

Parasitic helminthes

Worm diseases with the possible exception of those produced by monogenetic trematodes have not yet appeared to be a serious problem in seabass culture. This is probably due in large part to their complex life cycle and the difficulty in completing such cycles in the culture system. Helminthes parasites which have been found in seabass include monogenetic trematodes, digenetic trematodes, nematodes and acanthocephala.

Crustacean parasites

Crustaceans belonging to the Branchiura, Copepoda, Isopoda and Amphipoda are frequently found on the body surface and/or gills of caged marine fish.

Parasitic copepods

The parasitic copepods are among the most devastating of fish parasites. The mature female usually attaches to the fish and feeds on the host. After copulation the female matures and produces egg sacs while the male dies.

The only branchiuran reported is *Argulus* sp. Most of the copepods reported are caligids, which could cause epizootics in the farms. *Caligus* sp. has caused big problems in cultured seabass. They attach to the gills, buccal and opercular cavities, occasionally on the skin and fins of the seabass. Heavy infections can cause mass mortalities especially in young fish. *Lernanthropus* sp. are found attached to the gill of seabass especially in cage cultured fish. Large numbers of this parasite can cause anaemia to the fish host.

Parasitic isopods

Isopods which closely resemble *Aega* sp. have been found abundant in cage-cultured seabass. The parasite always attaches to the gills of its host. Clinical signs of infected seabass are as follows: fish lose appetite, become anemic and grow very slowly. Quick death can occur in 2–3 days in heavily infected young fish. *Nerocila* sp. and *Gnathia* sp. have also been reported in seabass.

Parasitic crustaceans are generally introduced along with fish caught in the wild for culture, but several of them are transmitted by wild fish around the cages. Prevention is therefore difficult.

In addition to the infectious causes, diseases and abnormalities due to environmental contaminants and nutritional deficiencies have been recognized as important problems in fish culture whenever diets as well as control or water quality become inadequate. Malnourishment or undernourishment of seabass under culture can result in slow growth, susceptibility to diseases or death.

In Asia, trash fish are widely used as feed in cage farming of marine finfish. Fry are often wild caught or derived from wild-caught broodstock. Furthermore, legislation for and implementation of farming licenses and zoning policies are not in place in most Asian countries. Coupled with a 'gold rush' mentality, this often results in too many fish and too many farms in a concentrated area, which in turn promotes disease transmission. The combination of all these factors, together with the diversity of organisms in tropical waters, leads to a truly challenging disease situation.

Furthermore, irresponsible use of antibiotics and chemicals for disease control in aquaculture can lead to residue problems, an increasing consumer concern, and to the development of drug resistance among the bacterial pathogens. In addition to developing antibiotic resistance, sick fish often do not eat and the efficiency of delivering antibiotics orally is often questionable. The use of antibiotics is a curative measure to treat an existing infection; in contrast, vaccination is a preventative measure, dependent on the immune system of the animal. Vaccines can act against bacterial, viral and, at least experimentally, parasitic infections and they will usually act only against the targeted pathogens. In Asia, with the exception of Japan, few fish vaccines are yet commercially available. The major advantages of prophylactic vaccination over therapeutic treatment are that vaccines provide long-lasting protection and leave no problematic residues in the product or environment.

Asian aquaculture will continue to grow at a fast pace due to both area expansion and production intensification. Under these conditions, the prevalence and spread of infectious diseases will unavoidably increase as a result of higher infection pressure, deterioration of environmental conditions and movement of aquatic animals. Accordingly, the effective control of infectious diseases has become more and more important in the cultivation of aquatic animals. Good health management is the best way for disease control. Collectively, this includes the use of healthy fry, quarantine measures, optimized feeding, good husbandry techniques, disease monitoring (surveillance and reporting), and sanitation as well as vaccination, and biosecurity measures when diseases do occur. Overall, the emphasis must be on prevention rather than treatment.