

SHRIMP FARMING TECHNIQUES, PROBLEMS AND SOLUTIONS

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5. SHRIMP DISEASES AND CONTROL

I. INTRODUCTION

Shrimp farming has become a highly competitive and lucrative venture all along the coasts of India (MPEDA, 1993) and in many of the Asian countries (Subasinghe and Shariff, 1994) in the recent past. Emphasis is given to enhance the unit area production by semi-intensive and intensive shrimp culture techniques which include high density stocking, fertilising and feeding. The results of experiments on intensive culture of shrimps indicate that their production could surpass the production of crops or fish to many folds. It is estimated that in India the farm raised shrimps accounted for about 28 percent in the 1990's compared to 2.1 percent in the 1980's. However, the techniques indented to enhance the production in many instances were found to deteriorate the water quality and predispose the shrimps to diseases (Tareen, 1982). The best example is the Taiwan shrimp industry which almost collapsed in 1989, during which period its share in Asian production dropped from 21 to 2 percent. The poor disease and health management practices have been considered to be the significant cause of the collapse (Shariff, 1994).

It is a well established fact that the success of aquaculture depends on the health of the candidate species being cultured. There are instances of 100 percent mortality due to diseases. Even if the diseases do not result in mortality, severe weight loss due to retarded growth affect the total production (Lipton, 1994). A non polluted environment, balanced feed, appropriate technology and good farming practices are the important preconditions for succesful shrimp farming. Very often, it is noticed that apart from the general poor water quality conditions, biotic agents play the major role in disease manifestation.

II. INFLUENCE OF ENVIRONMENTAL FACTORS

The shrimp diseases caused by environmental factors could be correlated to the type of culture system and the water quality management. The extensive, semi-intensive and intensive farming require "captive" sea water for farming activities. Shrimp hatcheries are of typically intensive or semi-intensive in nature. The success of hatchery or farm depends on the clean and clear seawater which is devoid of suspended materials, competitive organisms, disease causing organisms and pollution. It is well known that in the large bodies of ocean water, physico-chemical properties of the seawater tend to be balanced and buffered. Fluctuations, if any are low and generally remain within the tolerance limit of the organisms. But, as soon as the seawater is removed from the ocean,

the physico-chemical properties of this "captive" seawater begins to change and its capacity to support the life tends to decrease. In addition, the increased load of fertilisers, feed and excretory metabolites of the shrimps stocked in the system tend to change the water quality to an alarming extent. For example, low levels of dissolved oxygen, pH, high concentration of CO₂, ammonia and nitrate are deleterious to shrimp health, impair their growth and result in a wide variety of sublethal effects.

In the shrimp culture ponds, emphasis has to be given to the conditions in the topmost sediment layer and the water as the shrimps hide in this layer during daylight. The administration of large quantities of feed, part of which is dissolved and the production of faeces still rich in organic matter lead to intensive biodegradation process requiring considerable amount of O₂. In addition, depletion of DO and presence of H₂S go hand in hand. This situation often results in the dreaded **black-gill disease** in shrimps followed by mass mortality. Dissolved oxygen below 3.2 ppm should be considered as dangerous for the shrimps in the nursery and farming facilities.

The chronic soft-shell syndrome in *P. monodon* could be attributed to unfavourable pond condition such as high soil pH, low water phosphate and low organic matter in the soil (Batticodas *et al*, 1986).

Ammonia: Ammonia exists in the shrimp pond water in two forms viz., unionized (NH₃) and ionized (NH₄). Its toxic effects are mainly associated with the unionized form, the concentration of which is related to the total ammonia content, water pH and temperature (Emerson *et al*, 1975; Eddy, 1982). The unionized ammonia can readily diffuse through the gill membrane with its lipid solubility and lack of charge (Fromim and Gillette, 1968; Randall *et al*, 1982). Toxicities of ammonia on *Penaeus indicus* and *Penaeus monodon* indicate NH₃-N LC₅₀ values as 0.29, 0.95 and 3.17 mg/lit on *P. indicus* nauplius, zoea and mysis and 0.54, 0.76 and 2.17 mg/lit on *P. monodon* nauplius, zoea and mysis respectively (Jayasankar and Muthu, 1983 and Chin and Chen, 1987). The water quality suitable for shrimp farming is given in Table 1.

Pollution: Heavy metal poisoning such as by cadmium and copper could result in morphological deformities, damage in gill tissues and ultimately mortalities. The adverse effects of pollutants could be minimised by immediate water exchange.

Microbial toxins: Dinoflagellates, blue green algae and a few diatoms cause mortalities among the shrimps due to their exudates.

A list of the environmental mediated diseases among the shrimps is given in Table 2.

Table 1. Water quality criteria for disease preventive shrimp farming

Hatchery Systems

Parameter	Range
Temperature (°C)	26 - 33
pH	7.5 - 8.7
Dissolved oxygen (DO)	5 - 7 ppm
Salinity (ppt)	28 - 33
Turbidity (transparency)	50 FTU (25 - 60 cm)
Nitrite (NO ₂ -N)	less than 0.02 ppm
Unionised ammonia (NH ₃)	less than 0.1 ppm
Heavy metals	less than 0.01 ppm
Biological Oxygen Demand (BOD)	less than 1.0 ppm (5days)
Culture ponds	
Parameter	Range
Temperature (°C)	26 - 33
pH	7.5 - 8.7
Dissolved oxygen (critical)	3.7 ppm
Salinity (ppt)	15 - 35
Unionized ammonia (NH ₃)	0.1 ppm
Hydrogen sulphide	0.25 ppm
Heavy metals	
Hg	< 0.0025 ppm
Cu	< 0.1 ppm
Cd	< 0.15 ppm
Zn	< 0.25 ppm

Modified from Biswas (1992) and Pillai *et al* (1993).

When environmental problems are caused by poor farming practice, it is necessary to gain co-operation from all the farmers in an aquaculture area. In some cases even Government legislation may be necessary to limit practices which threaten the stability of farming. For example in Thailand serious environmental problems have developed in some farming areas because of unrestrained construction and operation of ponds (Flegel and Sriurairatana, 1994). These authors indicated that in extreme situations, single canals extending to several kilometers from the sea are used for both pond supply and discharge such that water quality deteriorates progressively from the seaside inward.

Table 2 Environment related shrimp diseases in culture systems

Disease	Causes	Symptoms
Cramped tail/Body cramp	Temperature shock in warm conditions	Lesions on body surface and tail
Muscle necrosis	Poor sanitary conditions influenced by over-crowding, low dissolved oxygen, salinity or temp. shock	White opaque areas in the abdomen
Tail rot	--	The distal portion usually infected
Black gill disease	Siltation, less DO	Blackening of gill and increased H ₂ S
Gill necrosis	Pollution (heavy metals)	damage in gill tissues
Blue disease	Poor soil-water quality	Bluish prawns
Red disease	Handling stress, detritus rich in organic matter	Reddish colouration of shell gill and pleopods
Gas bubble disease	Super saturation of atmospheric gases and oxygen	presence of gas bubbles in gills
Chronic soft shell syndrome	Poor pond soil-water condition, nutritional problems	Soft shell

III. VIRAL DISEASE DIAGNOSIS AND MANAGEMENT

The pond grown shrimps are susceptible to diseases caused by microbial agents such as viruses, rickettsia, bacteria, fungi and protozoa.

1. Viruses

Lightner *et al* (1993) have reviewed the information on shrimp viruses. According to them, at least eight virus diseases are presently recognised among the penaeid shrimps. The list of these viruses are given in Table 3.

Table 3. Penaeid shrimp viruses

Virus	Virion size (mm)	Nucleic acid	Probable classification
IHHNV	22	ssDNA	Parvo-like virus
HPV	22-34	ssDNA(?)	Parvo-like virus
LOPV	25-30	ssDNA(?)	Parvo-like viurs
REO	50-70	dsRNA(?)	Reo-like virus
BP	55-75 x 300	dsDNA	Baculovirus; occluded
MBV	75 x 300	dsDNA	Baculovirus; occluded
BMN	75 x 300	dsDNA	Baculovirus; non-occluded
TCBV	? X ?	dsDNA	Baculoviurs; non-occluded

Baculoviruses

The baculoviruses infect the epithelial cells of the hepatopancreas and midgut (Johnson and Lightner, 1988).

Transmission of these viruses is oral. Hence infections from parent to off-spring result from faecal contamination of spawned eggs by virus contaminated faeces, and horizontal transmission in culture systems results from faecal-oral contamination or from cannibalism (Leblanc and Overstreet, 1990). The incubation period is found to be 24 hours in experimental direct transmission trials. Baculovirus infection results in high mortalities in hatcheries, affecting the larval and postlarval stages (Brock and Lightner, 1990).

Baculovirus penaei (BP)

Several penaeid species of shrimps in their larval, postlarval and early juvenile stages are affected by BP (Johnson, 1983). The BP infections are characterized by prominent tetrahedral occlusion bodies in unstained squash preparations of hepatopancreas, midgut or faeces (Lightner *et al*, 1983). *Penaeus aztecus*, *P. penicillatus*, *P. stylirostris* and *P. vannamei* are found to be the susceptible species.

Monodon - type baculoviruses

The MBV -type infections are characterized by prominent spherical occlusion bodies in hepatopancreas and midgut epithelial cells. These can be seen in squash preparations of hepatopancreas, midgut or faeces examined by phase or bright field microscopy. Occlusin bodies range in diameter from 0.1 to 20 μm . Cultured population of *Penaeus monodon*, *P. plebejus* throughout Asia are susceptible to MBV-type

infections. In a few cases *P. monodon* MBV-type infections are found to occur along with the Gram negative bacteria including *Vibrio alginolyticus*, *V. parahaemolyticus* and *Pseudomonas* (Anderson *et al*, 1987).

BMN and other type C baculoviruses

In general the type C baculoviruses of penaeid shrimp are characterized by their inability to produce an occlusion body in the nuclei of infected cells (Johnson and Lightner, 1988). Diagnosis is accomplished by light microscopy by demonstration of necrotic hepatopancreatic tubule, epithelial cells that have markedly hypertrophied nuclei with margined chromatin, diminished nuclear chromatin, nuclear dissociation, and no occlusion bodies. *Penaeus japonicus* and *P. monodon* among cultured shrimps are found to be susceptible for BMN. The BMN in *P. japonicus* first infects the Protozoa 2 stage and mysis stage larvae. The disease progress further and affects the PL-9 or PL-10 to about 98 percent. A white-turbid hepatopancreas (midgut gland) in larvae and postlarvae is the first visible sign of the disease. As the disease progresses, the white turbidity becomes more apparent and well defined. Severely affected postlarvae of 6 to 9mm in length are reported to be easily distinguished since they float on the surface of water and exhibit a white midgut line through the abdomen.

The parvo-like viruses

In the culturable shrimps so far three types of parvo-like viruses have been recognised. These include, the IHHNV = Infectious Hypodermal and Haemotopoietic Necrosis Virus, HPV = Hepatopancreatic Parvo-like Virus and LOPV = Lymphoid Organ Parvo-like Virus. The Parvo-like viruses recorded from shrimps are small with a size of 20 to 30nm in diameter. Infections of these viruses can be distinguished using routine light microscopy according to their principal target organs/tissues and their unique cytopathology.

IHHNV

IHHNV is a small (approximately 22nm dia), ssDNA containing parvo-like virus, which has a world-wide distribution (Bonami and Lightner, 1991). In the Southeast Asia, this virus is noticed in *Penaeus monodon* broodstocks. In addition to this species, *P. stylirostris* and *P. vannamei* are found to be susceptible. The disease caused by IHHNV is also known as "runt-deformity syndrome" (RDS). The affected shrimp with RDS are characterised by often greatly reduced growth rates and by a variety of cuticular deformities affecting the rostrum (= 'bent rostrum'), wrinkled antennal flagella, cuticular roughness, deformities in cuticular, thoracic and abdominal areas of the exoskeleton.

IHHNV infections in natural conditions were recorded in *P. stylirostris*, *P. vannamei*, *P. monodon*, *P. semisulcatus* and *P. japonicus*. Vertical and horizontal type of transmission is recorded in the culture system. In the horizontally infected shrimps, the incubation period and severity of the disease is somewhat size and age dependent, with young juveniles always being the most severely affected. Infected adults rarely show the signs of the disease or mortalities (Bell and Lightner, 1987). Gross signs includes reduction in food consumption, followed by changes in behaviour and appearance. Experience in *P. stylirostris* indicate that the IHHN shrimps rise slowly in culture tanks to the water surface, there they stay motionless and then roll-over and slowly sink with their ventral side up on the tank bottom. Shrimps exhibiting this behaviour may repeat the process for several hours until they become weak to continue or till they are attacked and cannibalized by healthier shrimps present in the tank. *P. stylirostris* at this stage of infection have white or buff-coloured spots in the cuticular epidermis, especially at the junction of the tergal plates of the abdomen, giving the infected shrimps mottled appearance. In *P. monodon* the infected shrimps are often distinctly bluish in colour, and with opaque abdominal musculature.

Bioassay to detect asymptomatic carriers of the virus is conducted by feeding or injecting the cell free homogenates of IHHN-suspected shrimps. In addition, serological tests using monoclonal and polyclonal antibodies to IHHNV are being developed for IHHN diagnosis in shrimp culture.

LOPV

The Lymphoid Organ Pavlo-like Virus is a recently discovered virus from culturable shrimps in Australia. The affected shrimp species such as *P. monodon*, *P. merguensis* and *P. esculentus* exhibited multinucleated giant cell formation in their hypertrophied lymphoid organs (Owens *et al*, 1991). Such conditions were recorded from Taiwan in cultured *P. monodon* during the 1986-87 epizootic.

2. Bacterial disease, diagnosis and management

Rickettsial infections

Although this infection is not recorded yet from Indian waters, systemic rickettsial infections were reported from cultured *P. monodon* from Malaysia and Singapore. In *P. monodon*, the rickettsia occurred within large cytoplasmic vacuoles where it formed microcolonies of 19 to 33 μm in diameter. In heavy infections, cells with rickettsial inclusions were widespread in mesodermally and ectodermally derived tissues,

but absent in endodermally derived tissues such as midgut, hepatopancreas and caeca. Experimental treatment using medicated feeds containing 1.5 to 2.0 kg of oxytetracycline per 1000 kg of feed was found to be successful in reducing mortalities.

Vibriosis

Vibrio sp. were found to constitute the predominant normal microflora of the culturable species of shrimps. Due to their rich presence in the shrimp's microflora, researchers have found *Vibrio* sp. as frequent and opportunistic pathogen of the shrimps. The opportunistic pathogenic *Vibrio* sp. establish lethal influence as a result of other primary conditions such as other infectious diseases, nutritional disorders, extreme environmental stress and wounds (Lightner, 1988). However there are a few *Vibrio* sp. which are true pathogens.

Luminescent *Vibrio* in hatcheries

In hatcheries, larval mortalities associated with luminescence are reported in epizootic proportions in *P. monodon* and *P. merguensis*. The causative bacteria are strains of *Vibrio parahaemolyticus*, *V. alginolyticus*, *V. harveyi* and *V. splendidus*. The affected larvae refuse to feed. Scanning Electron Microscopy (SEM) studies indicate that the vibrios colonise specifically the feeding appendages and oral cavity. Rigorous management and sanitation helps to control the infestation. The separation of mother shrimps and their faecal matters from the eggs has to be done as soon as possible after spawning. Artemia nauplii being used as live feed should be rinsed before introducing into the hatchery during feeding. Chlorination and other forms of water treatment such as ultraviolet irradiation and filtration should be done to reduce the initial load of the rearing water. The affected shrimps are treated using antibiotics such as chloramphenicol, sodium nitrostyrenate and the nitrofurans (furazolidone, nitrofurazone, nitrofurantion and pefuran) at 25 µg per ml.

Vibriosis in *P. indicus* and *P. monodon* culture ponds

In India two species of *Vibrio* are found to be pathogenic to the shrimps. These include, *V. anguillarum* and *V. alginolyticus*. In shrimps mortalities were reported to begin towards the end of the growout period as the shrimp reach marketable size of 25 to 35 g or 2 to 3 months after stocking PL-20. Dead shrimps can be harvested in the morning from the pond edges. It is estimated that at harvest 5 to 30 percent of the production only could be attained. Most of the surviving shrimps also exhibit stunted growth. Indian white prawn, *P. indicus* cultured in brackishwater ponds are affected by

V. anguillarum. Blackening or whitening of the basal part of the antenna, the oviduct and edges of the abdominal shells are the symptoms.

Frequent water exchange, feeding with compounded diets containing antibiotics chloramphenicol help to control the disease. In addition to the above furacin at 1 mg per liter of water, terramycin at 40 mg per kg of biomass for 10 to 15 days through feed or feeding tylosin or tiamutin at 100 mg active ingredient per kg of feed for two weeks help to contain the sickness.

Tiger prawn, *Penaeus monodon* cultured in ponds are affected by *V. alginolyticus*. Septicaemic conditions followed by loss of reflexes and cuticular fouling by epibionts are the symptoms. The gills are often brown in colour. Early signs include, body reddening, extended gill covers and slight melanized erosions of the uropods, pleopods and periopods. Affected shrimps reveal empty stomachs and midguts and in some cases white watery liquid oozes out. Reducing the biomass (by partial harvest) and increasing the water exchange help to contain this disease. For the subsequent production cycle, it is advisable to dry the pond bottom until the bottom soil cracks. If excessive detritus is noticed the same has to be physically removed. Quicklime (CaO) is normally applied at the rate of 0.5 kg/m² of pond bottom. The treatment pattern is much the same as that of *V. anguillarum* infections.

Brown spot shell disease/burned spot disease/rust disease/shell disease/black spot disease

The above-referred names are synonyms of bacterial disease caused by a group of bacteria. In majority of cases, *Vibrio*, *Pseudomonas* and *Beneckea* have been known to cause this disease.

The disease is recorded from the freshwater prawns as well as from *Penaeus* sp. cultured in India.

Providing better water quality, removal of infected and dead prawns, reducing the stock and adequate nutrition help to control the disease. Feeding terramycin incorporated feed at 0.45 mg per kg of feed for two weeks, bath treatment using 0.05 to 1.0 mg of malachite green per litre of water are suggested.

3. Fungal diseases, diagnosis and management

Fungal diseases have been reported to cause extensive mortality ranging from 20

to 100 percent. Several fungi are known to be shrimp pathogens. Three groups of fungi commonly infect the larval stages of shrimps while another one attacks the juvenile or larger shrimps. The common fungus affecting the larval shrimps is *Lagenidium*. Apart from this species, *Siropodium* and *Haliphthoros* also affect the larvae. These fungi generally require a thin cuticle which is noticed only in shrimp larvae. The most common fungi affecting the larger shrimp belongs to *Fusarium* sp. Environmental factor such as low salinity prevailing in the monsoon season is found to precipitate fungal infections in the hatchery as well as growout systems.

Fungal infections in shrimp larvae: In the case of larval fungal infections (larval mycosis), it is interesting to note that the infection starts from a fungal spore which attaches itself to the egg of the shrimp and then germinates. The germling (mycelium) then grows as the larva of shrimp grows, ramifies through the body wall of the larva and develops rapidly inside it replacing the muscles and soft tissues of the larva. Ultimately the entire body of the larva becomes a mess of mycelia of fungus.

P. monodon, *P. indicus* and *P. merguensis* (banana shrimp) are affected by the fungi *Lagenidium* and *Fusarium* sp. To prevent this disease in the hatchery, the inflow water has to be thoroughly filtered. Chemical and ultraviolet irradiation of inflow water is also effective. Application of malachite green at 0.001 to 0.006 mg per litre of water and treflan at 0.01 mg per litre are also found to be effective.

Mycosis of adult shrimps: Although the exact extent to which the mycosis of adult shrimps caused by *Fusarium* sp. affect the shrimp aquaculture is not known, it is certainly considered as a potential threat. Almost all the culturable shrimps are known to be affected.

The *Fusarium* sp. may be identified by the presence of canoe-shaped microconidia and also due to the presence of cotton wool like growth.

The fungus gains entry into the body through the already eroded areas or cracks on the cuticle. Prevention and treatment courses are much like that of larval mycosis.

4. Protozoan diseases, diagnosis and management

Protozoan parasites and commensals of shrimp are found to occur externally or internally. The externally occurring ones are considered harmless unless they are present in large numbers. Those present internally can cause disease and are representatives of *Microsporidia*, *Haplosporidia* and *Gregarina*.

Cotton shrimp disease/milky disease of shrimps: The cotton/milky shrimp disease is caused by the protozoan parasite belonging to Microsporidian group. Almost all the culturable shrimps are affected. The muscle tissue becomes milky. The microsporidians are abundant in the infected shrimp and cause the white appearance. No eggs are found in milky shrimps and it is inferred that the microsporidian infection render the shrimp incapable of reproduction. Microsporidians are present in the affected shrimp in the form of spores which are microscopic. These spores are transmitted horizontally. Providing better water quality in the hatcheries and growout ponds and following strict farm husbandry practices prevent this disease. Although no satisfactory treatment is evolved yet, experimental results indicated the usage of 0.0075 mg of malachite green per litre of water in static condition for the Post Larvae and addition of commercial bleach to the culture system are successful.

Ciliate infestation: The ciliates, *Zoothamnium*, *Epistylis* and *Vorticella* and suctoreans, *Ephelota gemmipara* and *Acineta* may invade all the life stages of the shrimps and cause respiratory and locomotory difficulties when present in large numbers on the gills and shell. In the pond grown shrimps, the ciliates may form a fuzzy mat on the shell as a result of the deterioration of the culture water. Ciliate infestation can be prevented by avoiding heavy silt, high nutrient load, turbidity, and low oxygen tension. Affected shrimps can be treated with baths of chloroquin diphosphate or formalin to remove the ciliates.

Gregarine disease: Gregarines are common parasites of the digestive tract of shrimps. Their presence in large numbers in the gut interferes with particle filtration to the hepatopancreatic ducts or through the gut resulting in large scale mortalities. Providing better water quality conditions prevents this disease. No effective treatment is available as on date.

IV. DISEASES INFLUENCED BY DIETS

Pond grown shrimps are more often subjected to nutritional disorders than their younger stages in hatchery or nursery rearing period primarily because of the culture facility. In the case of unfed shrimps, they lose their normal full and robust appearance. The shell becomes thin and flexible as it covers the underlying tissue such as tail meat that becomes greatly resorbed due to lack of nutrients. The moulting is curtailed and in due course of time the shell and gill become darker.

Chronic soft shell syndrome: This disease occurs among the juveniles and adults. The affected shrimp is characterized by a persistently soft and thin exoskeleton, weakness and greater susceptibility to cannibalism. Inadequate amounts of nutrients such as

calcium and potassium is known to create this sickness. Dietary and environmental manipulation prevents the occurrence of this disease. This occurs among the juveniles to adults. Affected shrimps have bluish exoskeleton which is also soft and thin. The shrimps also become lethargic. Low levels of the carotenoid astaxanthin in the diet, poor soil and water quality are the causative factors. Reducing the stocking density, feeding with high quality feed and frequent water exchange in the culture system prevent this disease.

V. DISEASES OF UNKNOWN AETIOLOGY

Inflammation and melanization: Instances of tissue darkening is observed in shrimp farming. The blood cells congregate in particular tissue areas (inflammation) where damage has occurred and this is followed by pigment (melanin) deposition. An invasion by infective agent, injury or presence of toxins causes this defect.

Gills are prone to darkening due to their fragile nature and their function as collecting site for elimination of the body's waste products. Gills darken readily upon exposure to toxic metals or chemicals and also as a result of infection by fungi like *Fusarium* sp.

Cramped shrimp: Shrimps exposed to a variety of culture conditions develop cramped nature. The tail is drawn under the body and becomes rigid to the point where it cannot be straightened. The cause and remedy are not yet studied in detail.

VI. DISEASE INSPECTION AND CERTIFICATION

The rapid growth of shrimp farming in recent years has led to increase in the live transport of the shrimp young ones from one region to another. Such large movements inevitably pose a potential risk of introduction of hitherto unknown pathogens. With the improvised culture techniques, the chances of spreading of the disease is increased. The spread of viral pathogens in shrimps world over and Epizooti Ulcerative Syndrome (EUS) in the case of the fish in Asia can be taken as the best example in this regard. Transfer and introduction of different stages of shrimps has to be controlled by suitable regulations. This will reduce the risk of transferring pathogens from one place to another or from an imported stock to the native stock. Regular inspections on the health status and sanitary conditions of the shrimp farms are to be carried out by trained personnel.

The International Office of Epizootics and Animal Health Problems in Aquaculture, of late has dealt with crustacean pathogens through the Fish Diseases Commission (de

Kinkelin, 1992). The listed shrimp pathogens include: MBV, BP, BMNV and IHNV. The approach for health control in aquaculture involves: (i). assessment of health status of animals in a production site based upon inspections and standardised sampling procedures followed by laboratory examinations conducted according to the OIE codes. (ii). constraints of restocking open water and farming facilities only with products having a health status higher than or equal to that of animals already living in the considered areas, (iii). eradication of disease when possible, by slaughtering of infected stocks, disinfection and restocking with pathogen free animals, and (iv). notification by every member country of its particular requirements, besides those provided by the code, for importation of aquaculture animals and animal products.

VII. CONCLUSION

A number of diseases of shrimps cultured has been enumerated in the preceding discussion. The diseases pose threat to obtain maximum production. In many instances the poor water quality conditions of the culture system only predispose the candidate species towards diseases. Maintenance of best water quality could therefore be described as 'health maintenance', and be given top priority in shrimp farming. This will reduce the harmful effects of chemoprophylaxis as well as chemotherapy in farming activities.

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