



Aquaculture

REVIEW ARTICLE

An overview of diseases in fish hatcheries and nurseries

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ABSTRACT

Quality and healthy fish seed is the prerequisite for sustainable aquaculture. A major challenge to the expansion of aquaculture production is the outbreak of diseases. Disease induced mortality is a serious issue for the fish seed industry. The immature immune system in fish makes the early developmental stages more susceptible to infectious diseases. Common fish diseases in hatcheries and in early rearing systems are caused by protozoan, ciliates, myxosporidians, worms, opportunistic bacteria and fungi. Production of healthy fish seed and their survival rate depends on the proper health management strategies, maintenance of good water quality, proper nutrition and application of biosecurity measures. The paper highlighted the different types of diseases, causative agents and their prevention and control measures in fish hatcheries and nurseries.

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INTRODUCTION

Aquaculture is the fastest growing food producing sector in the world. Production of aquatic animals from aquaculture in 2014 amounted to 73.8 million tonnes which contributed 44.1% to the world total fish production (FAO 2016). Bangladesh has emerged as one of the leading nations in aquaculture production during recent years, which ranks sixth among the top 10 aquaculture producing countries of the world and its growth rate is quite comparable to that of China and India (FAO 2016). Aquaculture production in Bangladesh has been progressively increased and its contribution to total fish production has gone up from 38.2% in 1998-1999 to 55.93% in 2014-2015. The country produced 3.68 million tonnes of fish in 2014-2015 of which 2.06 million tonnes came from aquaculture (DoF 2016). Bangladesh contributed 2.65% in world total aquaculture production in 2014 (FAO 2016; DoF 2016). The main aquaculture production in Bangladesh comes from Indian major carps (rohu, *Labeo rohita*; catla, *Catla catla*; mrigal, *Cirrhinus cirrhosus*) and Chinese carps (silver carp, *Hypophthalmichthys molitrix*; grass carp, *Ctenopharyngodon idella*; common carp, *Cyprinus carpio*). Carps account for 88% of the fish recorded as produced in ponds in Bangladesh (DoF 2010). Nile tilapia (*Oreochromis niloticus*) and pangasius (*Pangasianodon hypophthalmus*) are cultured in ponds mostly as commercial basis by entrepreneurial farmers. Climbing perch (*Anabas testudineus*) and shing (*Heteropneustes fossilis*) are also

produced in ponds as minor commercial species.

Prior to 1990, most carp seed production was derived from collection of natural spawn from rivers. Millions of eggs and spawn were collected from major rivers such as the Halda, the Jamuna, the Padma, and their tributaries during the monsoon season (May-August). This situation was altered beginning in 1990, when a large number of hatcheries were established in different parts of the country (Hasan and Ahmed 2002). More than 98% spawn is produced in the hatcheries (Ahmed, 2005). At present there are 964 fish hatcheries (78 public and 868 private) in the country. In 2014-2015 about 547549 kg fish spawn was produced from these hatcheries while only 4,412 kg fish seed were collected from natural ground. Moreover, there are 10,802 fish nurseries all over the country that produced over 8 million fingerling during this period (DoF 2016).

Healthy and disease free fish seed is one of the prerequisites for sustainable aquaculture. Currently, in Bangladesh production of seed is not a problem but the crucial factor is to maintain its quality. Over the last two decades Bangladesh became self-sufficient to produce and distribute fry to the users but the quality of seed has been deteriorated (Sarder 2007). The performance of food fish is related to both the quality of seed and their management post-stocking (Little et al 2002). Hussain and Mazid (1997) reported reduced growth, physical deformities,

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diseases and high mortality in hatchery produced carp seed.

Fish disease has become a limiting factor in enhancement of fish production, where, producers, traders and consumers are mostly affected resulting in heavy economic losses. Disease problems constitute the largest single cause of economic losses in aquaculture. A global estimate of disease losses to aquaculture by World Bank in 1997 was in the range of US\$ 3 billion per annum (Subasinghe and Phillips 2002). In a study on the impact of fish disease in rural aquaculture in Bangladesh, Faruk et al. (2004) observed financial losses of approximately 15% of the actual production to rural fish farmers due to fish diseases. This loss was mostly due to poor understanding of the farmers on disease diagnosis and health management.

In recent years, the intensification of aquaculture system has led to major problems in outbreaks of fish diseases. High stocking densities, excess feeding and artificial fertilizations are common husbandry practices followed in intensive culture systems. These offer an ideal environmental condition for the growth of different types of fish pathogens and as a result the host organisms suffer from stress. Thus, fish become more susceptible to various infectious organisms such as protozoa, helminths, crustaceans, bacteria, fungus and virus. A range of aquatic diseases like epizootic ulcerative syndrome (EUS), tail and fin rot, bacterial gill rot, bacterial haemorrhagic septicaemia, columnaris disease, dropsy, various types of fungal and parasitic diseases are common in farmed fishes of Bangladesh (Chowdhury 1997; Mazid 2001; Mazid and Banu 2002; DOF 2002; Faruk et al. 2004). In Japan, mass mortalities due to infectious and non-infectious diseases have often occurred in larvae and juveniles reared in marine hatcheries. In 1980s, viral diseases such as viral epidermal hyperplasia in the Japanese flounder, viral ascites in yellowtail, viral nervous necrosis in Japanese parrotfish and striped jack have been reported. Vibriosis, pasteurellosis, gliding bacterial infection and other bacterial diseases have occurred in various marine fishes at their juvenile stages. On the other hand, larval fish most frequently develop intestinal infections represented by bacterial enteritis with *Vibrio ichthyenteri* in the Japanese flounder (Moruga 2001). Bruno and Poppe (1996) reported Saprolegniasis as a serious problem affecting egg production in trout hatcheries world-wide.

DISEASES IN FISH HATCHERIES AND NURSERIES

The risk of disease induced mortality is a serious issue for the seed industry. The immune system plays an important role in defence mechanisms in fish and it helps in combating against some fish pathogens in water. The immature immune system in fish makes the early developmental stages more susceptible to infectious diseases. Depending on the nature and severity, the disease may cause mass mortality of the affected seed in a short time, produce protracted small-scale mortality, reduce growth and result in poor quality seed. In addition, seed coming out of infected hatcheries could be infected and carry the pathogens to grow-out systems, where disease can manifest and result in mortality of stocked seed. Diseases caused by parasites, bacteria, viruses and fungi are common in freshwater seed production systems. Farmers should therefore; watch the health condition of fish at all levels and take prophylactic measures before disease outbreak.

Hasan and Ahmed (2002) conducted a survey on disease problems in 180 carp hatcheries and nurseries in Bangladesh and reportedly found disease as a big problem for hatcheries and nurseries. The authors listed a number of diseases found in hatcheries and nurseries which were white spot, tail and fin rot, EUS, fish louse, gill rot, dropsy, malnutrition, air gulping and deformities. The authors further noticed that the occurrence of deformed larvae were more common for spawn produced during late breeding season.

Yamin (2007) reported a number of diseases in fish hatcheries of Mymensingh, Jessore and Bogra districts of Bangladesh. The most prevalent disease of brood fish was argulosis followed by EUS, gill rot, dropsy and nutritional diseases. Other conditions like suffocation and fin rot were also reported but with lower incidence. Majority of the hatchery owners reported that they observed disease in brood fish mainly during winter season and after striping. The major disease problems of fish spawn as reported by the hatchery owners were fungal infection in fertilized eggs, white spot inside the yolk sac, loss of slime, spinal deformities, enlarge head and stomach, blindness and sudden spawn mortality due to unknown reason. Only few diseases were reported in the nurseries which included fin and gill rot, red mouth and enlarged head. The average economic loss occurred due to diseases was about 10-15% of the total profit.

In a recent study to examine the status of biosecurity and health management in 30 commercial fish hatcheries in Mymensingh district of Bangladesh, Faruk et al. (2012) reported that though the hatchery owners did not have good understanding about biosecurity procedure, still the biosecurity situation of the surveyed hatcheries were quite satisfactory. The authors found that majority of the hatcheries maintained good hygiene, cleaned hatchery units regularly, maintained proper water temperature, disinfected equipments, stocked disease free broods and followed quarantine procedure to some extent. However, no hatchery staff was seen to wear any protective clothing. Immunization and vaccination to protect fish against certain disease was totally absent. Hatchery owners reported some diseases in brood which included argulosis, EUS, gill rot, dropsy and nutritional diseases. The prevalence of disease in brood fish was about 15-20% with 5-10% mortality of infected fish. A number of health management and disease treatment measures were reported of which application of lime was the most common one followed by application of salt, potassium permanganate, antibiotics, pesticides and insecticides. A review in common diseases encountered in seed production systems of freshwater fish is discussed below.

Parasitic Diseases

Parasitic diseases in nurseries are one of the most important factors limiting the growth and survival of fry and fingerlings. Mass mortalities of carp fry and fingerlings have been reported due to protozoan and metazoan infections.

Protozoan diseases

Ichthyophthiriasis: The ciliated protozoa *Ichthyophthirius multifiliis* referred to as "Ich" is the causative agent of Ichthyophthiriasis or white spot disease. It is the most pathogenic of protozoan parasites affecting the performance of freshwater fish hatcheries and seed rearing farms (Mohon 2007; Kalita 2000). The disease has been reported in fry and fingerlings of *C. catla*, *L. rohita* and *C. mrigala* from nursery and rearing ponds (Chandra 2004). Minute white spots, nodular in form and in size are visible on the skin, fins and gills. Affected fishes show irritation, erratic movement and restless with tendency to rub on the sides. During the early stage scratching is seen on skin and going off feed. Some cysts join together to form irregular patches. This is an obligatory parasite. It is spherical in shape and the cilia are evenly distributed over the whole surface. Characteristic feature of the parasite are the horse-shoe shaped nucleus, and its rotating movement when alive. Prevention and control of *Ich* include prevention of exposure of fish to the parasites, prompt identification of the disease if it occurs; and treatment of infected fishes. *I. multifiliis* infection is usually introduced into fish populations by the addition of new infected fishes. No new fishes should be introduced in a culture facility unless they have been in quarantined for 2 to 3 weeks. A variety

of chemicals have been used for treating. The most successful treatment for the free-living form of *Ichthyophthirius* sp. is bathing in formalin solution of approximately 200 ppm for 1 h, or 25-30 ppm for long-term treatment. The mixture of formalin and malachite green at 25:0.1 ppm appeared to be a very effective treatment for *Ichthyophthirius* (Tonguthai 1997). The zinc free oxalate salt of Malachite green is also effective against *Ich.* Sodium chloride kills theronts in saturated salt solutions. A concentration of 7,000-20,000 ppm have suggested for pond treatment. Kamala is often used to control infection. Fishes in aquaria are treated with 25-50 ppm of formalin on alternative days until infection is cleared. Both treatments are done with 160-250 ppm formalin for 1 hour daily (Chandra 2004).

Trichodiniasis: The disease is caused by a large assemblage of peritrichous ciliates of trichodinids. They are capable in some cases cause heavy damage to their hosts with resulting mortalities. Fry, fingerlings and adults of *C. catla*, *L. rohita*, *C. cirrhosus*, *C. idella*, *C. carpio*, *H. molitrix*, *Tilapia mossambica* and other cultured species are reported to be affected by these parasites (Chandra, 2004). It is also a common parasite of *Pangasius* catfish cause heavy infections responsible for mortality during nursing period (Dung et al. 2008). *Trichodina* sp. occurs in the skin and gills of host fishes. Grayish blue veil like coating over the body surface could be seen along with darkening of the skin and excessive mucus secretion is the major signs of this condition. Presence of trichodina indicates deterioration of water quality. Water quality should be improved and stocking density be reduced. The infected fish could be treated with Formalin dip bath at the rate of 250 ppm for 3-5 minutes or Sodium chloride 2-3% for 5 minutes or with potassium permanganate dip treatment at the rate of 0.1% for 30-45 seconds or indefinite treatment with 2-3 ppm (Chandra 2004; DoF 2002; Mazid 2001). Formalin at 25-30 ppm is also effective to treat *Trichodina* in aquaria and ponds (Tonguthai 1997).

Certain ectocommensal ciliates (*Epistylis* sp., *Vorticella* sp. and *Zoothamnium* sp.) attach to the external surface leading to fouling. These ectoparasitic protozoans are often associated with mortalities of younger stages of cultured fish. The situation becomes worst in waters with low oxygen and high organic matter as most of these have simple and direct life cycle enabling them to multiply rapidly in such conditions (Mohon 2007).

Ichthyobodosis: The disease is caused by the flagellated ectoparasite *Ichthyobodo necator* and could be found in freshwater fish hatcheries. The organism has a free living stage in water and parasitic stage, which is usually attached on dorsal fins and tips of secondary gill lamellae of infected fish. Small spots appear on the body, which may fuse into a grayish white film from increased production of mucus. The more intensely affected areas are reddened and haemorrhagic. Fins may be damaged. Infected gills are pale and covered with mucus. Fish may loss appetite. Moribund fish rise to the surface become sluggish and dies. Control measures include Formalin flash treatment at 166 ppm for 1 hour or bath 1:4000 for 15-30 minutes. Treatment for 1 hour with formalin (1:6000) is also very effective. Fingerlings could be exposed to weak solution of Malachite green (1:4,00,000) for 40-60 minutes. Concentrated salt solutions (5%) are recommended for larger fish. Ponds with infected fish are drained and quicklime or chloride or limes is added before restocking with new or treated fish.

Cryptobiosis: It is caused by the flagellate protozoan *Cryptobia* sp. and also found in freshwater hatcheries (Mohon 2007). These parasites have been observed primarily in the stomach, but may be present in other organs. Fish affected with *Cryptobia* may become thin, lethargic and develop a dark skin pigmentation. A variety of treatments are presently being applied with limited success. Nutritional management has proven to take an active role in its control.

Myxosporidiean diseases

Diseases caused by endoparasitic sporozoans are a serious concern in fish seed farms. Myxosporidia are the most common of fish sporozoa. Chandra et al (1996) reported high prevalence of myxosporean ectoparasites in juvenile Indian major carps (*L. rohita* and *C. cirrhosus*) in nursery ponds of Mymensingh. They also reported severe gill infection of these juvenile carps by five different myxosporean belonging to the genus *Myxobolus*. All organs and tissues are possible sites of infection. The infective stage of the myxozoan diseases is the matured myxozoan spore. These spores present in the pond soil are normally ingested by the early feeding stages of fish. The infective element of the spore (sporoplasm) is released in the gut. The sporoplasm reaches the target tissue using the vascular route. Once inside the target tissue, the vegetative trophozoites cause massive destruction of the target tissue and produce large spore containing cysts. Infected fish show whirling swimming action (*Myxosoma cerebralis*), some species form, boils or cysts on the body surface (*Myxobolus pfeifferi* and *M. piriformis*). The period from ingestion of spore to expression of clinical disease may take anywhere between a month to several months. Indian major carp fingerlings coming out of contaminated nursery ponds carry the infection to grow out ponds and result in severe post-stocking mortalities (Mohon and Shankar, 1999). Elimination of the affected fish and disinfection of the environment is the best control of myxosporidiean diseases. Das and Das (1997) suggested to treat the pond with mahua oil cake and lime by which the infective stage are destroyed. Sodium chloride treatment (3-5%) destroys the spores and other developing stages but not the cysts.

Disease caused by monogenetic trematode

Monogenean trematodes, also called flatworms or flukes, commonly invade the gills, skin and fins of fish. *Dactylogyrus* spp. (gill flukes) and *Gyrodactylus* spp. (skin flukes) with their well developed attachment haptor and feeding apparatus can cause extensive pathology and mortality in early developmental stages of fish. Larval stages of digenetic trematodes (e.g. cercaria and metacercaria) are capable of causing mass mortalities in nursery systems (Mohon et al. 1999). The colour of the gills becomes faded and there is excessive secretion of mucus due to the presence of gill fluke. Clinical signs of skin fluke infestation include fading of the normal body colour and small spots of blood on the body surface. Dropping of scales and excessive mucus secretion may also occur. Treatment of monogeneans is usually not satisfactory unless the primary cause of increased fluke infestations is found and alleviated. The treatment of choice for freshwater fish is formalin, administered as a short-term or prolonged bath. Potassium permanganate can also be effective in controlling monogeneans.

Metacercarial larval stage of the species *Diplostomum* causes black spot disease in fry and fingerlings of catla, rohu and mrigal and silver carp in nursery and rearing ponds (Mohon 2007; Kalita 2000). Black ovoid patches are visible on the body surface of the affected fishes. These are pigmented patches overlaying cysts of the metacercarial larvae. Number of cysts may be few to hundreds. Control measure include removal of the molluscan population (first intermediate host) in the affected ponds and also the aquatic birds (final host) around it.

Diseases caused by crustaceans

Argulosis, caused by *Argulus* (Fish louse) is one of the most important parasites particularly in carp husbandry. Fry, fingerlings and adults of Indian major carps are affected (Ahmed 2004; Mohon 2007). With its well developed attachment organs and mouth parts, *Argulus* inflict considerable damage at the site of attachment and feeding thereby predisposing the fish to secondary systemic bacterial and fungal infections. The larvae

and adults of *Argulus* are parasitic to fish. This parasite penetrates the upper layers of the host's skin and feeds on blood and body fluids. Affected fishes become restless having erratic swimming movements. Attachment sites show sign of ulceration. Adult parasite is oval, flat, transparent to whitish in colour with two conspicuous black spots. The *Argulus* can be seen quite clearly with the naked eye.

The only sure way to prevent *Argulus* infection is to control the parasite access to protected habitat. Remove the submerged vegetation, wooden lattices placed in the pond will serve as artificial substrate to deposit its eggs, which can be removed at intervals to kill the eggs. Prophylactic measures are the control of the water intake and treatment of fish. Dipterax at the rate of 0.5 mg/l can be applied once in a week for 5 weeks. Kimura (1960) indicated that the use of Dipterex is effective in eradication of argulids. Specifically, a concentration of 0.2-0.3 ppm is effective, and adults and larvae fall off the parasitized fish and die within 12-24 h. Alternatively, Sumithion at the rate of 0.8 mg/l could also be applied in pond once in a week for 5 weeks. Potassium permanganate can be used to control *Argulus* of carp at 10 ppm concentration for 5 hours. Formalin controls *Argulus* in bath of 250 ppm for 1 hour.

Lernaea also known as anchor worm causes Lernaeosis. The adult female of *Lernae* sp. is parasitic, has anchor like appendages at the anterior end and egg sacs at the posterior end. The parasite burrows deep into the body fluids. Fingerlings and adults of carps are affected in the culture ponds. At initial stage fish become restless and try to rub its body against the sides and bottom of the pond due to irritation. Heavy infections lead to debilitation and secondary bacterial or fungal infections. The organophosphate trichlorphon (the principal ingredient of Dipterex) is most effective in eradicating anchor worm larvae (Tongothai 1997). Pond treatment with potassium permanganate at the rate of 4 mg/l found effective. A 3% salt dip followed by 0.2% prolonged immersion has been used to effectively control *Lernaea*.

Bacterial Diseases

In each type of culture and for virtually every species, specific bacterial pathogens are responsible for serious disease problems. Mohon (2007) reported a number of bacterial pathogens causing morbidity and mortality of fish seed in hatcheries and nurseries which include aeromonads, vibrios and pseudomonas. Bacteria can cause disease either as primary pathogens or as secondary opportunistic invaders. Ulcerative types of diseases are characterized by haemorrhagic surface ulcers and are caused by species of *Aeromonas*, *Pseudomonas*, *Vibrios* and *Flavobacterium*. Surface ulcerative disease conditions at times develop to acute systemic disease characterized by the presence and proliferation of bacteria in internal organs like kidney, heart, spleen, blood and other visceral organs. These diseases produce significant necrotic changes in all affected organs and can cause mortality in a short time scale. Bacterial haemorrhagic septicaemia caused by *A. hydrophila* is a major problem in carp seed production facilities. Poor water quality, organic pollution, temperature fluctuations and extremes, wild fish reservoir, overcrowding, poor nutritional status and trauma could easily predispose early developmental stages to bacterial infections. *A. hydrophila* also responsible for causing dropsy in juveniles of Indian major carps. Dropsy is characterized by the accumulation of water in the body cavity or in scale pockets. Scale becomes loose. Abdomen is bulged and very often due to secondary infection scales fall off. The incidence of rainbow trout fry syndrome (RTFS) caused by *Flavobacterium psychrophilum* in rainbow trout hatcheries is considered to be one of the biggest disease problems associated with the production of rainbow trout fry (Faruk et al. 2002). Bacillary necrosis of *Pangasius* (BNP) is a serious and economically important bacterial infection caused by *Edwardsiella ictaluri*. The disease occurs in all ages of fish,

although high mortalities are reported in fingerlings and juvenile fish. Outbreaks decrease production and increase costs associated with treatment and high fish mortalities. BNP shows few external signs at the beginning of the infection. Clinical signs are encountered immediately before death. Fish swim slowly at the surface of the water and when examined show pale color on skin and gills, and internal white spots on the liver, kidney and spleen. Careless treatment has resulted in antimicrobial resistance in *E. ictaluri* treated with oxytetracycline or sulfonamides (Dung et al 2008).

Fungal Diseases

Fungal growths on the surface of eggs and larvae of fish can cause extensive direct mortalities. Aquatic fungi can cause disease either as primary pathogens or as secondary invaders that follow traumatic injuries, infectious agents, or environmental insults such as poor water quality or low water temperatures. Incubated eggs and early development stages of all freshwater fishes are susceptible to external fungal infections. External fungal infection is also a problem in hatcheries during incubation of eggs. Fungi can prevent successful hatching when it invades fish eggs. The fungus first establishes on dead and unfertilized eggs and gradually spread to healthy developing eggs destroying the entire batch of incubated eggs. Egg washing and removal of necrotic substances such as unfertilized and damaged eggs helps to minimize fungal infection in hatcheries.

Saprolegniasis or cotton wool disease, caused by *Saprolegnia* species are among the most common fungal infections of fish hatcheries (Bruno and Poppe 1996). Eggs, fry and fingerlings of Indian major carps and exotic carps are affected. Saprolegniasis is a secondary manifestation of a pathology suffered by developing embryos. The disease is characterized by white fluffy patches of mycelia visible on the surface of the fish or eggs (Hatai and Hoshiai 1992). Poor water quality and high organic loads, including the presence of dead eggs, are often associated with *Saprolegnia* infections. The presence of *Columnaris* spp. bacteria or external parasites is also common with Saprolegniasis. The condition is often first noticed by observing cotton-like material colored white to shades of gray and brown on skin, fins, gills, or eyes of fish or on fish eggs. On eggs the disease is manifested by abundant mycelial growth on the cells resulting in death. *Saprolegnia diclina* also impacts on the aquaculture industry infecting a large proportion of the fish eggs cultivated on farms. Saprolegniasis is best prevented by good management practices such as good water quality and circulation, avoidance of crowding to minimize injury (especially during spawning) and good nutrition. Once *Saprolegnia* is identified, sanitation should be evaluated and corrected. Up till 2002, Saprolegnia infections in aquaculture were kept under control with malachite green, an organic dye that is very efficient at killing the pathogen. However, the use of malachite green has been banned worldwide due to its carcinogenic and toxicological effects and this has resulted in a dramatic re-emergence of Saprolegnia infections in aquaculture (Alderman 1985; West 2006).

Viral Diseases

Viral diseases cause serious problems in every aspect of aquaculture. Virus is a highly obligatory intracellular parasite. Virus replication is invariably at the cost of the host cell, either the cell is affected partly or fully. At the host level, virus affects target organ partially damaging and impairing its function or fully destroying it leading to morbidity and death of the host. There is limited information on the impact of viral pathogens in the early development stages of carps, tilapia and catfishes. Grass carp hemorrhagic virus (GCHV) since its first description in 1980s has been associated with mortalities of early developmental stages of Chinese carps (Yulin 2005). Among salmonids, the impact of infectious pancreatic necrosis (IPN)

virus has been well studied. Vertical transmission of viral pathogens from the mother to the progeny is a cause for serious concern in many cultured species. Koi herpesvirus disease (KHVD) is a herpesvirus infection (Hedrick et al. 2000) capable of inducing a contagious and acute viraemia in common carp (*Cyprinus carpio*) and varieties such as koi carp and ghost carp. The virus is highly contagious and may cause up to 100% mortality. All age groups of fish, from juveniles upwards, appear to be susceptible to KHVD. No treatment is available. Methods to control and prevent KHVD should mainly rely on avoiding exposure to the virus coupled with good hygiene and biosecurity practices. If precautions are not taken to prevent the introduction of viral agents, severe economic losses can occur. In viral diseases, regardless of the species being cultured, the only remedy is to quarantine and destroy the infected stock. Rigorous cleaning followed by disinfection of all facilities, equipment, and water supplies must precede further attempts to produce fish (Wolf 1988).

Environmental Mediated Diseases

Hatchlings and fry of carps are affected by gas bubble disease which is caused by supersaturated oxygen and nitrogen gases and high load of organic fertilizers at the pond bottom. Young fishes show erratic movement and gradually die exhibiting a whirling movement. The abdomen could be swollen. Fry, fingerlings and adults of Indian and exotic carps are also affected by algal toxicosis disease. Surfacing of fish occur with erratic movement and mortality in many cases. The causative agent is blue green algae (*Microcystis*, *Anabaena* sp.). Hasan and Ahmed (2002) reported sudden spawn death in hatcheries of unknown reasons but the operators assumed sudden sharp rise of water temperature in hatcheries and nurseries could be responsible for such massive death.

CONCLUSION

Disease is considered as one of the important problematic factors for the seed industry. It was found that parasitic diseases are particularly one of the most important limiting factors for growth and survival of fish fry and fingerling. The management and control of parasitic and other infections in aquaculture are a constant challenge, highly complicated by the current limited availability of efficacious licensed products. It is thus important to give emphasis on prevention rather than treatment of disease. Disease prevention is accomplished through good water quality management, nutrition and sanitation. Without this foundation it is impossible to prevent outbreaks of opportunistic diseases. Prevention should be considered the first line of defense when managing fish seed disease and survival. Establishment of seed certification system and diagnostic laboratory is important to check the health status of fish brood and seed. Implementation of biosecurity measures and setting up quarantine system is necessary to control possible disease introduction and spread. It is also necessary to support hatcheries and nurseries in producing healthy fish seed according to set criteria.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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