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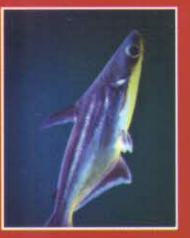

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MAJOR DISEASES OF CATFISH (*PANGASIUS*)

DIAGNOSIS AND MANAGEMENT APPROACHES

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The Pangasius - *Pangasianodon hypophthalmus* (Fig. 1) commonly known as the Pangasius or catfish, is cultured intensively, mostly by entrepreneurial farmers in India. Due to faster growth, easy rearing on artificial feed and higher survivability even in suboptimal water quality, it has become a vital aquaculture species in pond, wetland and enclosure system in large water bodies like, lakes, wetlands and reservoirs in India. However, intensive aquaculture of this fish resulted in various disease outbreaks and mortality. Depending on the aquatic environment and culture systems bacterial, parasitic and fungal infections are recorded in this catfish. Early diagnosis of these ailments with better management practices, suitable feeding strategies, preventive, chemo-prophylactic, and therapeutic measurements are

Fig. 1 - Catfish Pangasius - Pangasianodon hypophthalmus

essential for optimum production and better economic returns from the pangasius industry. This article highlights the important diseases of *P. hypophthalmus* and their diagnostic and management approaches, which would be useful for aqua culturists, aquaculture entrepreneurs, academicians and researchers.

Pangasius is a fast-growing fish, which has recently become a trendy food fish and valuable aquaculture species in South-East Asia. The fish is extensively cultivated in commercial fish farms (Fig. 2) in countries like Thailand, Vietnam, Bangladesh, India, and Myanmar. The fish, popularly known as 'Thai pangas', was introduced to Bangladesh from Thailand during the 1990s and has since developed into a popular species amongst fish culturists and consumers. The Asian catfish, *P. hypophthalmus* (Sauvage), is intensively produced in Vietnam, which exported 3,87,000 tonnes of fillet in 2007. The fish proved to be a great success in aquaculture system of Bangladesh, and it is the only catfish species used for commercial aquaculture in the country. In India, pangasius is cultured in an intensive manner, mostly by entrepreneurial farmers. The species was introduced in the year 1994-95 to India from Bangladesh, to enhance overall aquaculture production of the country to meet the increasing demand for food fish. Pangasius is generally farmed in India, under monoculture or polyculture with carp species.

The species can grow up to 1 to 1.5 kg in one year with annual yields of around 10 to 15 tons per hectare. Over the years, the fish became popular among the farmers in several states of the country with an estimated production of around 400,000 to 425,000 metric tons per year. Besides ponds and wetlands, it has become the most suitable candidate species for cage culture in vast water resources like reservoirs. Because of its omnivorous feeding habit, ready acceptance of artificial feed, and faster growth even in intensive stocking, the fish has become synonymous to the 'broiler chicken' of the aquaculture industry.

Like other farming systems, aquaculture is also plagued with disease problems which increased with intensification. In one estimate, it was reported that there was ~15% loss of the actual production of rural fish farmers due to fish diseases. Multiple factors have contributed to the current disease problems faced by the fastest growing food-producing sector globally. These include: (a) intensification of fish-farming practices through the movement of brood stock, post-larvae, fry and fingerlings; (b) unanticipated interactions between cultured and wild populations of aquatic animals; (c) introduction of new or non-native species for the aquaculture system; (d) expansion of the ornamental fish trade; (e) enhancement of marine and coastal areas through the stocking of aquatic animals raised in hatcheries; (g) poor or lack of effective biosecurity measures; (h) lack of awareness on emerging diseases; (i) misunderstanding and non-availability of specific pathogen free (SPF) stocks; (j) climate change and other stressors; and (k) other human-mediated movements of aquaculture commodities. Although *P. hypophthalmus* is less prone to suboptimal water quality conditions, morbidity and mass mortality are not uncommon and constitute one of the significant constraints in the farming of the species in several parts of India. Insufficient knowledge

Fig. 2 - Cage culture of Pangasius in reservoirs in India

Fig. 3 – Red spot disease in Pangasius

on diseases of this newly adopted species, predisposing factors, along with inadequate diagnostic support and availability of therapeutics lead to substantial economic loss during disease outbreaks.

Diseases of any fish, including pangasius can be broadly categorized as viral, bacterial, parasitic, nutritional and management origin. Recently, large-scale disease outbreaks with mass mortality in pangasius have been recorded by us. For awareness on diseases of this new species and with the objective of disease management, we present here the major disease conditions in pangasius caused by bacteria, fungi, and parasites and their most likely probable therapeutic and control measures in both pond and cage culture system of the country.

1. Bacterial diseases

(a) Red Spot Disease:

It is a septicaemic condition and is also known as Motile Aeromonas Septicemia (MAS). The infection occurs mostly in fingerlings and during the grow-out phase.

Aetiology: The disease condition is caused by motile aeromonads, especially, *Aeromonas hydrophila, A. sobria,* and *A. caviae.*

Risk factors: This infection often occurs during change in weather, from dry to rainy season, especially if fish are stressed by handling and transportation. Overcast sky with intermittent rain causing lack of sunlight and wide fluctuations in water temperature, may predispose fish to infection and disease outbreak.

Clinical symptoms and signs: Symptoms include slow swimming, anorexia, petechial haemorrhages on the head, mouth, and base of the fins. The vent may be red and swollen. On post mortem examination, pink to a yellow ascitic fluid may be noticed in the abdominal cavity (Fig.3). Reducing stocking densities and maintaining water quality can significantly reduce the incidence of this bacterial problem in fingerlings and grow-out fish in ponds. Particular precaution should be taken to reduce disease outbreak and mortality when the sky remains overcast with intermittent rain for a few days.

(b) Bacillary Necrosis of Pangasius (BNP):

This is a fatal septicaemic condition with high morbidity and mortality, especially in channel catfish. It is a severe and economically significant bacterial infection of various catfish species. The etiological agent can survive in pond water for around two weeks and up to three to four months in pond mud. Fingerlings and juvenile fish are most susceptible, but fish of all age groups may also be affected. The pathogen mostly causes acute septicemia, and thus the disease is also known as Enteric Septicemia of Catfish (ESC). In chronic infections, the bacteria target the nervous system and leads to encephalitis followed by holes in the head region, a condition commonly known as "Hole in the Head".

Aetiology: The disease is caused by Edwardsiella ictaluri belonging to the Enterobacteriaceae family. *E. ictaluri* is a common pathogen in catfishes, and so in pangasius. The bacterium is a short, gram-negative, pleomorphic rod with flagella.

Risk factors: High stocking density, suboptimal water quality, including pollution, malnutrition, and stress due to transportation may precipitate the disease. Adverse climatic conditions are considered as risk factors for the development and spread of BNP. The disease spikes up, during the rainy and winter seasons, when the temperature drops below 28° C. Survived fish remains as a carrier of the disease.

Clinical signs: BNP shows few external signs at the beginning of the infection. Signs tend to become apparent immediately before death. Affected fish swim slowly at the surface of the water. Pale coloured skin and gills are often observed during the course of the disease (Fig. 4).

Gross pathology: Classical macroscopic white spots on the liver, kidney, and spleen are generally noticed.

(c) Saddleback / Columnaris disease:

The bacterium *Flavobacterium columnare* has been reported as the etiological agent of freshwater Columnaris disease, also known as Saddleback disease.

Risk factors: Water quality variables, pond depth, reduced feed consumption, shorter intervals from stocking to disease outbreaks, and total ammonia nitrogen are chiefly associated with columnaris occurrence.

Clinical signs: In typical condition, there is discolouration of skin behind the head, giving a characteristic appearance of saddleback. There is also necrosis of the fins and gills. The disease affects a wide range of freshwater fish species globally, including pangasius.

Pathology: On histological examination, numerous Gram-negative, filamentous bacteria are seen on the skin, muscle and gill tissues of diseased fish.

Fig. 4 - Septicemic disease caused by Edwardsiella ictaluri

Fig. 5 - Saprolegniasis or cotton-wool disease

2. Fungal disease

Saprolegniasis:

The disease saprolegniasis is caused by water moulds (oomycetes) mostly belonging to the genus Saprolegnia. Saprolegniasis presents as cotton-like growth adherent to skin or gills and includes several genera of fungi. The water mould can only survive in soil, and freshwater and the fish acquires infection from the inanimate source. Saprolegniasis occurs mostly during the cold temperature and is often called as ***winter kill.***

Risk factors: Water moulds proliferate in fresh and brackish water with less than 2.8 ppt salinity. Most of them are saprophytes occurring naturally in the environment and are opportunistic pathogens, usually requiring prior injury of external tissues from mechanical abrasion or other primary pathogens. Chance of recovery is dependent on the severity and area of affected skin and gills.

Clinical signs: At the initial stage of the disease, small and focal white lesions of cotton-like growth appear on the skin. As the disease progresses, cotton-like growth on the surface of the skin and gills become the most prominent clinical findings of saprolegniasis. Fish will be emaciated, reluctant to consume feed and swim at the surface are important symptoms. At an advanced stage of the disease, the mycelium covers the whole body with the appearance of tangled mass all over the body (Fig. 5, 6).

Gross pathology: Brownish patches of cottony fungal growth on the skin, including the gills, dry, de-pigmented skin, and endophthalmia (sunken eyes) are

Fig. 6 - Photomicrograph of Saprolegnia sp. Zoosporangia and hyphae are duly marked.

prominent pathological signs. Along with mould, some external parasites may also affect the fish as concurrent infection. Clinical symptoms will be supported with an observation of the typical water moulds of skin scrapings of the affected fishes. This disease must be differentiated from bacterial disease caused by Flavobacterium spp. and related microbes where similar lesions are observed.

3. Ectoparasitic diseases

(a) Monogenea:

Monogenea group includes several gill and skin parasites belonging to Thaparocleidus. They cause a seasonal incidence of heavy infections in both pond- and cage-cultured pangasius during the rainy and winter seasons. The signs of the disease include sluggishness and slow swimming at the water surface, sloughing of mucus, and pale, swollen gills. Infected

fish have reduced appetite and as a consequence, become weak and vulnerable to bacterial infections. Sporadic outbreaks can occur with low mortality. Treatment with formalin is effective in controlling morbidity and mortality.

(b) *Trichodina* and *Epistylis*:

Trichodina and *Epistylis* are common parasites of pangasius catfish and cause heavy infections leading to mortalities during the nursing period. The parasite infestation can be observed year-round but is the heaviest when climate conditions are unstable, such as downpours of rain followed by periods of bright sunshine. The parasites affect mostly in ponds with high stocking density and deteriorated water quality. The critical signs and symptoms of the parasite infestation include breathing difficulties, anorexia, pale gills, swimming on the water surface, flashing or movement through plants, and in severe cases, fin erosion. Disinfection is an effective way to control parasites. Copper sulfate or formalin can be used as a treatment.

(c) White spot disease:

White spot disease is caused by a ciliated protozoan *Ichthyophthirius multifiliis*. The so-called 'ich' is a common parasitic disease in pangasius, at least in cages. Fry and fingerlings of the species are most susceptible. Affected fish swim slowly, and mortalities are high within five to seven days when water temperatures are below 28°C. In severe condition, hundreds of white spots less than 1 mm size can be seen on the skin and gills of affected fish. It is difficult to treat the disease condition (Fig. 7).

4. Endoparasite infestation

(a) *Myxosporean:*

Myxobolus and *Henneguya* species belongs to the Myxozoa which are commonly found in pangasius

Fig. 7 - Typical white spot lesions caused by Ichthyophthirius sp. in Pangasius

catfish. The cysts containing spores can be seen on internal or external organs. Infestations are generally widespread with no option of effective treatment. Drying and liming ponds for removing the intermediate oligochaete hosts is one of the alternatives to control the disease.

(b) *Microsporidians*:

Microsporidians are obligate intracellular parasites that occasionally, infiltrate the muscles and viscera of cultured catfish. Generally, microsporidians are not regarded as important catfish parasites, but their presence can significantly reduce the quality and marketability of fillets.

(c) *Balantidium* and *Ichthyonyctus*:

Balantidium and *Ichthyonyctus* species are ciliate protozoa mostly found in the large and posterior intestines of the juvenile as well as adult pangasius catfish. The pathogenesis of the parasite in pangasius is not clear. These parasites are found in close association with the guts of pangasius, including the nematodes and digeneans. There is no therapeutic guidelines for this disease.

(d) *Trypanosoma:*

The *Trypanosoma* species are the flagellate *haemoprotozoa* mostly seen in farm-reared *P. hypophthalmus*. The protozoan infections do not produce any apparent pathological changes in the fish and are therefore of very less significance.

Better management practices as preventive measure

In general, opportunistic pathogens in the aquatic environment are ubiquitous. As documented in many of the scientific reports, diseases are rarely the result of contact between the fish and a potential pathogen alone in an aquaculture system. In the presence of one or more stressors like poor water quality, low oxygen level, high stocking density, weak fingerlings, inadequate nutrition, etc. the opportunistic pathogens invade the fish and cause disease outbreaks. Thus, good aquaculture practices in pond farming limit the spread of diseases. The leading practices recommended for the fish farming industry toward disease control are as follows:

1. Environmental precautions and nutritional management:

The transmission of the fish diseases can be restricted to a great extent by curbing on three main issues: (i) optimum water quality, (ii) healthy and disease-free fingerling, and (iii) proper feeding management.

The most severe threat to pangasius is poor water quality. Circulating water using pumps, in turn, enhances the oxygen content of the water, thereby promoting an excellent way to prevent fish diseases. Better management practices include the incorporation of waste-water treatment ponds in the water outlet designs, and the control of water quality by measuring water parameters such as pH, oxygen, temperature, carbon dioxide, copper, phosphate, etc. For further disease traceability and monitoring of the broodstock, on account of antibiotics used, chemicals applied, and the source of the fingerlings, the certification on the overall health status of the stocked fingerlings is mandatory. Fish should be fed with a balanced diet and a consistent supply of nutrition-free from pathogens. Hence, industrial feed is often preferred over home-made feed in terms of quality. A home-made feed is very unstable and has a low protein content and high FCR. Moreover, waste (uneaten feed) is much higher if home-made feeds are used, which negatively affects pond water quality.

2. Therapeutic guidelines and considerations:

To diagnose and recommend an effective way for treatment, samples of moribund fish and water must be collected and analyzed in a laboratory at the earliest. As this process is cumbersome and demands for quite a lot of time, small scale farmers prefer to avoid this, though these strategies are mandatory for better disease management. However, monitoring the water and oxygen content, keeping an eye for the erratic behaviour among the fish shoal (e.g., gasping for air, strange swimming behaviour) and other natural events like sudden downpours must carefully be noted and be prepared to combat the untoward incidents.

It is essential to use the proper dose and dosage schedule of a recommended chemical for effective results. For safety reasons, it is always better to try the recommended chemical/antibiotic at a given dose and treatment time with a small population of

fish. Maximum residue limits (MRL) and withdrawal periods should always be considered before harvesting the fish. The veterinarians, aquaculture professionals or drug sellers need to know the disease situation at the farm before administering the medication. Only registered and permitted medicines are allowed for the chemotherapeutic and chemo-prophylactic purpose. Furthermore, any chemical, antibiotic or pathogen residuals detected in harvested fish should be traced back to the farm for food safety purposes.

Oxytetracycline is used for infections caused by a wide spectrum of bacteria among gram-negative bacilli of enteric origin and staphylococci. To treat bacterial hemorrhagic septicemia caused by *Aeromonas* spp., columnaris disease and pseudomoniasis, oxytetracycline @ 55-82 mg/kg body weight for consecutive ten days is recommended in feed with a withdrawal time of 21 days.

Florfenicol is a veterinary medicine has been introduced to replace chloramphenicol. It is a fluorinated derivative of thiamphenicol with broad-spectrum antibacterial activity that includes all organisms sensitive to chloramphenicol, gram-negative bacilli, gram-positive cocci, and other atypical bacteria. To control mortality due to enteric septicemia associated with *Edwardsiella ictaluri* and columnaris disease caused by *Flavobacterium columnare* florfenicol @ 10-15 mg/kg fish per day for ten consecutive days through oral route is recommended. At least 15 days withdrawal time must be followed to avoid human health hazard.

Sulfadimethoxine and ormetoprim combination @ 50 mg/kg fish per day for 5 days in feed is effective to control of enteric septicemia and bacterial hemorrhagic septicemia. For this antibacterial medicine, only three days withdrawal period is required.

Emamectin, belonging to avermectin family, is particularly effective against ecto- and endo-parasites of fishes. This is used for oral administration in feed @50 µg/kg/daily for 7 days.

Potassium permanganate ($KMnO_4$) the commonly used sanitizer can be used in pond @1-2 ppm it dose can also be decided based on the $KMnO_4$ demand test. For bath treatment of fish, $KMnO_4$ @ 4 ppm 10-30 minutes, can be used as a preventive measure.

Benzalkonium chloride (BKC), a quaternary ammonium compound, is also found to be very effective disinfectant reported to work against external bacterial pathogens and external parasites especially for white spot disease caused by Ichthyophthirius sp. when used as bath treatment @ 1 ppm for 15-30 minutes for five days.

3.Immunomodulation and vaccination:

Considering the feed conversion efficiency and microbial ecology of this fish suitable prebiotic and probiotic combination (Synbiotics) could play a significant role in promoting growth and prevention of various infectious diseases. It was reported that dietary administration of Eryngii mushroom *Pleurotus eryngii,* and *Lactobacillus plantarum* alone or in combination significantly increased the growth, innate immunity and protection against bacterial infection in *P. hypophthalmus.*

Aeromonas hydrophila is heterogeneous bacteria, and therefore vaccine development again this bacterium was particularly tricky. So more recently different approaches for this bacterium were followed in both in vitro culture media and cultured in vivo system. In addition, immunoproteomics was used to utilize common vaccine antigens among the field isolates. A recombinant vaccine was successfully developed. The first commercial fish vaccine for use in pangasius catfish has recently been developed that confers protection against bacterial necrosis by *Edwardsiella ictaluri*, which is the most significant disease affecting the catfish sector in Asia. The study suggested that a combination of primary vaccination by immersion with inactivated *E. ictaluri* followed by an oral boost with a formulated antigen preparation checked mortality caused by experimental infection four weeks post-boost. Thus, the immunization procedure offers a potential alternative for disease control through vaccination.

Please contact the corresponding author for references.