

An Overview of Channel Catfish Culture with Associated Disease and Treatment Considerations

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INTRODUCTION

Commercial catfish culture has grown into a multimillion dollar industry in the 30 to 40 years since its infancy in the 1950's. Through improvements in feed formulations, management practices and disease control, yields have increased from 1200-2000 pounds per acre to 4000-6000 pounds per acre, with reports of 10,000 lbs/acre. The industry experienced its most rapid growth during the 80's, with an average growth rate of 28% compounded annually. In 1991 390 million pounds of catfish were prepared for markets in processing plants. Through April of 1992, production is up 22% over 1991, on pace for close to 500 million pounds of processed fish in 1992 or 1993. Predictions are for 1 billion pounds of production by the year 2000.

CATFISH PRODUCTION

Although the channel catfish, *Ictalurus punctatus*, has been grown in a variety of culture systems, including cages, raceways and intensive recirculating systems, the vast majority of the production is in shallow, levee ponds. Ponds average 3-4 feet in depth at the shallow end, sloped to 6-8 feet at the deep end to allow for complete drainage through the drain in the deep end. Levees are generally sloped 3 or 4:1 to reduce erosion, and have a width of about 16 feet to allow passage of feed and harvesting vehicles.

Catfish production begins with the broodfish. Channel catfish sexually mature at 2-3 years of age depending on the strain and on the care they have received. Broodfish, held at densities of about 800-1200 lbs per acre, are generally stocked at male:female ratios of 1:2 or 2:3. Spawning begins when water temperatures are sustained at 70 F for several days and will continue until all fish have spawned or until the water temperatures remain above 84 F. Spawning takes place in containers placed in the ponds at about 10-40 per

surface acre. A variety of containers, open at one end, are used, including milk cans, ammunition cans, and plastic containers made specifically to spawn channel catfish. Broodfish pairs enter the container, where the female lays the adherent egg masses that are fertilized by the male as they attach to the bottom of the container. The male subsequently chases the female from the container and proceeds to continuously fan the attached egg mass to keep them well oxygenated and free of debris, which reduces fungal and bacterial contamination.

An average egg mass will contain from 10-25,000 eggs, depending on the female's size and condition. Although some producers allow the eggs to hatch in the ponds, the majority check the containers and remove the egg masses to a hatchery. The eggs are placed in baskets in shallow hatching troughs supplied with continuous water flow and paddlewheel devices that mimic the action of the male, circulating the slowly flowing water around the eggs.

At optimal temperatures of 78-82° F, eggs will hatch in about 8 days post-fertilization. Temperatures above this range can predispose the eggs to bacterial infections, while temperatures below this range will retard hatching and encourage fungal problems. At hatching, the fry carry a yolk sac that is absorbed over the next four days. After the fry absorb the yolk, they look like miniature adults and begin to feed. Fry are usually fed a 45-50% protein feed several times a day for the next 5-8 days to ensure a robust, actively feeding fry when they are stocked into the nursery ponds.

Nursery ponds are generally filled several weeks prior to stocking. They are usually treated to kill predacious insects and fertilized to establish a phytoplankton bloom that will shade rooted aquatic plants and provide a natural food source for the fry. Stocking rates are varied from 30,000 to 1 million fry per surface acre depending on the numbers available and on the size desired at harvest. The higher the stocking rates, the smaller the fish will be at harvest about 3-6 months later.

When fingerlings are harvested, at about 4-8 inches in length, they are stocked into production ponds at densities ranging from 4,000 to 6,000 fish per acre. Production ponds are harvested by two basic cropping systems. In single batch cropping, only one year class of fingerlings is stocked and the pond is drained and completely harvested after 12-14 months of production, depending on the initial size of the fingerlings stocked and the desired harvest weight (generally from 1-2 lbs). In multiple batch cropping systems, several size classes of fish are present in the pond at the same time. Faster growing fish are selectively harvested at periodic intervals and the harvested fish are replaced with an equal number of fingerlings. This process of harvesting and stocking is continued indefinitely and ponds are only rarely drained. Harvested fish are usually transported live to processing plants where they are filleted or processed whole for retail markets. A percentage commercial catfish produced are marketed live to pay fish-out operations or through fish markets that hold and sell live fish.

CATFISH HEALTH MANAGEMENT

Commercial production of channel catfish is a risky business. The high stocking densities and high feeding rates are designed to push the pond system to maximum

production per surface acre. Significant management skill and expertise is required to deal with inherent production risk factors, including bird predation, pesticide and herbicide contamination, and off-flavours induced by algal blooms. Also associated with production intensity are a number of water quality related problems. Dissolved oxygen is the most significant water quality parameter for fish production. Oxygen is soluble in water at significantly lower concentrations than it is available in air (about 8 mg/L compared to 280 mg/L). In ponds, although some oxygen is input through diffusion from the air, the primary source of oxygen is photosynthesis by microscopic aquatic plants.

This production is dependant on sunlight and fluctuates depending on the amount of solar radiation. During the night, the same plants that produce oxygen, in combination with the bacteria present in the ponds, remove oxygen to support respiration. If nighttime oxygen demand exceeds production, as in the case when a series of sunny days are followed by a series of cloudy days, oxygen depletions can occur. In addition algal die-offs can result in catastrophic oxygen depletions if supplemental aeration is not provided.

Although high loading rates of high protein feeds produces excellent growth, nitrogenous waste products can accumulate to toxic levels under these circumstances. Fish excrete nitrogen as ammonia, which, depending on the temperature and pH, can be toxic. The biological degradation of ammonia to non-toxic nitrate is a two step process, with another toxic metabolite, nitrite, produced as an intermediary. Fluctuations in the levels of nitrogenous waste products can occur as a result of daily pH cycles and after an algal die-off or a sudden temperature change.

Extremes of water quality, especially low dissolved oxygen, can result in significant death loss in commercial catfish ponds. Severe oxygen depletions without adequate aeration capabilities will result in 100% mortalities. Management practices, such as supplemental aeration with electric or diesel driven paddlewheels, have been developed to prevent catastrophic losses. However, the intensity of production ensures that sub-optimal water quality conditions will be commonplace in commercial catfish ponds. Due to the intimacy of the fish with its environment, sub-optimal water quality conditions have compounded effects on the animals physiology that predispose for disease. Thus, infectious and parasitic diseases that are rare in wild populations of fish, are commonplace in commercial catfish ponds, and the most significant disease problems are of bacterial etiology. For the three years from 1987 to 1989, bacteria were identified as the primary or secondary etiology in 85% (7183 of 8395) of the cases submitted to diagnostic labs in Alabama, Louisiana and Mississippi. Although the economic impact of these infections varies depending on the species of bacteria, the vast majority of total disease losses in the catfish industry are caused by the bacteria *Edwardsiella ictaluri*, *Cytophaga columnaris* and *Aeromonas hydrophila*.

Enteric Septicemia of Catfish (ESC) is a relatively new disease in commercial catfish culture, having first been described in 1976. Due to extensive transfer of fish nation wide and to its highly pathogenic nature, ESC has rapidly become the most devastating disease problem affecting the commercial catfish industry, incurring millions of dollars in losses and associated treatment costs annually. Although the causative agent, *Edwardsiella ictaluri*, has been described from walking catfish, white catfish and brown bullheads as well as some species of tropical fish, the bacterium is fairly host specific for the channel catfish. Clinical

manifestations of ESC in channel catfish vary considerably. Behaviorally, infected fish can be seen hanging tail-down at the surface or spinning and spiralling rapidly in circles. Gross external characteristics, which are occasionally absent in acute cases, include: petechial hemorrhage, particularly around the mouth and on the ventral surface; a raised or open ulcer on the midline of the frontal bone between the eyes; cutaneous, ulcerative, white lesions on the lateral and dorsal aspects of the head and body, presumably due to resolving hemorrhagic lesions or ruptured accumulations of bacterial growth; and, bilateral exophthalmia and ascites, with severe to moderate dropsy. Gross internal signs include: either a bloody or occasionally a clear yellow fluid in the abdominal cavity; swollen kidney, liver and spleen; a mottled appearance in the liver with either pale, necrotic areas in a darker red liver or hemorrhagic areas in a pale liver and, petechial hemorrhage in the musculature, adipose tissue, inner walls of the peritoneal cavity and intestine.

ESC is generally an acute septicemia that develops very quickly. Epizootics often occur with little warning in the way of reduced feeding activity or low grade mortality, so prompt application of treatment is critical to effective control. The incidence of ESC is highly correlated to temperature, with peak levels occurring in the range of 22-28 C, which occurs from April and May in south Louisiana to May and June in Mississippi and Arkansas.

Columnaris disease, caused by the gliding bacterium *Cytophaga columnaris*, is common throughout the world, affecting virtually all species of fresh water fishes, and is the second most common bacterial problem in commercial catfish culture systems. Externally, columnaris disease can affect both skin and gills. Skin lesions usually begin as irregular areas of epidermal loss, causing the lesion to lose its natural "sheen" and colouration. Infections frequently begin on the fins, which eventually become frayed and ragged in appearance. Initial lesions can progress to areas of extensive ulceration with penetration of the dermis and underlying musculature. *Aeromonas hydrophila* is commonly present in advanced lesions and probably contributes to the more severe pathology. In gills, the infection appears as irregular areas of light to dark brown discoloration and necrosis, with the most severe infections affecting almost the entire gill arch.

Cytophaga columnaris but causes disease in catfish primarily in the range of 25-32° C. Epizootics also occur in temperatures below 25° C, even as low as 15° C, but mortalities are generally significantly less than in warmer temperatures. This temperature relationship correlates to the late spring and early fall seasonality of *F. columnaris* clinical cases. Crowded conditions, handling and low dissolved oxygen stress also favour the development of columnaris infections especially in water with a high organic load at temperatures above 20° C. Following handling, lesions generally develop in 24-48 hours, followed by death at 48-72 hours if left untreated.

The motile aeromonads have been implicated in causing disease in many cold and warm blooded species, including humans. In channel catfish, MAS is the third most common bacterial disease and motile aeromonads are common secondary invaders with other infectious disease agents. Clinically, the motile aeromonads in channel catfish are opportunistic pathogens that can occur in acute and chronic situations, with the status of the infection being a result of a delicate balance between the fish, the pathogen and the environment. Inapparent or subclinical infections are often present and both *A. hydrophila* and *A. sobria* can be routinely isolated from the intestinal tract of healthy fish and from

pond water, as well as from clinical specimens. Chronic MAS disease is characterized by low grade mortalities, with a relatively small percentage of the population affected, but with affected fish often exhibiting extensive external pathology ranging from frayed fins and shallow, hemorrhagic or greyish ulcers to extensive necrotic lesions of the skin and underlying musculature.

Bacteria may be confined to the external lesions, but can usually be isolated from the internal organs, especially in advanced situations. Acute MAS is characterized by significant mortality, with a greater percentage of the population affected. External signs of disease are generally less severe, with petechial hemorrhage or ecchymoses most common. Internally the bacterium can be readily isolated from the blood and internal organs. Gross internal pathology may include serosanguinous ascites, enteric hyperemia, a soft and swollen liver and kidney, splenomegaly and hemorrhage. In addition the intestine may be flaccid and filled with bloody fluid or a yellowish material.

Two principal factors of the host-pathogen environment interaction contribute to the acute/chronic status of MAS infections; stress mediated predisposition to infection and the virulence of the *Aeromonas* strain, which is quite variable. Although consideration of these factors applies to other diseases, the opportunistic nature and heterogeneity of the motile aeromonad group makes the interaction of primary interest. Although the very nature of catfish ponds, with excessive crowding and high feeding rates, is conducive to the spread of infectious disease, outbreaks of MAS most commonly occur following shipping/handling, sub-optimal oxygen stress, nitrite induced methemoglobinemia, application of chemical treatments, rapid changes in temperature, or as a result of stress induced by infection with other bacteria or infestations with internal or external parasites.

TREATMENT AND CONTROL

At present, the only treatments available for bacterial septicemias in commercial catfish culture are Terramycin (oxytetracycline) in a sinking pellet and Romet (ormetoprim and sulphadimethoxine) in a floating pellet. Catfish farmers report variable treatment success with either of these compounds, with the degree of success probably depending on the promptness with which the treatment is applied following diagnosis. In addition, recent clinical records indicate that strains resistant to one or both of these compounds are becoming more and more commonplace.

Due to the potential for heavy losses, the detection of any fish exhibiting signs of ESC indicates the need for an immediate application of oral antibiotics. This is especially true if the temperatures are in the beginning of the temperature window, i.e. about 28° C in the fall when the temperatures are falling and about 22° C in the spring when they are rising. However, it is critical to follow up the preliminary assessment with a complete diagnosis in order to confirm the etiology, detect mixed infections and establish antibiotic resistance patterns. Failure to do this can result in either partial or total ineffectiveness of treatment and continued mortalities.

For columnaris disease, the treatment of choice depends on the state of the infection. For a purely external infection, which is generally the case when diagnosis is made early, a bath treatment with potassium permanganate at 2 mg/L above the permanganate

demand of the water will usually be effective. However, if the infection is systemic, antibiotic therapy with either Terramycin or Romet is indicated. In situations where the bacterium is both external and internal, antibiotic therapy alone will often control the infection if the fish are still feeding actively. If feeding activity is off due to the infection, a potassium permanganate treatment, followed immediately by antibiotic therapy, may be effective. Because *C. columnaris* will not grow on normal Mueller-Hinton agar a dilute Mueller-Hinton medium (3 g Mueller-Hinton broth and 9 g agar/L) supplemented with 5 percent fetal calf serum should be used. This medium is effective in determining resistance/sensitivity patterns, but the zone diameters may be difficult to evaluate relative to zone diameters on standard Mueller-Hinton agar because the reduced agar content affects diffusion rates. Zones greater than 25 mm should indicate sensitivity to Romet, while zones greater than 38 mm should indicate Terramycin sensitivity.

Although minimizing stress is a key to control of MAS, stress is an inherent part of intensive fish culture and cannot always be controlled. In instances where MAS is causing significant mortality, medication with either Romet 30 or Terramycin is indicated. Antibiotic therapy can be particularly helpful if delivered quickly at the onset of an epizootic that is stress induced; however, many MAS epizootics will resolve themselves without treatment. Thus the degree of stress and the mortality pattern must be carefully evaluated because the cost of treatment may exceed the value of the fish saved.

Decisions to treat fish affected by MAS also must consider predisposing stressors and current or potential infections with other bacteria or protozoans. For example, if heavy branchial infestations with external protozoans that may be acting as predisposing stressor are also present, chemical treatment to reduce the parasite load may also control the MAS. On the other hand, the chemical treatment may stress the fish enough to cause a shift from chronic to acute MAS infection, or even trigger a more serious outbreak of ESC. In situations where MAS is present as a secondary or tertiary problem to ESC or *columnaris*, antibiotic sensitivities need to be determined for all isolates.