THAD COCHRAN

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Maintenance Feeding of Catfish

Menghe Li, Bruce Manning, Danny Oberle, and Edwin Robinson

In a normal situation, catfish should be fed daily as much as they will eat without feed waste and without an adverse impact on water quality. However, under unusual circumstances it may be desirable to feed fish a restricted ration or even at maintenance levels. In the past few years we have conducted several studies to look at the effects of restricted feeding on catfish growth and production. From these studies we know that moderate feed restriction, either on a daily basis or by feeding less than daily, improves feed efficiency and reduces feed cost. However, production is also reduced and the production cycle is longer for fish fed a restricted ration compared to fish fed to satiation daily. This strategy may be appropriate during periods of poor water quality, disease outbreaks, or when the feed budget is limited.

Another strategy that may be useful in times of financial difficulty is to feed the fish at maintenance levels. Maintenance feeding means that all feed eaten by the fish is used to maintain the animal with no gain or loss of weight. This feeding strategy can be achieved by either feeding fish a maintenance ration daily or feeding less than daily. Since fish of various sizes are typically present in a given pond at the same time, it is better to feed all they will eat on days fed to allow the smaller, less aggressive fish to feed. Maintenance feeding can also be used to feed foodfish that cannot be harvested due to off-flavor problems.

Two primary factors affecting the maintenance ration are water temperature and fish size. This is because a fish's metabolic rate is largely dictated by water temperature and fish of different sizes and ages may have different nutritional needs for maintenance. Knowing the maintenance feeding frequency is important for pond management practices. In 2003, we conducted a feeding trial to look at the effects of initial fish size and weekly feeding frequency during the growing season on catfish growth, survival, and body condition.

We stocked nine ponds with catfish averaging 86 pounds per 1,000 fish and nine ponds with catfish averaging

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Maintenance Feeding of Catfish
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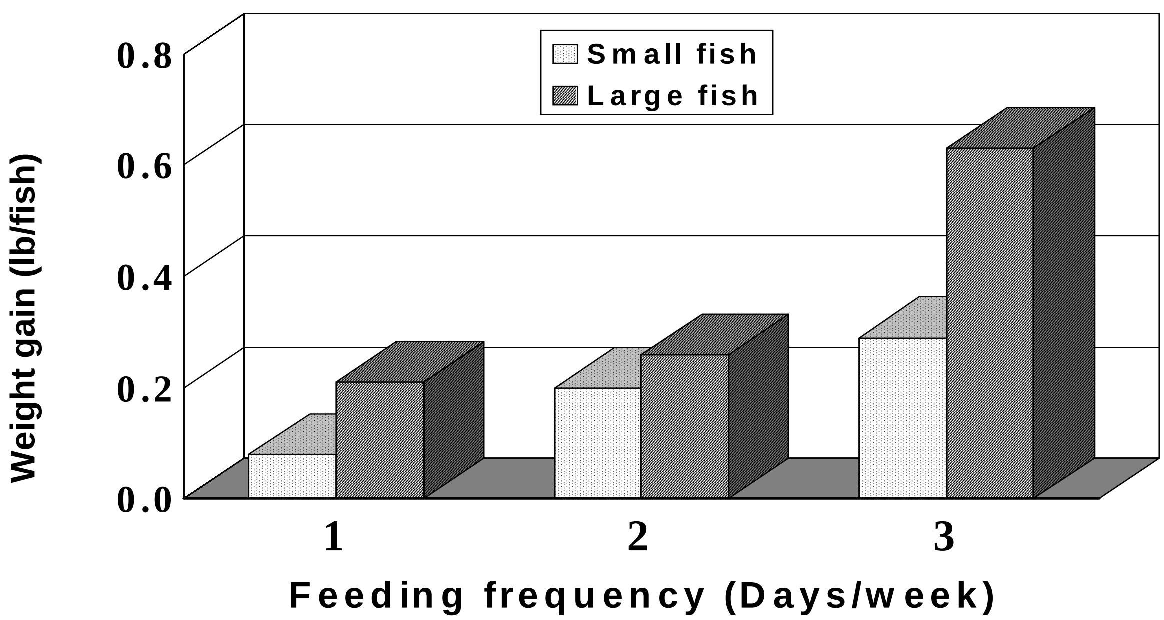
549 pounds per 1,000 fish. All ponds were 1/10-acre in size and stocked at a density of 6,000 fish/acre. Three feeding frequencies (once, twice, or three times per week) were tested in this study. Within each fish size group, each feeding frequency had three replicated ponds. On the day fish were fed, they were fed all they would eat (within 15 to 20 minutes) with a commercial 28% protein feed for 105 days (June to October). Pond management followed practices commonly used on commercial catfish farms.

In the once per week feeding group, catfish weighing 86 pounds per 1,000 fish gained 0.08 pounds per fish (92% of initial weight) while the catfish weighing 549 pounds per 1,000 fish gained 0.21 pounds per fish (39% of initial weight) (Fig. 1). This suggests that the maintenance feeding frequency for these sizes of fish stocked at 6,000 fish/acre would be no more than once a week when the fish are fed all they would eat. If the amount of feed fed is converted to percentage of fish body weight, the average daily feeding rates for fish fed once weekly are calculated to be about 1.6% and 0.7% for small and large fish, respectively. These feeding rates appear to be higher than maintenance feeding rates of 0.5% to 0.8% body weight that we found in an early laboratory study with a similar size fish fed daily at a restricted rate. On days not fed, pond-raised fish may consume some natural foods from the pond which may contribute to a small portion of the maintenance ration.

Regardless of the initial fish weight, as the weekly feeding frequency increased, the amount of feed fed and weight gain increased. These results were anticipated since weight gain of fish is generally correlated to amount of feed fed especially for fish fed a restricted ration. Also as expected, the condition factor, an indicator of a fish's overall condition and nutritional status, improved as the weekly feeding frequency increased. Neither initial fish size or weekly feeding frequency used in this study affected feed conversion. Larger fish had a better survival than smaller fish. However, weekly feeding frequency used in this study did not affect fish survival.

In summary, based on results from the present study, it appears that feeding once weekly to satiation can maintain the body weight of advanced fingerling and larger-sized catfish under a single-batch cropping system. However, if economic conditions permit, fish should be fed more frequently to maintain better body condition since feeding twice or three times weekly increases growth and improves body condition of the fish. If a multiple-batch cropping system (where various sizes of fish are present in the pond at the same time) is used, feeding more frequently may also increase the chances that the smaller, less aggressive fish will be able to consume some feed.

Figure 1. Effect of feeding frequency on weight gain for two sizes of catfish.



Calcium Improves Hatching Success

Brian Small

The aquifer used for channel catfish hatcheries in much of the Mississippi Delta has a calcium hardness (Ca-hardness) of less than 10 ppm as $CaCO_3$. Previous NWAC research has shown that when Ca-hardness concentrations fall below 10 ppm in hatchery water, fry survival and growth is severely reduced. Because of that research, it is recommended that a minimum Ca-hardness concentration of 10 ppm be maintained in channel catfish hatchery water. However, the effect of low Ca-hardness concentrations during various phases of embryo development on hatching success has not been previously reported. In this study, we determined the effect of a low Ca-hardness concentration (5 ppm) during sequential 24-hour periods on hatching success of channel catfish.

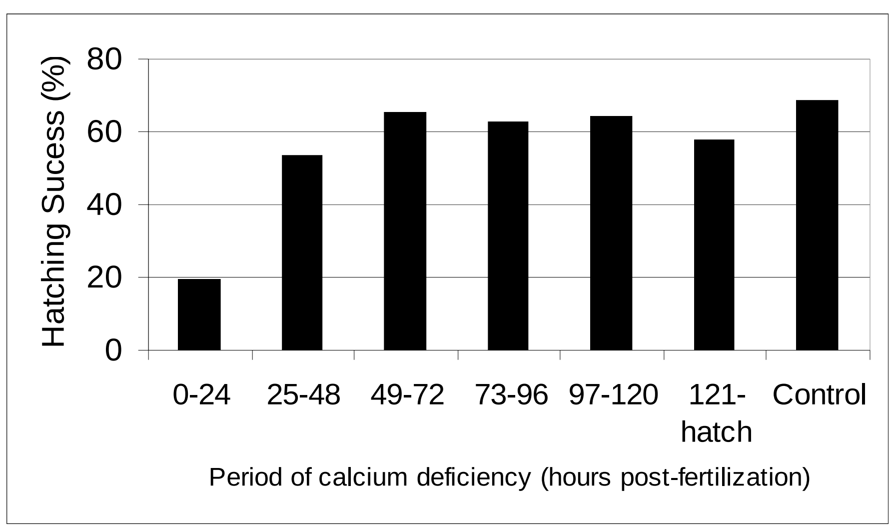
The possibility of a calcium metering pump failure during the hatchery season is a concern to commercial catfish hatcheries utilizing soft water wells. In the present study, daily Ca-hardness concentrations from unsupplemented well water averaged 5 ppm. By allowing the fish to spawn in a pond, the eggs were fertilized and briefly incubated in a water environment with abundant calcium (Ca-hardness = 107 ppm) prior to removal to the hatchery. This methodology allowed for a practical approach to assessing the effects of Ca-hardness in hatchery water while simulating common commercial practices.

Following removal from the pond, eggs were microscopically evaluated to estimate time of fertilization. New spawns, less than 1 hour post-fertilization were used in the study. The spawns were divided into equal masses such that every 24-hour period from fertilization to hatch was represented by three different masses. Hatching occurred on the sixth day. As a result, there were six sequential 24-hour periods in which three different egg masses received low Ca-hardness water (5 ppm). As a control, a separate group of egg masses received calcium-supplemented water throughout the study. Daily Ca-hardness averaged 95 ppm in the calcium-supplemented hatchery water.

The results of this research clearly demonstrate an effect of Ca-hardness on hatching success (Fig. 1). Of the six 24-hour developmental periods observed with and without calcium supplementation, the first 24-hours after fertilization was determined to be calcium-critical. Hatching success averaged 72% lower when eggs were incubated in low-calcium water during the first 24-hours after fertilization. Regardless of calcium supplementation, hatching success was similar to controls for all the remaining 24-hour periods.

Previous research in our laboratory has also demonstrated enhanced sensitivity to low temperatures and handling of channel catfish eggs during early embryo development. Together with this recent observation of early calcium dependence, these results suggest that the first 24-hours after spawning is a sensitive developmental period. This information provides important management information for improved hatching success following periods of no calcium supplementation, such as when a metering pump fails. In such an event, management practices might include leaving newly spawned eggs (less than 24 hours old) in the pond an extra day or manually adding a calcium solution to hatching troughs designated for new spawns. Ideally, a minimum Ca-hardness concentration of 10 ppm should be maintained in channel catfish hatchery water to maximize both hatching success and fry survival.

Figure 1. Effect of a low Ca-hardness concentration (5 ppm) during sequential 24-hour periods on channel catfish hatching success.



An Environmental Management System for Catfish Pond Effluents

Craig Tucker, John Hargreaves, Donnie Rutherford, and Susan Kingsbury

Catfish pond effluents will not be regulated by the U.S. Environmental Protection Agency when they publish their national aquaculture discharge rule this summer. Although this is clearly good news for the catfish industry, farmers should continue to improve environmental stewardship by implementing practices that reduce the discharge of potential pollutants to the environment. Not only is this wise from the standpoint of resource management, but certain effluent management practices have ancillary benefits that may actually improve overall farm economic performance.

In 2001, we developed an Environmental Management System (EMS) to reduce discharge of pollutants from catfish ponds. The EMS consisted of four farm practices that, when implemented together, should reduce the amount of material discharged from ponds.

One of the practices in the EMS was pond water-level management. This practice was incorporated to reduce effluent volume. Specifically, the water-level management scheme we used was to allow water levels to drop 12 inches below overflow stage height before adding well water (Fig. 1). When well water was added, ponds were filled only to within 8 inches of overflow stage height. As such, ponds could capture between 8 and 12 inches of rain before they overflowed.

The other three practices incorporated into the EMS were chosen to reduce the concentration of substances in effluents. Those practices were 1) limiting daily feed inputs to 100 pounds/acre per day, 2) using a 28% protein feed, and 3) maintaining a maximum fish density of 7,500 fish/acre. Pollutant discharge and fish production from EMS ponds are being compared to “traditional” ponds managed without water-level management, without feed limitation, using a 32% protein feed, and with a stocking scheme where 10,000 fish/acre are added each spring.

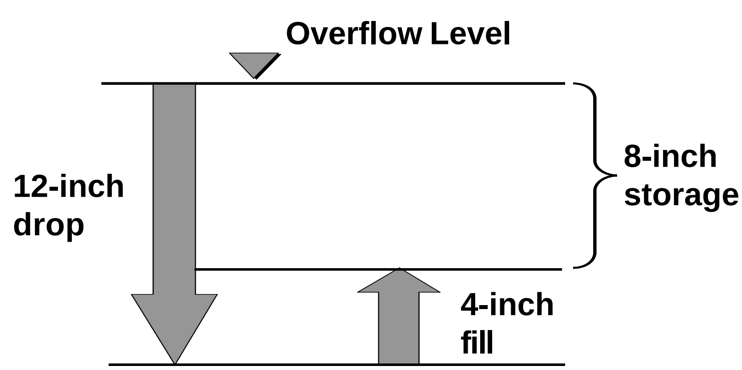
After 3 years of study, average concentrations of nitrogen, phosphorus, solids, and organic matter have not differed in effluents from the EMS and traditional ponds. Therefore, management practices such as feed restriction and feed protein level have had little effect on the concentration of substances in effluents.

However, the total amount of material released (which is the mathematical product of concentration and effluent volume) differed greatly between EMS ponds and traditional ponds. Overall discharge of nitrogen, phosphorus, solids, and organic matter was reduced by about 70% in ponds managed with the EMS. Since, as explained above, there was no difference in the concentration of substances in effluents, all of the reduction in amount of material discharged was attributable to reduced effluent volume resulting from the water-level management scheme used in EMS ponds. Managing water levels to increase water storage capacity and capture rainfall reduced the 3-year total overflow from 151 inches in non-EMS ponds to 60 inches in the EMS ponds.

By capturing all that rainfall rather than allowing it to simply overflow into drainage ditches, groundwater use was also drastically reduced by using the EMS. Over the 3 years of the study, an average of 7 inches of water has been added to EMS ponds each year while almost 20 inches of water has been added each year to traditional ponds. Water needs varied from year to year and, in 2001, well water was never pumped into the EMS ponds.

To date, average annual fish production is 5,100 pounds/acre in the EMS ponds and 5,069 pounds/acre in the traditional ponds. Overall, it appears that an effective EMS for effluent management and groundwater conservation can be used in catfish ponds with no detrimental effects on fish production.

Figure 1. Water-level management scheme for catfish ponds.



Number of Trematode Infestations Increasing

Jimmy Avery, David Wise, and Todd Byars

In the summer of 1999, Mississippi catfish farmers began experiencing fish mortalities and decreased production due to infestations of a digenetic trematode identified as a species of *Bolbophorus*. As effective treatment regimes were developed to control the parasite, the rate of new infestations began to taper off. However, the number of ponds experiencing new infestations is again increasing.

At least four factors have contributed to the recent rise in *Bolbophorus* infestations. First, a large flock of pelicans (the final host for the parasite) has remained in the Mississippi Delta during spring and summer. Second, recent economic conditions have lead to abandonment of many ponds, and these out-of-production ponds provide favorable loafing sites for pelicans in the vicinity of active farms. This has resulted in infestations in areas that previously experienced no pelican pressure. Third, some farms that have had infestations in the past are now under new management and the new farm personnel may have less experience in scouting for infected fish. Finally, personnel on some farms have relaxed scouting and treatment regimes because they falsely believed that the previous decline in trematode infestations meant that the problem was under control.

Far from being under control, the incidence of trematode infestations is rapidly increasing. We urge catfish producers to make an immediate evaluation of the infestation rate on their farm. Ponds containing fish experiencing a drop in appetite that cannot be explained by other diseases or poor water quality should be checked first. A small cutting seine can be used to collect fish that have been attracted to an area by feed. At least 20 to 30 fish should be examined on site. Catfish infested with *Bolbophorus* have small cysts that usually appear in the tail area. The cysts are white or red raised bumps either just under the skin or deeper in the muscle tissue. It is essential that producers retain written documentation of infection rates and presence of snails in individual ponds for evaluating treatment effectiveness and establishing monitoring programs.

Control is dependent on breaking the life cycle of the trematode by discouraging pelican use of ponds and reducing snail populations. Pelicans can be extremely difficult to harass from an area and may visit ponds at night as well as during daylight.
If ponds that are out of production cannot be drained, adjacent producers should seek permission to harass loafing pelicans. Reducing snail populations requires a combination of chemical treatments, biological control, and aquatic weed control. (For more information on this problem, request a copy of SRAC Publication No. 1801, "Infestations of the Trematode *Bolbophorus* sp. in Channel Catfish." The publication is also available at http://www.msstate.edu/dept/srac/fslist.htm)

Treatment efforts should be focused on ponds with active infections. The indiscriminate use of chemical treatments on ponds that do not have active infections is not an effective approach to this problem. By treating only ponds with active infections, producers can concentrate treatment costs to problem ponds in a shorter time period.

Ponds with active infections should be treated with hydrated lime and/or copper sulfate to reduce snail populations along the pond margin.
To be effective, the correct amount of chemical must be applied and the pond margin thoroughly covered. Apply dry hydrated lime at a rate of 50 pounds per 75 to 100 feet of pond bank in a band 3 to 4 feet from the pond edge. Hydrated lime also can be mixed with water and applied as a slurry. At a concentration of 4.0 to 4.7 pounds of hydrated lime per gallon of water, apply 20 gallons of slurry per 100 feet of levee. Copper sulfate is applied at a rate of 10 pounds of copper sulfate plus 1 pound of citric acid in at least 70 gallons of water. This amount will treat a 6-foot band along 250 feet of pond margin. Caution should be taken when using this level of copper sulfate in small ponds, ponds with low alkalinity, or ponds with heavy algae blooms.

Bayluscide® has a Section 18 permit in Mississippi for controlling rams horn snails in commercial catfish ponds. It is applied at a rate of 1.5 pounds per acre-foot of water as a whole pond treatment. To reduce costs, the pond is usually drawn down to a depth of 1 foot. Since this pesticide is toxic to non-target aquatic organisms, it can only be used in ponds with no fish.

Black carp have been successful in lowering numbers of snails in ponds and appear to be the best option for

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2003 CVM Aquatic Diagnostic Laboratory Summary

Al Camus, Pat Gaunt, and Michael Mauel

Diagnostics

In 2003, the Aquatic Diagnostic Laboratory at Stoneville received a total of 1,132 fish case submissions, 832 diagnostic and 300 research. Diagnostic cases were received from a total of 113 farms. In addition, 851 water quality samples from 77 farms were analyzed. Laboratories across the Southeast have reported a trend toward decreased reliance upon diagnostic facilities in recent years. Conversations with farmers have revealed possible causes, including limited treatment options, lack of approval for new chemical treatments, the cost of treatments during this period of economic downturn, and an increasing reliance upon restricted feeding as a means of coping with certain diseases. It is also suspected that with few new farms entering into production, experienced producers are diagnosing their disease problems pond side. The Laboratory staff would like to stress that we are here to serve the industry and encourage producers to continue to take advantage of this valuable free service.

Each individual case represents a composite of fish from a single submission collected from one pond. It should be mentioned that the numbers represented in this report are derived solely from submissions received by the laboratory and do not necessarily reflect actual disease incidence in the field. Routine diagnostic procedures include evaluation of gill clips, fin and skin scrapes, gross external and internal lesions, touch impressions of tissues, bacterial and viral cultures of various tissues, as well as histopathology.

As in previous years, the bacterial diseases enteric septicemia of catfish (ESC) and columnaris disease dominated the numbers of producer submitted cases. Examined as a single disease, ESC accounted for 10.7% of cases, but in combination with other disease agents was diagnosed in 34.6% of cases (39.8% in 2002). Columnaris had a slightly higher tendency to occur alone, accounting for 13.8% of cases, and in combination with other pathogens, was present in 44.7% of all cases (44.5% in 2002), making it the most frequently diagnosed disease seen by the laboratory. ESC and columnaris were diagnosed together in 19.8% of case submissions. These numbers have remained relatively consistent over the past seven years, where on average ESC was diagnosed in 37.2% and columnaris in 44.1% of all diagnostic cases.

Proliferative gill disease (PGD) was the third most commonly diagnosed disease, representing 10.8% of cases (16.3% in 2002). Saprolegnia, the cause of winter fungus, was present in 5.4% of cases, down from 10.1% in 2002. The number of channel catfish virus (CCV) disease cases rose from 5.8% in 2002 to 8.9% in 2003 and remained above the 7 year average of 4.6%. The number of channel catfish anemia (CCA) cases remained essentially unchanged at 5.2% (2003) versus 5.3% (2002), but remained above the 7 year average of 4.0%. *Ichthyophthirius multifiliis* (Ich) cases declined from 2.2% last year to 0.5% in 2003, below the 7 year average of 1.3%.

The number of *Bolbophorus damnificus* trematode cases continued to decrease from a high of 5.6% in 2000, to 2.0% in 2002, and 1.1% in 2003. While the number of cases seen does not necessarily reflect incidence in the field, decreased losses attributed to *Bolbophorus* are believed to be the

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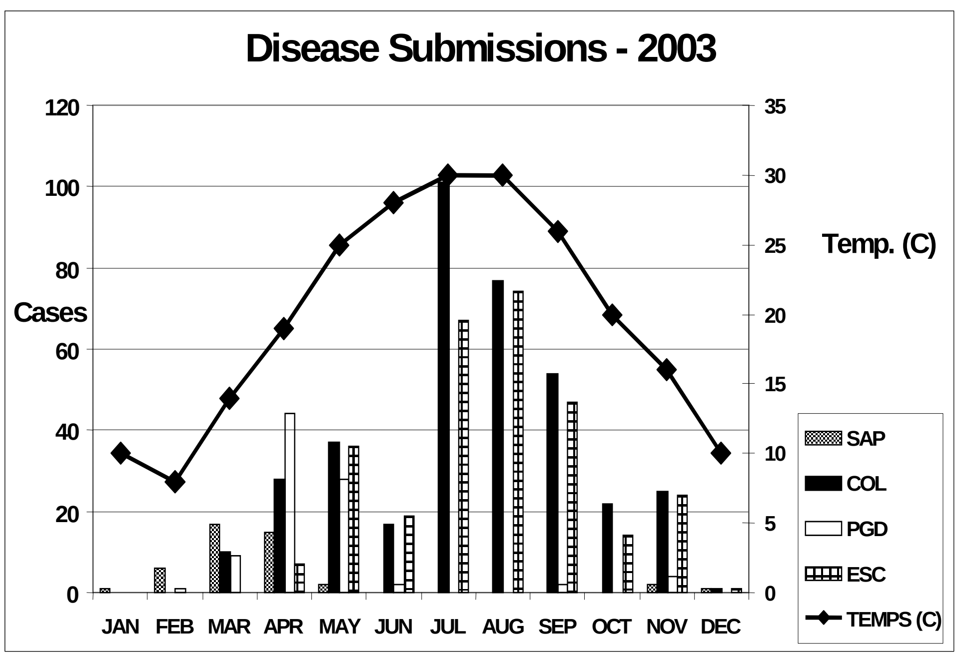

result of increased surveillance by producers and control of the rams horn snail, intermediate host of the parasite. Preliminary data for 2004 indicates the incidence of trematodes is currently on the rise. Cases of visceral toxicosis (VTC) approximately doubled from 2.0% in 2002 to 3.7% in 2003. Although an environmental toxin is suspected, the cause of this disease remains unknown.

As a component of the Mississippi Veterinary Diagnostic Laboratory System, the Aquatic Diagnostic Laboratory for the first time requested to be inspected by and received full accreditation from the American Association of Veterinary Laboratory Diagnosticians Board of Accreditation. The review process recognizes the Laboratory's efforts to provide a comprehensive diagnostic service to the catfish industry that emphasizes quality assurance as a major component of the program. Research facilities were also inspected this year and received full accreditation by the Association for Assessment and Accreditation of Laboratory Animal Care.

Research

Visceral toxicosis of catfish (VTC) is the name applied to a syndrome of unexplained catastrophic mortality events that have occurred sporadically on Delta catfish farms since 1998. In addition to investigating outbreaks on farms, documenting lesions, and performing bioassay procedures, the Laboratory has enlisted the support of the Mississippi State Chemistry Laboratory to isolate and characterize a potential toxin from the serum of affected fish.

Previous studies indicate that channel catfish anemia (CCA) a well known, but poorly understood cause of mortalities is believed to result from interruption of the normal maturation sequence of red blood cells. Preliminary findings of research conducted in 2003 indicate for the first time that iron deficiency may be involved in the development of this enigmatic condition.

Bacterial diseases are a major impediment to the profitability of catfish farming, for which only two antibiotics are approved. Florfenicol (Aquaflor®), an antibiotic approved for use in other countries, but not in the U.S., was tested for effectiveness against ESC. The results of trials submitted to the U.S. Food and Drug Administration have been accepted for efficacy, safety, and tissue residues. Final approval of the drug for use in catfish is anticipated in 2004 and will provide farmers with a new tool for combating ESC.

Research conducted to evaluate the effect of sublethal *Bolbophorus* sp. infection on the resistance of catfish to bacterial infection indicates that initial exposure to and penetration by trematode cercariae decreases resistance to ESC. The presence of encysted metacercariae (grubs) alone does not appear to compromise fish health. These findings suggest that limiting exposure to the parasite by breaking its life cycle through control of the snail intermediate host can effectively limit associated losses from ESC.

Number of Trematode Infestations Increasing

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long-term control. Based on limited studies, it appears the most economical rate is 10 fish per acre. These fish are very susceptible to catfish harvesting operations, so seine crews must be diligent in returning black carp to the pond. In some states, permits are required to possess black carp. Mississippi catfish producers should contact the Mississippi Department of Agriculture and Commerce or call the National Warmwater Aquaculture Center for permit application assistance.

Aquatic vegetation along the pond edge may actually concentrate snail populations making them easier to control and monitor. However, submerged vegetation out from the pond margin provides habitat for snails in areas where they are out of the reach of chemical treatments. Grass carp and aquatic herbicides should be used to eliminate any submerged weeds.

In summary, farmers must remain vigilant in their prevention strategies. Trematode infestations have the potential for causing extreme financial difficulty for affected farms. Farmers should monitor fish stocks and keep snail populations under control. Reducing the impact of trematode infestations on an individual operation will require a concerted effort by both management and labor.

Swim-Tunnel Respirometer: Its Usefulness as a Tool to Study Catfish Health and Physiology

Doug Minchew and Rachel Beecham

As a research tool, the swim-tunnel respirometer is invaluable. It allows us to investigate a wide range of physiological and health issues related to the culture of catfish. For example, the swim tunnel can be used to study the relationship between high levels of physical exertion; the onset, severity, and recovery from infectious disease episodes; the impact of various diseases on fish metabolism; the impact of forced swimming (caused by paddlewheels, seining, hauling tank aeration, etc.) on fish health and growth; stress and recovery from environmental and man-made challenges; and the comparative swimming capabilities of various species or strains of catfish. Swim tunnel studies can also be used to estimate the amount of energy used by catfish for various types of swimming activities.

The study of energy use is important because catfish, like other organisms, have limited amounts of energy available for all of their daily activities, including swimming, feeding, fighting, and growing. Catfish spend most of their time swimming at low speeds or resting on or near the pond bottom. These activities require relatively small amounts of energy. On the other hand, less common activities, such as escaping from predators, chasing prey, fighting, and swimming against fast currents often require repeated, high speed, short duration sprints that can result in fatigue, lowered resistance to disease, reduced growth, and/or death. These short-term, intense activities can use most of a fish's available energy. The way fish partition energy between metabolic demands influences their activity level, growth, reproductive success, and ultimately their survival. The laws of thermodynamics mandate that energy resources used in one aspect of metabolism will not be available for use in others. For example, the energy used to process and digest food will not be available for locomotion or growth. Likewise, the energy used for various types of locomotion will not be available for food processing or growth. Obviously, trade-offs must be made between the various components of metabolism.

A swim-tunnel respirometer (Fig. 1) is designed to force a fish to swim against a current under controlled environmental conditions. To use the swim tunnel, oxygenated water is added to the chamber, a fish is then placed in a tube inside the chamber, and the chamber sealed. Initially, the current is set at a low speed such as 4 inches/second, and the fish is allowed to acclimate for a period of time prior to the start of the experiment. A number of accepted swimming protocols can be selected depending upon what question we are trying to answer. For example, in a recently completed experiment, we used a swim-tunnel respirometer to compare the swimming endurance of six to nine inch channel, blue, and hybrid catfish fingerlings using a protocol that forced the fish to swim at a fixed speed until they fatigued or swam for 200 minutes or more. Test speeds ranged from 12 to 47 inches/second. Hybrid catfish had the greatest anaerobic swimming capacity, as they were significantly better burst swimmers (short distance sprinters) than either of the other two species. On the average, hybrids were able to swim at 47 inches/second for 26.2 seconds,

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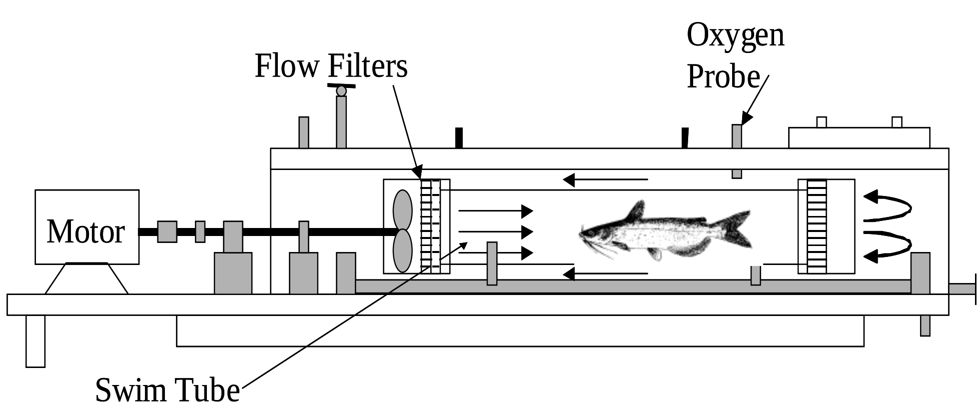
Figure 1. Schematic of the swim-tunnel respirometer.



Research on Fish Diseases

Craig Tucker and Sarah Harris
Southern Regional Aquaculture Center

Losses to infectious diseases are a serious threat to the profitability of catfish farming. Important diseases include those that seem to emerge suddenly as well as those diseases that have been present from the earliest days of aquaculture.

A good example of a "new" disease is the trematode *Bolbophorus damnificus* that encysts in the flesh of the catfish. The adult worms are in fish-eating birds (final host) and the intermediate stages are in snails and fish (intermediate hosts). In recent years the parasite has had a major impact on the catfish industry in parts of the lower Mississippi River Valley, producing both catastrophic losses and chronic infections that reduce fish growth and marketability.

Unlike trematode infestations, columnaris disease has been a significant problem in cultured fish for centuries but effective prevention and treatment remain elusive. Columnaris disease, caused by the bacterium *Flavobacterium columnare,* remains a very serious problem not because it is new, but because of serious gaps in our understanding of the biology of the organism.

In 2000, the Industry Advisory Council of the Southern Regional Aquaculture Center (SRAC) requested that a project be developed to address important diseases in southern aquaculture. The co-chairs of the Industry Advisory Council at that time were Lester Myers of Isola, MS and Jerry Williamson of Lake Village, AR.
In 2001, a group of 12 fish health specialists from across the region met to identify the focus of this project. That group identified trematodes and columnaris as diseases that could benefit from additional research funded by SRAC.

The three-year project that was subsequently developed by SRAC began in the spring of 2003 and will focus on methods of identifying and classifying *Bolbophorus* trematodes and columnaris-like bacteria and developing methods for their management and control. The project involves 20 scientists from the following nine institutions: Louisiana State University, Auburn University, Clemson University, Mississippi State University, North Carolina State University, University of Tennessee, University of Arkansas at Pine Bluff, USDA-APHIS (Starkville), and USDA-ARS (Stuttgart).

For information on all SRAC projects, visit our website at:

http://www.msstate.edu/dept/srac

In addition to the wide variety of information offered, you can print copies of all SRAC publications, obtain the address of your state Aquaculture Extension Specialist, and link to many other useful sites.

Research on *Bolbophorus* trematodes will focus on characterizing the life history of the parasite and evaluating various methods of breaking its life cycle by controlling the snail intermediate host.

Research on columnaris-like bacteria will focus on four issues: 1) development of standard methods for the isolation, culture, and antimicrobial susceptibility testing; 2) characterization of strains of columnaris-like bacteria; 3) development of reproducible challenge models for columnaris-like bacteria; and 4) using the challenge models to correlate strain virulence with strain characteristics so that diagnosticians will be better able to assess the risk of columnaris infections.

Although the project is only a year old, several important findings have been made, especially in the trematode studies. For example, the proposed trematode life cycle involving American white pelicans, rams horn snails, and channel catfish has been confirmed. Also, it appears other birds, such as cormorants and egrets, do not serve as hosts for the adult trematode. Laboratory and field trials indicate that mild sub-lethal active trematode infections, commonly observed in channel catfish production systems, can greatly reduce production by reducing feed consumption. Infection with trematodes increases mortality associated with enteric septicemia of catfish, with losses in concurrently infected fish being much higher than losses attributable to either disease alone. Treatments with copper sulfate and hydrated lime were both shown to be effective at lowering snail populations in near-shore areas of the pond and can be used as part of an overall plan to control the disease.

Effect of Minimum DO Concentration on Channel Catfish

Eugene Torrans

During the past thirty years, channel catfish production rates in commercial ponds have risen from 1,000 to 3,000-6,000 pounds/acre. Some farms are reportedly producing as much as 8,000 to 10,000 pounds/acre and have plans to increase production rates even more in the future. This intensification is largely due to higher stocking and feeding rates made possible by increased aeration.

The dissolved oxygen (DO) within a pond may vary by as much as 10 to 12 ppm at one point in time and may fluctuate in the pond by 15 to 20 ppm between dawn and late afternoon. How long fish are exposed to a particular concentration may be even more important than temporary exposure to the lowest concentration in a daily cycle.

Every farm has its own oxygen management plan. Some farmers begin aeration when the DO drops to 5 ppm, and try to maintain it at a minimum of 3.5 or 4 ppm. Other farmers do not begin aeration until the DO drops below 2 ppm, feeling that if the fish are not showing any visible stress everything is fine. Who's right? This two-year study was conducted to provide some additional scientific data upon which oxygen management decisions could be based.

Six quarter-acre ponds were each equipped with three 1/2-hp paddlewheel aerators (6 hp/acre) and one 1/2-hp circulator. This large aeration capacity was used for two reasons. First, it allowed us to limit the decrease in DO and maintain it at a predetermined concentration. Second, it would presumably allow us to stock and feed at rates much higher than are currently used in the industry. This could provide insight into what other water quality parameters (besides DO) might degrade if industry feeding rates continued to increase.

A commercial system was used to continuously monitor water temperature, DO, and aerator status, and also control aeration. Data were relayed to a computer and recorded every 20 minutes throughout the study. Fish were fed a commercial floating feed daily to apparent satiation. Water was added only to compensate for evaporation and seepage. Ponds were harvested at the end of each growing season.

There were two treatment groups in both years of this study. Aeration began in the "high oxygen" treatment in both 2001 and 2002 when the DO dropped below 5 ppm. This served as a control treatment that allowed relative comparisons between years. Aeration began in the "low oxygen" treatment when the DO dropped below 2.5 ppm (in 2001) or 1.5 ppm (in 2002). Ponds in both treatments required little aeration in the spring and fall. Water temperature and feed consumption were both low during those months, and the DO rarely decreased to the aeration set-points.

The lowest DO recorded in the high oxygen treatment averaged 4.4 ppm and 4.5 ppm from June through September of 2001 and 2002, respectively. The minimum DO in the low oxygen treatment averaged 2.6 ppm in 2001 and 1.7 ppm in 2002. On days that aeration was required, the 6 hp/acre of aeration was able to maintain the DO close to the set-points.

Delaying aeration until the DO dropped to 2.5 ppm (in 2001) had little impact on feed consumption or production. Feed consumption (Fig. 1) was 6.3% less than the high oxygen treatment, but the net production in the two treatments was similar (Fig. 2). However, it must be noted that if this DO concentration did not increase after sunrise due to photosynthesis, a constant DO concentration

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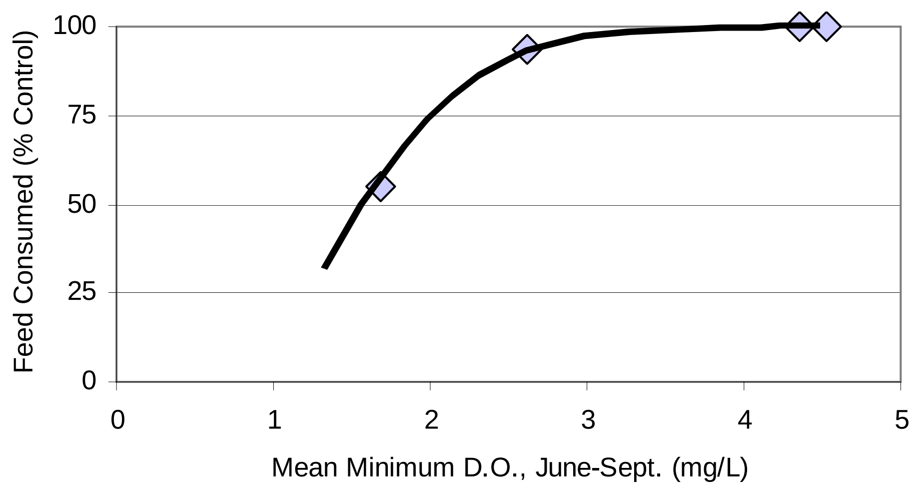
Figure 1. Feed consumption (as per cent of high oxygen control values) versus average minimum DO concentration. Average feed consumption in the low oxygen treatment each year was expressed as a percent of the high oxygen treatment (control) that year.



of 2.5 ppm would likely have had a major negative impact on the fish.

Delaying aeration until the DO dropped to 1.5 ppm (2002) did have major impacts on most production parameters, although visible signs of oxygen stress were not observed. Feed consumption was reduced 45.1% (20,482 vs. 37,296 pounds of feed/acre in the high oxygen treatment; Fig. 1). Fish in the high oxygen treatment consumed 600 pounds/acre on the peak day, an average of 289 pounds/acre per day for the peak feeding month, and an average of 249 pounds/acre per day from July through September. Average fish weight in the low oxygen treatment was 30.5% less than the control (1.16 pounds vs. 1.67 pounds), and net production was 54% less (9,551 vs. 20,765 pounds/acre; Fig. 2). The Feed Conversion Ratio was not statistically different between treatments either year. Thus, it appears that if feed was consumed, it was converted with similar efficiency over the range of DO tested in this study.

Maintaining lower DO concentrations required less aeration. Aeration time (hp-hours/acre for the season) in the low oxygen treatment was reduced 62% in 2001 and 84% in 2002 compared to the high oxygen controls. The reduced aeration in the low oxygen treatment was due to three factors: 1) with a lower DO set-point, aerators come on later in the night and shut off earlier in the day, 2) oxygen transfer efficiency is improved at lower pond DO concentration, and 3) the fish consumed less feed at a lower DO, further reducing the need for aeration.

Even at the high feeding rates in the high oxygen treatment ponds in 2002, water quality was similar to the low oxygen treatment. Concentrations of total ammonia, unionized ammonia, and nitrite in both treatments were within normal ranges encountered in catfish culture. It appears that in our small research ponds, feed can be increased in proportion to available aeration far above levels currently used in the industry (Fig. 3).

Summary

In this study there was no benefit to initiating aeration before the DO concentration dropped to 2.5 ppm. Net production was not increased with a minimum DO maintained above that concentration, but more aeration was required. However, if the DO was allowed to decrease to 1.5 ppm before aeration was initiated, most production parameters (except survival and FCR) declined by 30% or more, even though visible signs of stress (fish at the surface or crowded near the aerators) were not observed. Fish in the high oxygen treatment in 2002 consumed 37,296 pounds of feed/acre, compared to 20,482 pounds/acre in the low oxygen treatment. This greater food consumption, presumable due to the higher DO concentration, meant the difference between fingerlings (stocked at 81 pounds per 1,000 fish) reaching market size (1.67 pounds) in one season, instead of having sub-marketable fish (1.16 pounds) at the end of the growing season. While similar relative results have been obtained from a concurrent study using 1-acre ponds, results from these small research ponds cannot be extrapolated directly to large commercial ponds that have very different mixing characteristics.

Figure 2. Net fish production (as per cent of high oxygen control values) versus average minimum DO concentration. Average net fish production in the low oxygen treatment each year was expressed as a percent of the high oxygen treatment (control) that year.

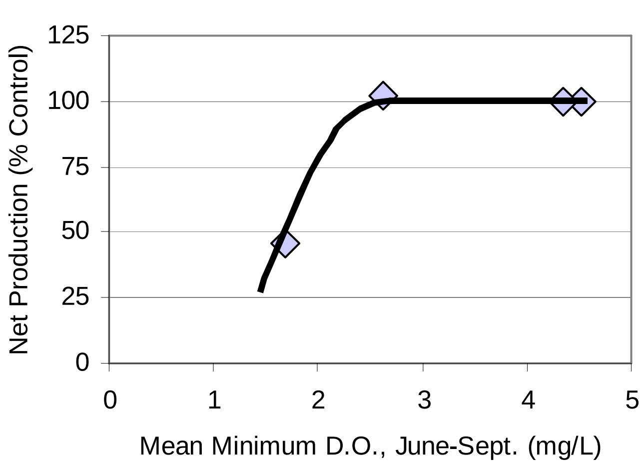
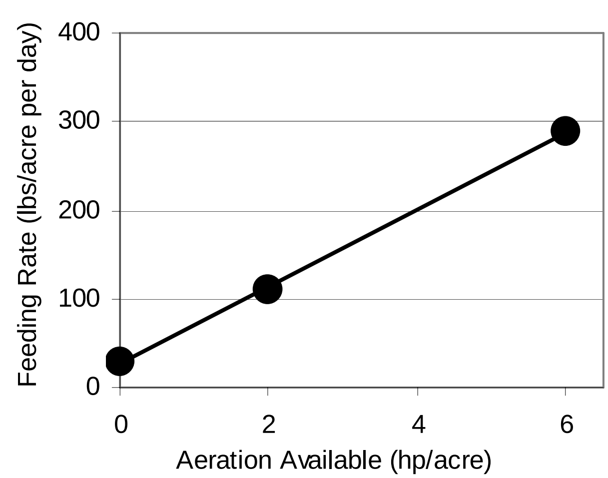


Figure 3. Feeding rates allowable over an extended time period versus the amount of aeration available. The two lower points are from literature; the highest value was obtained from the high oxygen treatment in 2002.



Swim-tunnel Respirometer
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channels for 22.5 seconds, and blues for 2.8 seconds. Hybrid catfish also swam longer without fatigue than the blue or channel catfish at all speeds of 39 inches/second or greater. Channel catfish were consistently better endurance swimmers, as they were able to maintain all speeds less than 27.5 inches/second, the longest. The channels also had sustained speeds (no fatigue at 200 minutes or more; this represents aerobic swimming capacity) of 23.6 inches/second while hybrid and blue catfish only had sustained speeds of 19.7 inches/second. Blue catfish had the lowest aerobic and anaerobic swimming capacities at all speeds.

We cannot say for certain, without concurrent growth studies, that these observed differences in the swimming abilities of fingerling hybrid, channel, and blue catfish result in growth advantages for the better swimmers in a pond environment. It is likely that the hybrid fingerlings (size and distance being equal) would win a sprint to feed or avoid predators with the channel fingerlings coming in a close second and the blue fingerlings a distant third. It is also possible that the channel catfish fingerlings could have an advantage in obtaining a position closer to a paddlewheel during times of low oxygen and could maintain that position longer than the blues or hybrids. It is clear that if superior swimming ability equates to better growth and survival in a mixed population of hybrid, channel, and blue catfish fingerlings in a pond environment, the blue catfish are at a serious disadvantage.

The swim-tunnel respirometers will allow researchers to conduct many such experiments that will continue to increase our knowledge of catfish health and survival.

Welcome to New Personnel at NWAC

Sarah Harris

Dr. Robert Li recently joined the USDA-ARS Catfish Genetics Research Unit as a Research Molecular Biologist. Dr. Li is a native of Xinyang, a midsize city in central China, where his parents still live. He came to the U.S. in 1990 for his advanced degrees. Dr. Li earned his Ph.D. from Yale University in the biological sciences in 1994 and worked for approximately 10 years in the pharmaceutical industry for Genaissance Pharmaceuticals in New Haven, Abbott Laboratories (VYSIS) in Chicago, and Monsanto/Pharmacia/Pfizer in St. Louis. At Genaissance, his group developed expertise in genomics such as cDNA selection, subtractive hybridization, positional cloning, and physical mapping. At Abbott, Dr. Li participated in the development of an integrated DNA microarray system for cancer diagnostics in 1996. This system is now commercially available and is the first so called genomic DNA microarrays for detection of human genomic abnormalities such as gene amplification, deletion, loss of heterozygosity (LOH) and other genetic imbalances. At Monsanto/Pharmacia/Pfizer, Dr. Li utilized cutting edge genomics tools such as Laser Capture Microdissection (LCM), TaqMan, and DNA microarrays to analyze gene expression in cancer, inflammation, and bone diseases. Dr. Li's expertise in gene expression and functional genomics will benefit our applied breeding program, especially in the area of catfish health. He can be reached by phone at 662-686-3535.

Mississippi State University and U.S. Department of Agriculture Cooperating