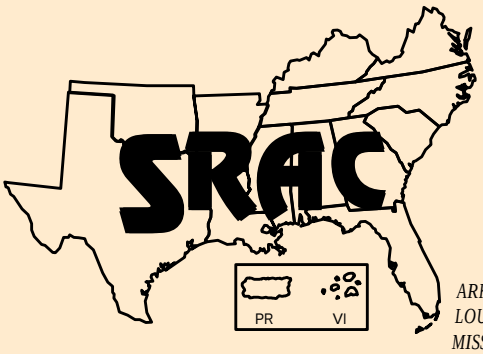

SUMMARY OF PROJECTS

ARKANSAS
LOUISIANA
MISSISSIPPI
KENTUCKY
VIRGINIA
OKLAHOMA
TEXAS
ALABAMA
GEORGIA
NORTH CAROLINA
SOUTH CAROLINA
VIRGIN ISLANDS
FLORIDA
TENNESSEE
PUERTO RICO

The Southern Regional Aquaculture Center

CONTENTS
December 2000

The Southern Regional Aquaculture Center (SRAC) is one of five Regional Centers established by Congress and administered through the USDA Cooperative State Research, Education and Extension Service. The Centers provide a mechanism for assessing local aquaculture industry needs, establishing research and extension priorities, and implementing regional research and extension projects.

Projects supported by the Regional Centers are unique in several important ways:

- Center projects are responsive to regional industry needs;
- Projects usually address broad, fundamental issues rather than narrowly focused problems;
- Projects are planned and conducted as cooperative efforts that bring together competent scientific talent from several participating institutions; and
- Results of projects are made quickly available to the industry in an accessible, understandable format.

SRAC was organized in 1987, and the first research and extension projects were initiated in 1988. The thirteen states and two territories included in the Southern Region are listed in the masthead, above. Mississippi State University serves as the Host Institution for SRAC, and the Administrative Center is located at the Thad Cochran National Warmwater Aquaculture Center, Stoneville, Mississippi.

Priority research and eduction needs for the Southern Region are identified by the Industry Advisory Council, which consists of industry representatives from throughout the region, and the Technical Committee, which is composed of research and extension scientists. These two groups recommend project areas to the SRAC Board of Directors, who then selects priority categories for project development and funding.

This report presents a summary of projects currently being funded by SRAC.

For further information on the Southern Regional Aquaculture Center and detailed reports of the results of SRAC projects, visit the SRAC web site at ***http://www.msstate.edu/dept/srac***

Publications, Videos and Computer Software

CHALLENGE

Aquaculture is one of the most rapidly expanding agricultural industries in the United States and the world. Aquaculture currently produces about 25% of the world's seafood supply. Most domestic production takes place in the southeast region, where more than 100 species of fish, shellfish, aquatic reptiles, and plants are cultured for food or ornamental purposes. The total farm value of southeastern aquaculture is over one billion dollars. Aquaculture is a young, unique, and rapidly expanding industry, and the need for information to sustain growth and development has increased dramatically over the past 20 years.

RESPONSE

Extension and research scientists in the southeastern United States initiated this project to produce research-based fact sheets, videos, and other educational materials to support aquaculture production and marketing in the region. The concept of using the SRAC program to produce high-quality educational materials is based upon the benefits of using a region-wide pool of experts to develop materials for distribution through the nationwide network of Extension Specialists and County Agents. This process makes efficient use of personnel and funds at the State level, and results in timely, high-quality educational materials that are readily available to scientists, educators, producers, and the general public.

Every publication contains understandable, factual information that provides guidance for producers, processors, consumers, or investors. Subject matter includes biology and life history of specific culture species, culture techniques and systems, nutrition, water quality and waste management, disease treatment, off-flavor management, consumer education, marketing, and much more. In many instances, this project serves as a vehicle to publish previously available research information in a peer-reviewed extension outreach format. Other publications present new information derived from SRAC-supported research and extension projects.

Twenty-nine scientists from the following institutions and agencies contributed to publications this year:

- Harbor Branch Oceanographic Institute
- Kentucky State University
- Langston University
- Louisiana State University
- Mississippi State University
- North Carolina State University
- Oklahoma State University
- University of Arkansas at Pine Bluff
- Texas A&M University
- University of Kentucky
- USDA-ARS Pine Bluff, Arkansas
- University of North Carolina at Wilmington
- University of the Virgin Islands

PRINCIPAL ACCOMPLISHMENTS

Ten publications were printed this year, with 15 more in progress. One of the publications was the fourth in the series "RAC Results." Publications in this series highlight the impacts of SRAC projects in a brief, popular format. The most recent "RAC Results" publication, "Analysis of Regional and National Markets for Aquacultural Food Products Produced in the Southern Region" summarizes the 1988-1990 SRAC project of the same name. All publications were distributed throughout the Southern Region and to interested Extension Specialists in other regions.

The Southern Regional Aquaculture Center has now published 157 fact sheets and 20 videos. These publications provide essential information for aquaculture producers, lending agencies, and consumers of aquaculture products. Educators in high schools and colleges use SRAC publications in classrooms throughout the United States and the world. Copies of all fact sheets are available at http://www.msstate.edu/dept/srac on the Internet. ❖

Management of Environmentally-Derived Off-flavors in Warmwater Fish Ponds

CHALLENGE

Blue-green algae and other naturally occurring aquatic microorganisms can produce odorous compounds that give fish objectionable off-flavors. The development of off-flavors in market-sized fish is a severe economic burden to fish farmers because it interrupts the orderly flow of fish from pond to processor. Holding fish in inventory while waiting for flavor quality to improve interrupts cash flow and increases the time needed to raise a crop, thereby exposing fish to increased risk of loss to diseases. In the catfish industry alone, off-flavor costs farmers $10 to 60 million a year. Off-flavors also have impacts far beyond the farm because market development for aquaculture products depends on offering the consumer a consistently high-quality product. Over the long run, inconsistent product quality due to preharvest off-flavors may adversely affect market demand and aquaculture industry development, with the overall effect of reducing profits for all segments of the industry.

RESPONSE

Fourteen research scientists have teamed in a five-year project that began on June 1, 1996, to investigate mangement practices that may reduce the economic impact of inconsistent flavor quality. The scientists represent these institutions:

- University of Tennessee
- University of Arkansas at Pine Bluff
- Auburn University
- Louisiana State University
- Louisiana Tech University
- University of Memphis
- University of Mississippi
- Mississippi State University
- Texas A&M University

A broad range of possible solutions to this problem are under investigation, including:

- Modifying feeds and feeding practices so that less waste enters the pond to stimulate blue-green algal blooms;
- Using safe, inexpensive chemicals to remove nutrients that stimulate blue-green algal blooms; and
- Controlling blue-green algae with filter-feeding fish, natural microbial pathogens, natural plant products, or the algicide copper sulfate.
- In addition to the algae control measures above, investigators will look for methods of increasing the rate of odor elimination by fish and for better methods of assessing flavor quality.

PRINCIPAL ACCOMLISHMENTS

Work on this project showed that modifying feeds to reduce waste phosphorus generation can be accomplished from the nutritional standpoint but, at the high feeding rates used in commercial catfish farming, the reduction in phosphorus input has little impact on algae that develop in ponds. Although dietary phosphorus modification may not lead to improved water quality in ponds, the information gathered from investigations of phosphorus availability from various feedstuffs is already being used by feed manufacturers to refine commercial diet formulations, with a cost savings to the farmer.

Another finding of this project that has been adopted by the aquaculture industry is the use of routine, low-level copper sulfate treatments for preventing algae-related off-flavors. Under experimental conditions, weekly treatments of catfish ponds with copper sulfate reduced the incidence of off-flavor by 80% and increased net revenues by over 40% compared to untreated ponds.

Several other treatments and practices investigated in this project show promise. For example, phosphorus levels in ponds can be reduced by precipitating phosphorus as aluminum or calcium

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Verification of Management Practices for Major Aquatic Species

CHALLENGE

Verification programs are designed to validate agricultural research and extension recommendations in a commercial setting and to shorten the time between research discoveries and their adoption on farms. The results of verification programs also show whether recommendations and research programs need to be modified based on what has been learned. Adoption of verification program practices usually increases industry yields, and by demonstrating an integrated management plan on an existing farm, producers can relate to the results more than to typical research results. Although research verification programs are common in agriculture, they have yet to be conducted in United States aquaculture.

RESPONSE

This project was initiated to establish verification programs in five states in the region. The emphasis is on developing the interdisciplinary process and internal committees within each state. While actual field results of verification trials of different management protocols will be valuable, this project is intended to stimulate development and use of verification trials as a new extension tool.

Nineteen research and extension scientists are participating in the three-year project, which started on January 1, 1997. The following institutions are involved:

- Auburn University
- Clemson University
- Louisiana State University
- North Carolina State University
- University of Arkansas at Pine Bluff

PRINCIPAL ACCOMLISHMENTS

Four states (Alabama, Arkansas, North Carolina, and South Carolina) are conducting verification programs for catfish production systems (including levee ponds, watershed ponds, hybrid watershed-levee ponds, and cages). The Louisiana program is concentrating on crawfish. Management protocols and verification committees have been developed for each state and full verification trials are underway. In all, there are 16 cooperators, 27 ponds, and 6 cage culture systems enrolled in the program that represent various regions of the participating states.

One of the most significant, and unanticipated, benefits of this project has been the increased trust and confidence that farmers have in county agents and in extension recommendations. Also, county agents have shown increased interest in aquaculture programs due to the proactive nature of the verification program. Validation of the benefits of the production practices used in verification trials has prompted several cooperators to implement verification practices in other ponds on their farm. ❖

Management of Environmentally-Derived Off-flavors in Warmwater Fish Ponds (continued from page 3)

salts, or by treating the pond bottom to reduce phosphorus flux from soils to water. These practices could be an important management procedure for improving quality of pond water and effluents and in combating off-flavor. Another example of a potentially effective practice is the use of filter-feeding fishes, which has been shown to be effective in controlling odor-producing algae in small-scale systems. Perhaps the most intriguing result is the success achieved using bacterial pathogens of odor-producing blue-green algae. If these results can be transferred to pond-scale ecosystems, the work may lead to a novel, safe, and effective method of controlling flavor problems in fish.❖

Optimizing Nutrient Utilization and Reducing Waste Through Diet Composition and Feeding Strategies

CHALLENGE

Nutrition and feeding costs are the largest operating expense in fish farming. Expenses include not only the cost of the feed but the man-power and equipment necessary to deliver the food, and the potential for the food to cause water quality deterioration. Protein is a major component of the costs of feed ingredients and the component which contributes nitrogen to the water either from uneaten food or fish wastes. The two areas which offer the greatest potential for significant improvement in production efficiency and waste minimization involve manipulation of diet composition and refinement of feeding strategies.

RESPONSE

This project was developed to provide a scientific base for optimizing feed composition, feeding frequency, and amount of feed to provide efficient production and reduce wastes in channel catfish, hybrid striped bass, baitfish and crawfish culture.

Nineteen scientists are participating in this three-year project, which began December 1, 1997. The following institutions are involved:

- The University of Memphis
- Auburn University
- Louisiana State University, Baton Rouge
- Louisiana State University, Rice Research Station
- Mississippi State University, Starkville
- Mississippi State University, Stoneville
- North Carolina State University
- Texas A & M University
- University of Arkansas at Pine Bluff
- University of Georgia

The project was initiated to 1) determine the effects of diet composition on fish production, nutrient utilization, and excretion of organic and nitrogenous wastes for catfish and hybrid striped bass; 2) assess the effects of various feeding strategies and techniques on fish production, nutrient utilization, and waste reduction for channel catfish, baitfish, and hybrid striped bass; and 3) develop and refine feeding strategies for crawfish that effectively enhance production by augmenting the forage-based system.

PRINCIPAL ACCOMLISHMENTS

Channel Catfish — Several promising approaches to improving protein use in catfish feeds have been identified. For example, catfish production was not affected when the crude protein level in the diet was reduced from 30% to 25%, even if supplemental lysine was not provided in the reduced-protein diet. Another study showed that channel catfish production and feeding efficiency were the same when fed diets with all-plant ingredients or with 4% menhaden fish meal, yet the all-plant diet costs 5% less, which would reduce cost of production for catfish by as much as $6,000,000 a year across the industry. In yet another study, feeding 12.5% less of a 32% protein feed to catfish in production ponds produced the same yield of fish as feeding a 28% protein to satiation. Feed efficiency and economics were improved by feeding the 32% protein feed with no difference in nitrogen or phosphorous wastes or phyto-plankton production. Feeding 22.5% less of a 36% protein feed did reduce fish production.

Changing feed strategies according to water temperature or quality appears to have a minimal impact on fish production. Fish production, feed consumption, feed conversion ratio, visceral fat, and total ammonia nitrogen were positively correlated to feed consumption or feed input. Fish fed every day throughout the growing season consumed the most feed and had the highest net production. These studies suggest that catfish should be fed to satiation daily for maximum production. In a related study, it was found that the brief cooling of water at night during hot summers is important in reducing the stress response of channel catfish.

Reduction of the protein concentration of the feed and marginal reductions in feeding rate have not

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Optimizing Nutrient Utilization and Reducing Waste Through Diet Composition and Feeding Strategies (continued from page 5)

been found to have measurable effects on nitrogen concentrations in water. This may be related to the fact that uptake by fish is only one of several complex fates of nitrogen in water. The four main losses of nitrogen from ponds were determined to be fish harvest (32% of the total nitrogen added to ponds), denitrification (17%), ammonia volatilization (12%), and accumulation in pond soils (23%). Likewise, different phosphorus concentrations in feed had no effects on soluble reactive phosphorus, total phosphorus, or algal biomass, although using low phosphorus diets may be beneficial by reducing the phosphorus load to bottom soils by conserving their ability to adsorb phosphorus.

Hybrid Striped Bass — A significant finding of this project was that reducing daily feeding frequency from three to four times a day to two times per day had no effect on total production or size distribution of hybrid striped bass fingerlings. Also, adult fish fed once a day either in the early morning or late afternoon had higher production, average weight, and were more uniform in size than fish that were fed either during the mid-morning or mid-afternoon. Reduction of feeding times during the day will reduce production costs by decreasing labor requirements and reducing wear on feeding equipment.

Studies also investigated the affect of dietary lipid and water temperature on growth. Results showed that diets with intermediate levels (10 to 15%) of dietary lipids enhanced growth of hybrid striped bass when compared with fish fed a 5 or 20% lipid diet. Whole body lipid deposition and intraperitoneal fat accumulation increased with increased dietary lipid levels. Other studies showed that growth and nutrient utilization were significantly higher for fingerling fish at a moderate water temperature (80°F) than at a higher temperature (90°F), regardless of dietary energy to protein (E/P) ratios. The reduced growth at the higher temperature may be due to increased energy requirements at this temperature. Feed consumption decreased with increasing dietary E/P ratios. Feed efficiency, protein efficiency and protein conversion efficiency were highest at a dietary E/P ratio of 9 kcal/g protein.

Golden Shiners — Diets with oils from soybean, cod liver, canola, or olive, and various combinations were evaluated in feeding trials. Fatty acid analysis revealed marked differences of n-6 to n-3 ratios among the oil sources, and diets with n-6 to n-3 fatty-acid ratios of 2.1 to 7.0 promoted growth better than those with low (0.3) or high (148 to 198) fatty acid ratios. Soybean oil appears to be a better single source of lipid than canola, cod liver, or olive oils for promoting growth, although stress response (cortisol levels) of golden shiners was not significantly affected by lipid source in the diet. Golden shiners did, however, have higher serum cortisol concentrations than channel catfish before and after exposure to a stressor. Poultry fat is readily available in Arkansas as a by-product of poultry processing, and a diet high (13%) in poultry fat supplies sufficient n-6 fatty acids for shiners, and natural pond forage apparently supplies sufficient n-3 fatty acids. The qualitative fat requirement may vary among several factors and is apparently different between golden shiners and goldfish. Golden shiners grew better on 4% poultry fat than on 14%, but survival was better at the higher fat level. However, weight gain, survival, feed efficiency and body fat of goldfish were all higher at the higher fat level.

Crawfish — Identification of inexpensive locally available feedstuffs for supplementing feeding of crawfish has shown that rough rice seed and whole raw soybeans increased growth over crawfish fed by the cultivated rice forage system alone. Growth was similar to that obtained by feeding a formulated 25% crude protein feed. However, feeding supplemental feed decreased the effectiveness of baited traps used in harvesting in ponds. Limiting the supplemental feeding to only one day a week failed to generate larger crawfish than those in the forage system alone. Supplemental feeding with rice seed had a significant effect on sparing rice forage, but feeding too often reduces the effectiveness of baited traps when harvesting.❖

Management of Aquacultural Effluents from Ponds

CHALLENGE

Aquaculture operations in the United States have recently come under increased scrutiny because of potential or perceived environmental degradation caused by the discharge of water from production facilities. Aquaculture is now under consideration by EPA as a candidate industry for new regulatory activity. Therefore, regulation of pond aquaculture effluents in the southeastern United States within the next few years is a distinct possibility. Regulatory requirements to operate ponds without discharge could drastically alter the way pond aquaculture facilities have traditionally been managed. Additionally, these requirements would impose additional financial burdens on existing operations and restrict further development of the regional aquaculture industry.

RESPONSE

The aquaculture industry has an opportunity to participate in the process of formulating regulations, because the approach and framework for the regulatory process have not yet been decided. Through this regional research project, the research community can provide information required by permit writers for the development of rational regulatory mechanisms. This project will provide important information on the character of effluents from aquaculture ponds and explore management methods for reducing the volume and improving the quality of pond effluents. This information will be used to develop a set of best-available pond water management practices which will be evaluated for environmental risks and economic performance.

Fourteen research scientists and extension agents are collaborating on a three-year project initiated on April 1, 1999. The following institutions are involved:

- Auburn University
- University of Arkansas at Pine Bluff
- Louisiana State University
- Mississippi State University
- North Carolina State University
- Virginia Polytechnic Institute and State University
- South Carolina Department of Natural Resources - Waddell Mariculture Center

PRINCIPAL ACCOMLISHMENTS

Solids in rainfall overflow and in 80% of the water discharged during intentional drawdown of ponds are very difficult to settle because most of the solids are very small. Treatment of the final 20% of water during intentional discharge can be accomplished with sedimentation basins designed with a hydraulic retention time of 8 hours, although a settling time of 2 to 4 hours is sufficient to reduce total suspended solids in effluents to 75 to 90% of original concentrations. Solids removal is associated with settling of the mineral fraction, with little change in organic solids concentrations in effluents. Preliminary economic analysis indicates that using existing ponds as sedimentation basins is more economical than building new sedimentation basins.

Effluent volume can be reduced by increasing pond depth to increase rainwater storage capacity and linking the combined storage/production pond to adjacent conventional ponds. After one year of study, effluent volume was reduced by approximately 65-75% and groundwater use was reduced by 25-38% compared to conventionally managed ponds.

Participants in this project are active participants in the Federal Joint Subcommittee on Aquaculture Effluents Task Force. They have assembled and provided the Task Force and EPA with general information on the aquaculture sectors in the Southern region, the characteristics of pond effluents, and the effectiveness of various effluent management options and best management practices.❖

Control of Blue-Green Algae in Aquaculture Ponds

CHALLENGE

Aquaculture ponds are ideal habitats for blue-green algae, which can cause serious environmental problems during culture. Excessive abundance of blue-green algae causes low dissolved oxygen concentrations, and some species synthesize odorous natural compounds responsible for off-flavor in fish. A few species of blue-green algae also produce compounds that are highly toxic to aquatic animals. Blooms of blue-green algae occur in all aquaculture ponds, including those used to raise catfish, hybrid striped bass, and baitfish. The annual economic loss associated with these algal blooms in southeastern aquaculture ponds exceeds $50 million, and methods for controlling these troublesome algae would be of tremendous benefit to the aquaculture industry. Any treatment demonstrated to be effective in controlling blue-green algae has considerable potential for improving existing aquacultural management techniques and enhancing on-farm profits.

RESPONSE

This project will evaluate a variety of treatments designed for the control of blue-green algae in aquaculture ponds, including the the use of natural chemicals as algicides, nutrient manipulations, and water circulation techniques. The goal is to replace undesirable blue-green algae with more desirable phytoplankton communities. In addition, a modified pond culture system, the partitioned aquaculture system (PAS), is being evaluated as a method to eliminate blue-green algal dominance in pond systems. It is anticipated that these efforts will reveal which treatments are beneficial.

Twenty-one research and extension scientists are participating in the three-year project which began on January 1, 1999, and represent the following institutions and agencies:

- University of Arkansas at Pine Bluff
- Auburn University
- Clemson University
- University of Georgia
- Louisiana State University
- University of Mississippi
- Mississippi State University
- North Carolina State University
- University of Tennessee
- USDA/ARS, Southern Regional Research Center

PRINCIPAL ACCOMLISHMENTS

Research has been initiated at two institutions to develop natural chemicals that prevent the establishment of noxious blue-green algal communities. More than 4000 plant and algae extracts have been prepared from plants, true algae, and blue-green algae. Forty-three of the extracts (12%) have shown strong anti-blue-green algal activity. These findings indicate that natural products (small biologically active organic compounds) produced by organisms that live and compete in environments rich in blue-green algae are a valuable source of new, selective algicides against that group of algae.

Researchers at six institutions are evaluating nutrient manipulations to promote desirable phytoplankton communities (i.e., eliminating blue-green algae). Methods being evaluated include manipulating the ratio of nitrogen-to-phosphorus in the water, reducing the availability of phosphorus from bottom muds, enhancing the availability of inorganic carbon, increasing levels of salinity and potassium, and manipulating trace metal availability. Work to date has not provided a means for controlling blue-green algae in ponds, but has demonstrated that several treatments such as applications of legume hay, iron, and other micro-nutrients (including potassium chloride) are not effective. Studies have revealed the following regarding pond fertilization practices: 1) EDTA is an excellent chelating agent for micro-nutrient metals in fertilizers; 2) sodium nitrate is an excellent nitrogen source for sportfish ponds;

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Control of Blue-Green Algae in Aquaculture Ponds (continued from page 8)

and 3) sodium nitrate is also a useful nitrogen fertilizer for bait minnow ponds. Despite long-term use of granular fertilizer in baitfish study ponds, sediment-bound phosphorus does not appear to exert a discernible effect on water quality under commercial production conditions. An unanticipated finding of this work was high soil sulfur levels in baitfish pond bottom samples, which led to the development of new baitfish pond management practices to reduce chances of hydrogen sulfide problems.

The use of plankton-feeding fish is being evaluated at three institutions. In Georgia, blue-green algae became abundant in April in ponds stocked only with channel catfish, but later in ponds where other fish were present with catfish (May in ponds with fathead minnows and June in ponds with threadfin shad). At another location, blue-green algae did not become abundant until August. It was apparent that blue-green algae were less abundant in the ponds with threadfin shad; however, all ponds had blue green algae blooms by late summer. Shad stocking is being considered by catfish farmers who had off-flavor catfish and who could not utilize herbicides for control of blue-green algae. In Alabama, stocking of threadfin shad with fingerling channel catfish resulted in improved water quality in the late growing season. This apparently resulted in improved culture conditions and significantly greater survival of catfish in the presence of shad.

Information from the work in Georgia also helped refine the practice of using fathead minnows for control of proliferative gill disease in catfish ponds. The behavior of fathead minnows in channel catfish ponds indicated a need to encourage spawning by adding spawning substrate or restocking fathead minnows at regular intervals to maintain a density of at least 1,500 minnows per acre.

The effects of water circulation on phytoplankton communities is under investigation at five institutions. Research in Mississippi suggests that some threshold level of turbulent mixing is necessary to overcome light limitation of phytoplankton production and shift phytoplankton community composition from dominance by cyanobacteria. If artificial mixing of ponds is attempted, a uniform flow field should be developed to avoid areas of concentrated turbulence that can suspend pond soils.

Researchers at Clemson University have demonstrated that 17,000 pounds of channel catfish per acre can be produced in the innovative partitioned aquaculture system (PAS). The PAS couples high-density raceway culture of fish with paddlewheel-driven, high-rate algal growth basins for treatment of ammonia and organic wastes. This allows 100% reuse of culture water in self-contained, self-oxygenating culture units. The PAS technique offers the potential to provide a method to increase current fish production in a system that appears to eliminate blue-green algal dominance and associated fish off-flavor problems. The systems offers the additional benefit of eliminating discharge of waste nitrogen and phosphorus, which currently pose an eutrophication threat to surface and groundwater supplies.❖

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