AQUACULTURE CRSP 21ST ANNUAL TECHNICAL REPORT

TECHNIQUES FOR THE PRODUCTION OF *CLARIAS GARIEPINUS* FINGERLINGS AS BAITFISH FOR THE LAKE VICTORIA NILE PERCH LONGLINE FISHERY

Social and Economic Aspects/Product Diversification/Experiments (10NSR5)
Final Report

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ABSTRACT

Clarias gariepinus is probably the most widely distributed fish in Africa. It can endure very harsh conditions by using its accessory air-breathing organ, it is omnivorous, and it grows quickly. As a result, this species has a high potential for aquaculture. In recent years *Clarias* have also become important to the Lake Victoria Nile perch fishery, which is of enormous economic importance in Kenya, Uganda, and Tanzania. Although trawling for Nile perch is practiced by some fishers, it is not legal on Winam Gulf, a main fishing zone in Kenya, so some fishermen have resorted to longline fishing, using fingerling-sized *Clarias* as bait. A quick survey of fishermen indicated that they bait from 100 to 1,000 hooks per boat per day, and if one assumes there are 50 boats, the demand in Kenya will be between 5,000 and 50,000 *Clarias* fingerlings per day. At 300 fishing days per year, this equates to an annual demand of between 1.5 and 5 million fingerlings. The present supply of fingerlings is intermittent, however, partly because most methods of capturing wild fingerlings have been banned. Fishermen therefore find themselves in a difficult situation because they need the bait at an affordable price to be able to continue fishing. At the reported selling price of 5 to 8 KSh per fingerling, the industry could be worth up to KSh 40 million annually (or about US$0.5 million). An estimated production cost of about 0.1 KSh per fingerling, farm-based production of *Clarias* fingerlings could be a highly profitable business for fish farmers.

Research on the artificial propagation of *Clarias* spp. has provided a host of options for farmers, ranging from highly controlled induced spawning to many variations of partial control to the unpredictable but easy natural spawning. However, survival of larvae to the fingerling stage remains problematic, regardless of the propagation method used. Factors identified as contributing to poor survival include cannibalism, lack of adequate cover, and predation by insect larvae and other aquatic organisms.

This report discusses four sets of experiments being conducted at the Chepkoilel Campus of Moi University, Eldoret, Kenya, with the objectives of determining the best percent shade cover for nursery ponds, the best stocking densities, and the best culture periods for rearing *Clarias* larvae, and the best of several alternative live foods (rotifers, copepods, *Artemia*) to offer larvae during the nursery phase. Two experiments are being conducted in hapas suspended in 300 m^2 earthen ponds and two are being conducted indoors in 30 liter glass aquaria. The durations of these experiments will be from 21 to 30 days. Preparatory work began in May 2003 and the research is currently underway. All experimental work is expected to be completed by the end of 2003. Full results will be reported in student theses (M.Sc.) coming out of Moi University in early 2004.

INTRODUCTION

Clarias gariepinus is probably the most widely distributed fish in Africa (Skelton, 1993). It can endure very harsh conditions by using its accessory air-breathing organ, is highly omnivorous, and grows quickly. This fish has high potential for aquaculture. Research into the culture potential and the artificial propagation of this fish began in the 1970's. (DeKimpe and Micha, 1974; Hogendoorn, 1984). The aquaculture industry in South Africa boomed as a result of *Clarias* culture but supply exceeded demand as competing cheap salted fish were made available, and the industry has since re-vamped its aquaculture industry to include a greater diversity of fish. *Clarias* and the *Clarias* Î *Heterobranchus* hybrid are major aquaculture species in Nigeria. Research on the artificial propagation of *Clarias* has provided a host of options for farmers, ranging from highly controlled induced spawning to many variations of partial control to the unpredictable but easy natural spawning. Simpler techniques using hypophysation and hapa spawning have been used at Sagana Fish Farm, in Central Kenya, whereas

more intensive, electrical energy-dependent techniques of fry rearing have been developed over the years and are used in South Africa and in Europe.

Clarias have also become important to the Lake Victoria Nile Perch fishery, which is of enormous economic importance in Kenya, Uganda, and Tanzania because of its foreign currency earnings and the employment it provides for people near the lake. Trawling is practiced by some of the wealthier fishers but it is not legal on Winam Gulf, which is an important fishing zone in Kenya. Poorer fishermen have resorted to longline fishing and their favorite bait is fingerling-sized *Clarias*. Desired bait size varies but ranges from 5 to 20 grams per fish. A quick survey of fishermen gave hugely varied numbers of fishers and number of hooks per fisher but it seems that fishers bait from 100 to 1,000 hooks per boat per day, and assuming 50 boats this translates into a demand in Kenya between 5,000 and 50,000 *Clarias* fingerlings per day. At 300 fishing days per year, this equates to an annual demand of between 1.5 and 5 million fingerlings.

The present supply of fingerlings is intermittent and seems to be related to the extent of water hyacinth rafts drifting in near shore, with *Clarias* being numerous under the water hyacinth. Fishers sometimes use small-mesh beach seines and mosquito nets to catch fingerlings for bait, but beach seining is highly destructive of the spawning habitats of native cichlids and is illegal. Fishing with mosquito nets has also recently been banned by the government. Fishers find themselves in a difficult situation because they need the bait at an affordable price to be able to continue fishing. At the reported selling price of 5 to 8 KSh per fingerling and an estimated production cost of about 0.1 KSh per fingerling (Veverica, personal communication, 2001), farm-based production could be a highly profitable business for fish farmers.

Although a number of practical methods for the spawning of *Clarias* have been developed, survival of larvae to the fingerling stage remains problematic. A primary concern with respect to fingerling survival has been cannibalism. Type one cannibalism occurs when the fingerlings are crowding in a dark corner and inadvertently eat each other. Type two cannibalism, in which the fingerlings actively hunt one another down, begins to develop as the fish reach about 3 grams. Altering habitat can help reduce the incidence of type one cannibalism and frequent grading can reduce type two cannibalism. Preliminary work at Sagana has indicated that frequent grading, daily feeding and weekly fertilizing, and use of corralled grasses as fertilizer and cover can increase the number of fingerlings per unit area harvested (Veverica, personal communication, 2001). Early observations were that compost piles along pond edges seemed to be the preferred habitat of the *Clarias* fry, so these enclosures were increased to cover 20% of the pond (from 5%) but using floating grasses instead of cut grass that sinks. The floating grasses are very fibrous and do not decompose fast enough to cause oxygen depletion. They do not take root in the pond and will not multiply in the pond and compete for nutrients as do water hyacinth and Nile cabbage or water lettuce (*Pistia stratiotes*).

Complete shading is preferred but limits the production of phytoplankton, which is needed to produce oxygen and as a base for the food web. In addition, partial harvesting to grade off the faster growing fingerlings is impeded by the presence of the grasses and many of the larger fingerlings can be left behind to cannibalize the others. A trial conducted in December 2000 gave very promising results, with survival over 50%.

Growth is density dependent; the higher the rearing density of larvae, the lower their growth rate. Therefore, there will be a need to determine optimum densities for stocking *Clarias* fry in the high altitude areas. Growth and survival of larvae fed on live feed also needs to be compared in order to evaluate the possibility of reducing farmers' dependency on costly formulated food.

The present set of studies was designed to follow up on preliminary work in order to develop a set of research-based extension recommendations for producers of *Clarias* fingerlings as bait fish. Partial enterprise budgets will be made for all treatments and a full enterprise budget for the "best" treatments will be reported. The specific objectives of these studies are to determine the optimal following conditions for *Clarius* fingerling production:

1) Shading regime.
2) Larval stocking density.
3) Larval grow-out period.
4) Larval live feed.

METHODS AND MATERIALS

Four studies aimed at achieving the above objectives are being conducted at the Chepkoilel Campus of Moi University, Eldoret, Kenya. Percent shading, stocking density, and culture period studies are being conducted in hapas suspended in 300 m^2 earthen ponds at Chepkoilel Fish Farm, and additional studies are being conducted in indoor aquaria, including a stocking density study and a comparison of live feeds as first feeds for *Clarias* larvae. These indoor studies are being conducted in 30-l universal glass aquaria in the hatchery facility attached to the main office of the Moi University Department of Fisheries.

For the experiments being conducted in hapas, ponds were given an initial dose of fertilizers consisting of urea at 10 kg N ha^{-1}, DAP at 4 kg P ha^{-1}, and cow manure at 500 kg ha^{-1} two days prior to stocking, and fertilization is being repeated at half of this initial dose on days 7, 14, and 21. Beginning on day four the fish are being offered trout feed (36% protein) twice daily at a rate of 10 kg ha^{-1} d^{-1}; the feed is being put at the grass/water margin. The ponds are being managed as static-water systems, with water added weekly only to replace losses due to seepage and evaporation. Dissolved oxygen and temperature are being measured at 0700 h and 1700 h every three days, at depths of 5, 25, and 50 cm at three points in each pond. The three sampling points are at the grass-covered end (i.e., under the grass cover), at the grass/water interface, and at the open end of the pond. Secchi disk visibility is being measured at the open end of the pond every three days. Fish sampling is being done as partial harvesting of all fingerlings that remain in a 3/8 inch mesh seine, beginning on day 12 and repeating every four days thereafter.

Percent Shading Experiment

For this experiment, fry are being reared in 1Î1Î1 m hapas placed in a pre-fertilized earthen pond of 300 m^2. The hapas have different shading levels of 0%, 30%, 60% and 100%. The hapas were stocked with 6- to 10-day-old *Clarias gariepi-*

nus larvae (swim-up fry) at a density of 100 per m^2. Shading was done by covering with cut grasses. There are three hapas (replicates) for every shading level, giving a total of 12 hapas for the experiment. Fry will be reared for 30 days followed by a complete harvest, after which the average weight and survival rate for each shading level will be determined. Dissolved oxygen, temperature, pH and secchi depth of the pond water are being measured at 0700 h and 1700 h every three days. If one of the treatments shows a distinct benefit and if time allows, this experiment may be repeated at different shading levels. Null hypotheses for this experiment are that:

1) Survival of the fry/fingerlings has no relation to percent coverage by grasses
2) Total fingerling harvest has no relation to percent coverage by grasses
3) Size of fingerlings at harvest has no relation to percent coverage by grasses
4) Dissolved oxygen concentrations have no relation to percent coverage by grasses
5) Net returns among the tested treatments are not different

Data from this experiment will be analysed by ANOVA and regression techniques.

Aquarium Stocking Density Experiment
In this experiment the growth and survival of hatchery-bred fry reared at different stocking densities in 30-l darkened aquaria is being assessed. Stocking densities of 5, 10, 20, and 30 fry l^{-1}, with four replicates each were randomly assigned to 16 aquaria. Fish are being fed a formulated diet (40% crude protein) to apparent satiation, six times a day at two-hour intervals throughout the 21-day rearing period. A flow through system is being used to give all aquaria similar water quality. Water quality parameters including dissolved oxygen (DO), ammonia (NH_3), and pH are being monitored three times a day. Temperatures are being monitored and recorded at four-hour intervals using Optic StowAway® Temp data loggers. The results of this experiment will be analyzed using ANOVA and regression techniques. Null hypotheses are that stocking density does not not have significant effect on survival, fingerling production, or net returns from fingerlings produced and sold.

Hapa Stocking Density Experiment
For this study *C. gariepinus* fry were stocked randomly in hapa nets suspended in a 300 m^2 earthen pond at densities of 100, 200, and 400 per m^3 with four replicates per treatment. Each of the 12 hapa nets measures 50 cm Î 50 cm Î 80 cm. The fry will be reared for a period of twenty-eight days. Sampling is being done on day 14 and repeated every 7 days thereafter for weight and total length measurements. Dissolved oxygen, pH and water temperature are being measured at 0700 h and 1700 h every 3 days. The results of this experiment will be analyzed using ANOVA and regression techniques. Null hypotheses are that neither stocking density nor length of grow-out period has significant effect on survival, fingerling production, or net returns from fingerlings produced and sold.

Live Feeds Study
This study aims to compare the growth and survival rates of *C. gariepinus* fry when fed three different diets: rotifers (*Keratella* ssp.), copepods (frozen *Cyclops*) and nauplii (*Artemia salina*). Each of twelve rectangular tanks (45 cm Î 30 cm Î 30 cm) was stocked with 100 4-day-old fry weighing 5 mg and 6 mm in length. Treatments (3 live feeds) were allocated to the experimental units (tanks) in a completely randomized manner. Fish are being fed six times a day at two hour intervals, starting at 0800 h for a period of 28 days. Sampling for weight and total length measurements is being done every seven days. Temperature is being kept constant at 26°C in all the tanks, and total ammonia-nitrogen, dissolved oxygen nitrite and pH are being monitored daily. Null hypotheses for this experiment are that the type of live food offered does not have a significant effect on either survival or growth of *Clarias* larvae reared in aquaria. The results will be analyzed using ANOVA and regression techniques.

The research proposals of the four Moi University graduate students conducting this research under CRSP sponsorship are attached to this report. The final results of each experiment will be reported in the thesis of the student who conducted the work and will be submitted to the CRSP upon completion.

RESULTS

It is expected that all of the experimental work described here will be completed by the end of 2003 and that the theses of the four Moi University graduate students conducting the work will be ready for examination by the end of April 2004. A copy of each completed thesis will be provided to the CRSP when it has been approved by the Moi University Graduate School.

ANTICIPATED BENEFITS

Anticipated benefits include:

- Fishing pressure on immature *Clarias* in Lake Victoria will be reduced.
- Reduction in beach seining will reduce habitat destruction on native fishes in Lake Victoria.
- Net income to fishers may increase if baitfish are more available and if costs are kept down through competition among bait producers.
- A steady supply of *Clarias* fingerlings will also help in other areas where *Clarias* is gaining popularity as a cultured food fish.

Regarding meeting demand for fingerlings, demand for *Clarias* far exceeds supply in the area near Sagana Fish Farm, where *Clarias* over 500 g are prepared and packaged as skinned fillets. The publication of enterprise budgets will provide the information needed by the government and by projects working closely with the Lake Victoria fishery such as the World Bank-funded Lake Victoria Environmental Management Project to make informed decisions as to what is needed to help develop the bait fish industry.

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