Marine Finfish Culture in the Caribbean: A Model for Development

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INTRODUCTION

In the State of Florida, between the years 1965 and 1977, the Florida Aquaculture Association estimates that US$35-50 million was ventured and lost in the fledgling mariculture business. Most of these ventures were located in south Florida, the Florida Keys, and later in central America and the Dominican Republic. Reasons for failure were:

1. Poor business plans.
2. Heavy upper level management with big expense accounts.
3. Poor site selection.
3. Regulatory constraints.
4. Inadequate technology to succeed.

By far this latter point was the overriding culprit. In retrospect, the business plans of many of these companies were formulated on little or no methodology data and certainly no proven track record. Companies were financing basic research and hoping to develop technology before foreclosure. The sum of all of these factors toward the end of the period resulted in distrust of the industry by investors and government agencies. Some of the businesses created long lasting environmental damage. Permitting of expansions, necessary to upscale operations, were denied. Mariculture in Florida plunged into the dark ages, and still today, individuals familiar with mariculture programs of the 1960's and 1970's are more than skeptical.

It is questionable whether or not coastal fish and/or crustacean mariculture will ever develop significantly in Florida, the continental U.S. state with the most suitable climate, water resources, and local markets for industry development. Today the level of mariculture technology far surpasses that of the middle 1970's both in crustacean and finfish mariculture. The lure of suitable natural resources, warm climate, long growing seasons, favourable labor and land prices, coupled with unfavorable conditions in the continental U.S. make countries of the Caribbean Basin a potential area for development. The purpose of this paper is to separate fact from fantasy technologically, and to outline the technology that is ready for commercialization, and that which is not.

NASSAU GROUPER MARICULTURE

At the cocktail party last night, I was told that in the Caribbean if you want cultured freshwater fish, you culture Tilapia in freshwater, and if you want seafood, you culture Tilapia in seawater. I happen to enjoy eating Tilapia very much. However, what I enjoy more is grouper. The Nassau grouper (*Epinephelus striatus*) is highly regarded as table fare, and like many Caribbean reef fish, stocks of Nassau grouper have been depleted by artsanal trap fisheries and/or longline fishing. There is currently no technology to culture Nassau grouper. However, a large, reputable, U.S. aquaculture company is very interested in warmwater aquaculture and is seriously considering investing in commercialization of Nassau grouper mariculture in Antigua. A comparison of the company plan and available technology reveals some sound consistencies and some serious flaws.

NET-PEN CULTURE IN ANTIGUA

Antigua is one of the Leeward Islands and is located along the northeastern edge of the Caribbean Sea. The island is generally round in shape, 108 sq. mi., and emergse from the submarine platform called the Barbuda Bank. Water depth between Antigua and the only other island of the bank, Barbuda, is generally less than 30 meters. Water depths between the bank and neighboring islands are generally greater than 300 meters.

The general plan for growout of grouper on Antigua is to locate rows of net-pens or rectangular cages in fingers of Nonsuch, Belfast, and possibly Carlisle Bays. Carlisle Bay being the most oceanic of the selected areas might offer a nice comparison to the other two bays. A slight problem, at the time of my survey of this area, was a total lack of water quality data. One must assume that water quality in an area such as the relatively shallow bays on the windward side would be suitable due to sufficient exchange rates. Modified Witham collectors with known history and biweekly sampling were used to estimate fouling rates and draw cursory assumptions about net-pen maintenance. Up to this point the overall plan sounds encouraging. A review of the literature and first hand observations that I made on a recent trip of Southeast Asia resulted in positive expectations for development of a grouper research project, with later scale-up to a pilot scale project.

NET- PEN CULTURE IN MALAYSIA

Let us now take a closer look at net-pen culture in Malaysia. There is a Grouper/Sea Bass net-pen farm located between Malaysia and Singapore in the East Johore Straits. A standard farm consists of 32 raft units about 5 m x 5 m x 5 m. A small hut and staging area is usually located at the head of the farm. Raft units are tied to each other and to a main rope. Nets and ropes are usually constructed from polyethylene, polyamide, polyester, polypropylene, or polyvinyl chloride.

Chua and Teng (1980) summarized the economics of grouper (*Epinephelus slamoides*) culture in Malaysia. After testing treatments of 15, 30, 60, 90, and 120 fish per m^3, the optimum volume was determined to be 60. Stocking size was 55 g and 15.7 cm, thus optimal stocking density is 3.35 kg/m^3. Approximately 92% of these fish are marketable (>500 g) after 8 months. Total weight of these fish is about 90 kg. Only 5 kg of fish were below market size.

Fish are either fed trash fish or pelletized ration. Ration used in Malaysia was about 40% protein. Fish reach marketable size in 6 months (700 g), survival is about 93%, mean food conversion is about 1.89, and net production was 35.7 kg/m^3. Highest production occurred when 251 cm^3 of habitat was provided for each 60 fish/m^3 of net-pen volume.

Finally, production costs were US$2.00 using the conventional method of culture and could be reduced to US$1.28 by intensification. Net income over capital costs in Malaysia is 33%. Total labor costs for the 6 month period are only US$1000. Sale price was US$2.92/kg .

Labor costs for a production period of six months would be twice as expensive, based on U.S. Department Of Commerce wage scale data which would not seriously effect the cost of production (labor is only 2.6% of total costs). Transportation and food costs would no doubt be higher. The point is, the cage culture/grouper mariculture model looks interesting from an economic viewpoint. The principle constraint to development at this time is seed stock production, and this unknown is what removes the grouper model from the commercialization list.

HATCHERY TECHNOLOGY

Grouper can be source spawned. Most islands in the Caribbean used to have large spawning aggregates of Nassau grouper, which schooled during the spawning season in the northern hemisphere (winter). If such aggregations existed it may be feasible to collect sexually mature individuals by hook and line and induce final maturation with ovulatory stimulants such as HCG, LHRH analogues, or pituitary extracts. Many of these aggregations have disappeared or are in areas difficult to find. The technique, although suitable for small research projects, is not suitable for production scale. I will present a paper on Friday that demonstrates limited feasibility of source spawning of snook. The method works because large numbers of broodstock are available and are easy to collect.

In order to operate a reliable hatchery, methods to spawn Atlantic grouper must be developed. Chen *et al.* (1978) ripened a captive broodstock in net-pens. Fish were hatchery reared, thus somewhat domesticated. Because groupers are protogynous hermaphrodites, males are usually difficult to obtain using these methods. Chen *et al.* (1978) were able to transsex females and use the sperm for fertilization of hormone induced eggs. Similarly, Roberts and Schlieder (1983) captured and maintained a broodstock of females and male gag, *Mycteroperca* *microlepis*. Males were transsexed with 17a-methyltestosterone and photothermally induced to undergo vitellogenesis; maturation and egg releases occur on-command in gag (natural spawns without fertilization). We felt this was a major breakthrough in controlled spawning of grouper. This research was put on-hold because of other priorities (work with common snook). Currently, a new research project in Belize may further demonstrate refinements in source spawning Nassau grouper using hormone induction.

FINGERLING PRODUCTION

Grouper larvae have been reared to fingerlings in Asia using two methods: the so-called American striped bass method and the Japanese method. The so-called American striped bass method is now used routinely in the U.S. for fingerling production of marine fish. Success rates for grouper fingerling production using these methods are hard to find. Success probably is not too high as stocking of net-pens with wild-caught fingerlings is very prevalent.

The predominant food found in the guts of larval marine fish are nauplii, copepodites, and adult copepods during about the first 30 days of life (Phase I fingerling). Undoubtedly, along with rotifers, other organisms are prey items for first feeding fishes. Larger first feeding larval fish such as red drum, can feed on copepod nauplii early, within the first few days. Red sea bream begin feeding with mouth size about 370 μm, and can easily feed on small rotifers at first feeding as can *Centropristis*, the black sea bass. *Mycteroperca* and species of *epinephelus*, such as Nassau Grouper, are much smaller at first feeding, and probably need a feeding schedule similar to the one for black sea bream utilizing trocophore larvae for the first days of feeding. Whether or not first feeding of grouper can be accomplished using the striped bass system of fingerling production needs to be determined experimentally. If not, a suitable scheme would be a combination of the Japanese method (prefeeding) and the striped bass method.

The above technical information on culture of grouper demonstrates some promise in grow-out, but demonstrates a lack of sufficient technical information on hatchery technology.

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