Is it worth trying?

SIGANID CULTURE

Millions of people depend directly or indirectly on fishing for their livelihood. Fish is a major source of animal protein for developing countries like the Philippines.

World production of fish now stands at 100 million tons a year of which 13 million tons come from aquaculture. About 30 million tons of the annual catch is processed as fish meal or oil for animal feed and 70 million tons consumed by humans (Study of International Fisheries Research In: Fish for the Future- A Summary Report '93).

By the year 2000, the imminent increase of population would certainly demand for more fish. This will require significant improvement in sustainable management of our fishery resources to increase production.

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Improve
tments should, however, be
done by harnessing our natural resources
without sacrificing their use by future genera-
tions. What good is development now if
there’s none to use tomorrow?

A number of aquaculture species have
been successfully tried and in fact been
regarded as a stable aquaculture industry in
various countries.

Dr. R.D. Guerrero III in *Agribusiness
Weekly* (Mar 1988) said that a candidate
species for fishfarming should be one that can
be spawned in captivity (or whose fry is abun-
dant in the wild) and can be raised economi-
cally (not expensive to feed), and can survive
well in a confined condition. Rabbitfish or
siganid - one of the most common fishes in
Philippine waters - appears to satisfy these
requirements. They are excellent food fishes
and highly esteemed by people in the Indo-
Pacific Islands.

The vast potential of the species for
culture was seen in early '60s. Since then,
there has been a lot of studies done in various
species of siganids but its commercial farming
has not yet been fully established as an
industry. What holds back the private sector to
venture into this business?

Researchers in SEAFDEC/AQD who
have done experiments on siganids believe
that there’s a need for more investigations and
refinements before it could be recommended
for commercial purposes.

This issue features the mariculture
potential of siganid, different culture systems
used, and aquaculture techniques developed
in the Philippines and other countries. It also
highlights the siganid farming on a commercial
scale.

It is hoped that this may serve as an
eye-opener to fish farmers and entrepreneurs
and make siganid farming one of the stable
aquaculture industries just like other species. If
requirements are met, then farming siganid is
really worth trying.

Notes from scientists who have done studies on siganids:

"Fish culture should first be a science, then it becomes an art. The bottom line is that culture
conditions for siganid broodstock, larvae, and juveniles must approximate conditions in nature"
-T. Bagarinao

"The prospects for siganid farming in the Philippines looks very promising, provided the
present problems affecting it could be alleviated".
-M. Pacoli

"Siganids are voracious feeders. They feed on anything. However, they prefer green foods
and are more or less vegetarian. The prospect of siganid fry cultivation is bright because of
their abundance in certain seasons of the year".
-W. Rosario

"There seems little doubt that siganids have great potential for mariculture".
-T.J. Lam

"Rabbitfish hold particular promise for small-scale operator by virtue of their natural seed
availability within Indonesian waters and ability to feed on a wide variety of low cost and
locally available animal feed lines in dried form".
-A.G.J. Tacon et al.
Status of Siganid Aquaculture

S. guttatus and S. vermiculatus - ready for adoption?

Of the species found in the Philippines, *Siganus guttatus* and *Siganus vermiculatus* are considered good candidates for aquaculture because of their faster growth rate compared to other siganid species. The former is more commonly cultured than the latter because of the availability of its fingerlings.

Siganids are cultured in either brackishwater ponds or cages. Both methods were found to be economically feasible.

**Hatchery.** Although a hatchery technique has already been developed for siganids, especially for *S. guttatus*, there are no commercial hatcheries for this species in the Philippines. At present, *S. guttatus* fingerlings for stocking in ponds or cages are bought from dealers or directly from the fishermen. The supply of fingerlings from the wild, however, is barely sufficient to meet the growing demand. The situation will become worse if *S. guttatus* culture in cages will expand and will be intensified.

**Cage culture.** Cages for siganids are usually made of bamboo. The size of cages ranges from 3-4 m x 3 to 5m x 3m. In some places, cages can be as large as 15m x 5m x 2m. The cages are kept in place by means of anchors. Floaters used are either plastic drum, styrofoam, or wooden boxes.

Siganids are stocked at a density of 30-40 fingerlings per sq m. They are fed with pollard (finely ground bran together with the scourings obtained from wheat) once a day at 3-5% body weight or a mixture of pollard, algae (mainly filamentous green algae and *Ulva* sp.) and some vegetables like boiled squash and swamp cabbage (kangkong) or algae alone. There are a number of studies on the nutritional requirements, digestive system, and food and feeding habits of siganids, conducted in the Philippines but there are no commercially available formulated diets for siganids until now.

Some cage operators stock 100 to 200 of *S. guttatus* fingerlings in grouper cages to minimize or retard the growth of algae on the nets. The siganids are then harvested together with the groupers at the end of the culture period and are an added source of income for the farmers.

**Culture period and survival rates.** In about 5-8 months, the siganids (mainly *S. guttatus*) will reach marketable size of 200-300 g if the initial stock had an average total length of about 5-6 cm. Survival rates are generally from 70 to 80%. Although siganids had been and are being cultured by the private sector, the profitability of commercially culturing them in cages remains to be demonstrated.


*Lingayen Gulf, Pangasinan has the richest source of siganid fry in the Philippines.*

*Aqua Farm News* Vol. XII (No. 5) September-October, 1994 3
What do you know about siganids?

(The following basic information about siganid were mostly taken from Biology and Culture of Siganids by MN Duray, published by SEAFDEC/AQD in 1990 and A Fundamental Study on the Seed Production of the Rabbitfish Siganus guttatus by S Hara 1987, a doctoral thesis submitted to the University of Tokyo).

Biology

Siganids or rabbitfish are identified by their deep, compressed body, snout resembling that of a rabbit, 13 pungent spines in the dorsal fin, seven spines in the anal fin, and two spines in the ventral fin. The skin is leathery but the scales are smooth, small and closely adherent; hence, the fish is often mistaken as without scales. The color is olive-green to brown depending on the species.

Identification of rabbitfish is difficult because of the few morphological differences between species. Available descriptions for species differentiation rely largely on coloration of live fish. But colors change with age and emotional state of live material, as well as in death, and with method of preservation of the fish.

Rabbitfish are subdivided into two groups based on behavioral characteristics, coloration, and habitat. One group includes species that live in pairs, are site-tenacious, brightly colored and associated strictly with coral reefs. These coral-dwelling species are fragile, sensitive to physico-chemical changes and usually show interspecific aggressive behavior (S. corallinus). The other group includes species which school at some stage in life, move over substantial distances, and are gray or drab. They are sturdy and apparently resistant to considerable variations in salinity and temperature. These schooling species are important food fishes and currently the subject of a number of mariculture studies.

Larvae of rabbitfishes are pelagic and common in waters beyond the outer reef, but do not wander as far offshore as do larvae of migratory coastal species with pelagic eggs. Juveniles and adults occupy very diverse shallow water habitats including coral reefs, sandy and rocky bottoms with or without vegetation, lagoons and river mouths, and mangrove swamps. Only S. argenteus has been seen in the open ocean.

Reproduction

There is no known external feature to distinguish the sexes of rabbitfishes except during the breeding season.

Some rabbitfish species mature in captivity when environmental conditions are favorable and food is adequate. Sexual maturity is attained in less than a year but at different sizes in various species.

Artificial propagation

Natural spawning of captive fish has been observed in various species. Tidal level is the most important factor in the spawning (S. canaliculatus) and spawns when the tide recedes. Spawning at night in the open water near the surface was reported in Ecological Studies on the Philippine Siganid fishes in Southern Negros, Philippines by Laviña & Alcala and published in 1974.

At SEAFDEC/AQD, S. guttatus spawns monthly in 6 m diameter canvas tanks with little change in water level. Natural spawning follows a lunar cycle (2-3 days after the first lunar quarter the whole year round).

Rabbitfishes have been successfully induced to spawn spontaneously by hormonal treatment although the response to hormonal injection depend on the stage of oocyte development.

Fry and fingerling culture

Juveniles resemble the adults in body shape and color, and may or may not live in the same habitat as the adults. The period during which the juvenile stage is reached varies with the species. Rate of transformation is affected by temperature, type of food given, etc. Groups of juveniles occur in certain coasts at predictable time of the year.

Rabbitfishes are generally tolerant to wide salinity changes and can survive reduced oxygen concentration. The variation in
tolerance to low oxygen is related to the differences in metabolic rate among species.

Growth of fry and fingerlings is generally slow and the average growth rate of the same species varies with the holding system. During culture, growth may be faster at some periods and slow in others with highest values at 5.0-6.5 g/week for all the species studied.

The suitable stocking rate in ponds is 50 fish/m². Growth is faster but survival is lower when rice bran is fed. Lumut (filamentous green algae) is a better food than lab-lab (a complex of blue-green algae, diatoms, bacteria, others).

**Fisheries**

Traditional rabbitfish fishery has existed in countries such as Guam and the Philippines where the market value of the fish is high. In the Philippines, rabbitfishes are among those caught in insular demersal fishing.

**Aquaculture**

Since the recognition of the potential of rabbitfish for mariculture, a great deal of studies have been done on the reproduction and/or larval rearing of the different species of siganids. However, successful results of larval rearing to the juvenile stage were obtained in only four species, i.e. *S. lineatus*, *S. vermiculatus*, *S. fuscescens* and *S. guttatus*. To establish technology for the seed production of siganids there are various biological aspects to be studied.

Wild fry of some siganid species have been traditionally farmed in ponds in the Philippines and yielded promising results. There are, however, limited information to come up with a culture system for the fish. Not all species of siganids can be cultured hence acceptability and viability of the species need to be identified before its culture.

A market survey should be done to identify factors affecting the market value and acceptance of various species in the different regions - such as palatability and abundance - in order to provide a rational basis for selection of species to be cultured.

Juvenile siganids occur in great abundance during certain seasons in the Indo-Pacific and maybe collected easily. They are not being utilized in some regions especially in Singapore-Malaysian regions. In the Philippines, they are made into food paste or “bagoong” - a wasteful practice because they can be utilized more if allowed to grow to a marketable size.

**Problem areas**

The status on the five major problem areas identified by the Siganid Mariculture Group in 1962 are the following:

**Species Survey.** Although earlier work has been on the species identification, surveys are needed to identify the factors affecting the market value and acceptability of various species.

**Juvenile-to-Adult Farming.** A number of studies on farming juveniles in different holding systems have yielded conflicting results. Since the fish in captivity accepts any kind of food, cheap and locally available feed should be tried. There is a need to study the nutritional requirements and the growth and survival of fish under different feeding regimes. Culture techniques in ponds, cages, and pens should be developed.

**Fry production.** Natural or induced spawning of *S. guttatus* have been reported. The effects of environmental factors, natural food and type and size of tanks on fry survival, and the nutritional requirement of larvae and food requirements of broodstock in relation to size need to be investigated.

Fry are available in great quantities during particular periods but methods for their capture, handling, and transport should be standardized. Fry collecting grounds should be identified and described.

**Diseases.** The limited space and high stocking densities in intensive culture systems result in mass infection or infestation of the culture fish with parasites. Control measures must be provided to avoid fish mortalities.

**Production Economics.** There is a dearth of information on the economics and sociocultural aspects of rabbitfish farming. More efforts in this field is necessary.
Siganid farming in the Philippines and other parts of the world

**Philippines**

In the Philippines, certain species of siganids are either monocultured or polycultured with milkfish. These fishes are algal feeders, hence, there is no problem if they are cultured in milkfish ponds. Siganids, however, cannot tolerate low salinities and high temperatures so ponds should be close to the seawater source. If siganids are farmed alone, the water level in the ponds is maintained over 50 to 70 cm or if they are farmed with milkfish, the ponds are deepened in certain parts for the siganids to retreat into during the hotter time of the day.

The general principles employed in siganid farming are similar to those used in milkfish farming. The layout of the ponds, type of food grown, stocking rates, and rearing periods in the various ponds are similar.

Siganid fry are often captured in the various devices used to collect milkfish fry. However, two special methods are used in the Pangasinan Region (Luzon): using green filamentous algae as lures and using a scare line. Bundles of green filamentous algae are suspended in the water from stakes in tidal rivers and estuaries where the fry are likely to occur. The fry that are lured by this food are periodically collected with a scoop net which is taken gently under the bundles of algae. The other method uses a scare line and a fine-meshed net. A scare line with several strips of white palm leaves strung on it is dragged along stretches of water likely to contain siganid fry, driving the latter into a large fine-meshed net. A fine-meshed scoop net is used for collecting the fry.

As siganid fry are very sensitive, they are not taken out of the water. If the transport period is short, they are placed in fine-meshed bamboo or cane baskets suspended in water and gently towed along the tidal river or water supply channel leading to the ponds. A small bundle of green filamentous algae is suspended in the water within the basket to serve as food and to keep the fry interested in it while they are being towed along. The passage of water through the meshwork of the basket helps to keep the fry supplied with well aerated water. The fry should be gradually acclimatized to the pond water.

Siganid fry are also transported in the earthenware pots used for transporting milkfish fry. However, only about 150 to 300 fry are generally placed in each pot. A small bundle of green filamentous algae is suspended in the water within the pot to serve as food. Care is taken to keep the pots containing siganid fry in a cool place.

If siganids are farmed alone, the stocking rates are the same as for milkfish. If farmed with milkfish, suitable adjustments are made in the number of both species to maintain optimum stocking rates for the conditions prevailing in the ponds.

The siganids attain marketable size within five to seven months. If they are farmed with milkfish, both can be harvested by draining the ponds. However, cast nets are often used to harvest the siganids separately.

Tanzania

Tanzania has vast areas of aquatic resources but there are shortages of fish for local consumption.

The inland waters give the bulk of the average annual fish production than fishing in the sea. Fish production, however, has steadily gone down because of uncontrolled fishing techniques.

Although several ponds and lakes are productive, the influx of fishermen and intensification of fishing activities resulted in the decline of fish production. Thus, to augment fish yield and meet the increasing demands of the people, mariculture of the rabbitfish was initiated in 1978.

Studies showed that the fish breeds throughout the year with peaks occurring between November and March/April. They are herbivorous, feeding mainly on blue green and calcareous algae. This fish also consumes a number of zooplankton species to supplement its plant food.

There are at least six distinct species of *Siganus* in the area: *S. canaliculatus* (=*S. oramin*), *S. sutor*, *S. luridus*, *S. corallinus*, *S. stellatus*; *S. rivulatus* and *S. argentus*. Of these species, *S. oramin* appears to be dominant.

Fry are plentiful immediately after the peak breeding season and usually found in the grassbed and weedy areas.

Seining for fry usually involves three to five workers. The fry are beach seined, sorted out by hand, and kept in plastic buckets. The bucket is then transferred to a waiting boat and the fry are stocked in the cages. In areas with good algal growth, one seine haul yields between 100 and 400 fry (when seining is done during low tides). It takes two or three days to stock one cage with 1000 fish.

Before fry are stocked, a sub-sample of 30-50 fish is taken and preserved for length and weight measurements to get the average size and weight of fish in the rearing cages. The size and weight measurements are then taken monthly to study the growth of the fish. The average weight of the specimens enables workers to determine the amount of food to be supplied to each cage (about 5% of total weight of food is supplied every day). The amount of food is increased weekly corresponding to the growth rate and checked monthly.

A wooden frame 3 x 3 cm is joined at the edges by means of brass screws (brass is preferred because of its rust resistance.) A hole (2-cm diameter) is made at each corner of a rectangular frame. A galvanized pipe of about 2 cm diameter and 183 cm long is inserted into the hole so that it is about 180 cm suspended in the water. Two plastic floats are

The cage being lowered into the water.
Two 1/2-acre (1.25 hectares) ponds were stocked with rabbitfish (*Siganus vermiculatus*) of varying sizes. The fish (average weight: 70 g) were stocked at 296 and 140 individuals per acre in ponds 1 and 2, respectively. The rabbitfish were grown together with 1600 fingerlings of milkfish and mullets (*Mugil* and *Liza* spp.) in each pond.

Both ponds were initially treated with 10 kg urea, 50 kg superphosphate and 70 kg of chicken manure. Additional amounts of 20 kg of chicken manure were added after 50 and 100 days.

Within 130 days the rabbitfish reached an average weight of 137 g in pond 1 and 190 g in pond 2.


"See? Overpopulation could stunt your growth."

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enclosed in a small cage and are fixed at the corners of the frame so that about 30 cm of the cage is above the water surface to ensure that the fish could not escape when the sea is rough. A synthetic fiber net is fixed on the cage with all the corners tied to the galvanized pipe with a rope (10 mm) threaded into the pipe from the lower end into the wooden frame where it is tied. The cage is used after the edges of the net are fastened to the wooden frame and then to the bamboo rafts.

The cages are usually set during high tide to allow enough anchor rope length. Rafts keep the cages firmly anchored close to one another and provide a stage for feeding and observing the fish.

Fish like any other living organism needs adequate food to carry out all metabolic processes. Starvation retards growth of fish while over-feeding aside from being wasteful, fouls the habitat. Food fed to the fish was calculated from the estimated weight of the fish at the time of stocking. Conditioning the fish of its "feeding time" daily minimizes wastage of food as very every fish is active at such times and consumes as much food as possible.

When fish reaches marketable size (20 cm), they are scooped out of the net into a bucket. The net is loosened and lifted at one end so the fish are concentrated at the opposite end.

Valued in Saudi Arabian markets, siganids demand a very high price because suitable areas for sea cage culture are not common. However, shallow confined lagoons with limited water exchange attract substantial seasonal schools of siganid fry.

In 1982, a series of improvised 10-m sea cages made of wooden beams were anchored in Sharm Al-Galawa, 55 km north of Jeddah. A box-shaped net with mesh size of 2.0 cm knotless nylon was hung to eight 170-l drums which were used as float.

*Siganus rivulatus* fry (3 g average) captured from local sharms (lagoons) were stocked into five cages at 20, 30, 40, 50, and 60 individuals per m². One month later another three cages were stocked with *S. rivulatus* fry (3 g average) and a week after with sea bream (*Crenibus crenibus*, 20 g average) at 10, 20, and 30 individuals per m², respectively, in the same three cages. All caged fish were fed a moistened mixture of soya meal (53%), fish meal (14%), maize (15%), and vitamin-mineral premix (3%) which was allowed to harden in plastic feed trays before suspending in the cages. Feed was given approximately 8% of cage biomass per day.

The siganid adapted well to the cages and quickly learned to feed from the trays.

During the first 2 months the larger sea bream competed vigorously with the smaller siganids for space near the feeding tray. Competition around the trays reversed in later months with the larger siganids dominating the trays.

The caged fish showed no signs of stress at high ambient temperatures. Some occasional nipping was observed in the high density monoculture cage. Feeding decreased by approximately 14% at lower temperatures.

In 150 days, the sea bream grew to 45 ± 3 g. The siganids grew to marketable size, 102 ± 6 g in the monoculture as well as polyculture cages. Result suggested that density was not limiting growth even at 60 individuals per cubic meter. Although the sea bream could not assert competitive pressure throughout the trials, it is significant that initial competition did not inhibit growth of *S. rivulatus* in the polyculture trials.

Growth of *S. rivulatus* in cages in the sharms at low stocking densities, exceeded that experienced in the Gulf of Aquaba. This in addition to siganid's good market value in Saudi Arabia, justifies the work with cage grow-out system using high stocking densities and intense management techniques to determine its economic viability for producing marketable fish.

Pond culture of siganid on a commercial scale

(The following article is based on the paper presented by M. Urmaza, Sr. at the First National Conference of Fishpond Operators in April 1983. Featured in Greenfields Magazine, Vol. 13(6) June 1983)

Two siganid species - *Siganus vermiculatus* and *Siganus teuthis corallina* - are cultured in the Philippines. These are identical except for the marks on their bodies. *S. vermiculatus* is generally light gray with very distinct spiral lines all over its body. On the other hand, *S. teuthis corallina* is also light gray, but has blue spots that are smaller than mango seeds.

Both species are oblong, with poisonous spines on their dorsal, ventral and anal fins. Their mouths are small and lined with fine teeth. They feed on water plants, especially filamentous or green grass algae and water *digman*, and disintegrated shells of dead mollusks.

Other siganid species are not cultured for food because they don’t grow big and some are raised as ornamental fishes.

These usually appear in tidal flats and near the mouth of big rivers that are not very far from gulfs. Schools of siganid fry swarm two or three days before and after the last quarter of the moon and new moon in February to early October. Sometimes, schooling is unpredictable; it may occur two days before and after the full moon.

The common breeding places of gravid siganid are near the mouths of rivers where the fry grow to about 10 mm long. As they grow bigger, they migrate to tributaries or streams with brackishwater, living under the shade of dead thorny branches of plants and other vegetation. Fish farmers buy “starter” fingerlings from fishermen who maintain fish shelters in rivers and streams.

Fry for transport over long distances are placed in double polyethylene bags filled with brackishwater and oxygen which can hold 200 10-mm fry.

Siganid fingerlings can be transferred from one pond to another by means of bamboo baskets (kaing) lined with moist green grass algae. The fish must not be kept out of water for more than 15 minutes. Don’t stock siganid in freshwater. The fish may survive in a freshwater fishpond only if gradually acclimatized. Never place fingerlings in an open container filled with brackishwater nor transfer them from one pond to another when rain is imminent.

You may also transfer fingerlings using floating bamboo or wooden baskets. After filling the baskets with fingerlings, tow these with a banca or motorboat to the stocking point.

**Nursery pond.** Fish farms usually have three ponds, and the smallest of these is the nursery pond - the seed bank of a fish farm, and should be at least five percent of the total fishpond area. Thus, if the total fishpond area is two hectares, the nursery should be 1,000 sq m.

The siganid nursery should be much deeper than the bangus nursery, and adjacent to a river so that, if necessary, the water can be readily replenished at high tide.

Before stocking, get rid of predators or competitors by drying the nursery pond, but not to the extent of cracking the pond soil.

The food recommended for siganid fry is the young, fine filamentous green algae (*Chaetomorpha* or *Cladophora linum* species). You may also use *Enteromorpha tubulosa* if it is available. Both species are found in fishponds and rivers.

Plant filamentous algae in small clumps throughout the nursery pond. Do this late in the afternoon or early in the evening when water is cool so the algae won’t float and be exposed to the sun the following day. When
the algae have grown halfway between the pond bottom and the water surface, stock the pond with fry.

To provide fish with a continuous supply of food, construct a secondary dike across the middle of the nursery pond. Also build a small check-gate to facilitate draining and flooding, and fish food production. Alternate the planting and grazing of algae in the two lots when algae in the first lot is consumed, screen it and drive the fish to the second. Then plant the grazed lot with algae.

**Stocking.** Stocking the nursery pond with fingerlings should be done early in the morning or late in the afternoon. However, during cool, cloudy periods, stocking can be done anytime of the day. Stocking rate is 20-30 fry/m², depending on the volume of food in the pond.

Put a bamboo screen or nylon net on the check-gate or water control pipe to prevent escape of fry and entry of predators and competitors when pond is changed. Siganid fry are sensitive to stagnant water and sudden changes in water temperature and salinity, so allow new water to come in every high tide. This will also improve water aeration. Always maintain water depth at highest level in the pond.

**Transition pond.** The transition pond, larger than the nursery pond, is an essential part of a fish farm. In this pond, the fish farmer hastens the growth of fingerlings so that when the fish are transferred to the rearing ponds, these will reach market size within a short time.

Ideally, this pond should be one-fourth to one-third of the size of the total fishpond area. It should be adjacent to the nursery and rearing ponds to facilitate transfer of fingerlings and sub-adult fish. Construct a secondary dike across the middle of the transition pond to facilitate rotational planting of green grass algae.

Build a check-gate at a place where obstacles can not impede water flow when the pond is drained or flooded. Always fill the pond with fresh brackishwater every high tide.

The culture of fish food in the transition pond is the same as in the nursery pond.

Gather floating algae that have turned dark brown or gray, then throw these to places in the pond where no algae are growing. When you do this, sunlight will reach the algae growing beneath the water surface, inducing these to grow faster and produce an even growth of algae. Keep the water deep, and check the pond dikes for leakage and seepage.

Stock siganid fingerlings at the rate of 6-10 /sq m, depending on the amount of fish food in the pond. You may also stock in the transition pond only the number of fish you want to raise in the rearing pond, add 5-10% of this number for mortality allowance. If the pond has thick algal growth, make pathways where fish can freely swim and graze.

Transfer sub-adult fish to the rearing pond as soon as these reach the desired size. Do this early in the morning or late in the afternoon, preferably when tide water is entering the pond. **Always handle fish with care.** The rearing pond is the final place to grow siganid and 1-1.5 m deep is very ideal for growing them. The fish farmer must give more attention to fish food production, since the number of fish he can stock largely depends on the amount of fish food in it.

**Rearing pond.** To prepare the rearing pond for the next crop, clean and completely drain it dry for one or two days. Remove all fishes usually tilapia that may disturb the growth of the algae. Plant the filamentous green algae, following the steps discussed in page 13.

When there is enough algae in the pond, it is ready for stocking. Don't wait for the algae to float. Stock the pond with fish when algal growth has gone halfway between the pond bottom and the water surface during the highest tide. When fish are stocked at this stage of algal growth, they will have ample space to swim and graze, and the floating of the algae will be delayed.

Stocking rate is 1,500 to 2,000 fingerlings per hectare, depending on the volume of fish food in the pond and the size of the fish to be stocked.

Freshen the water of the pond by letting in tidal water before carefully transferring the
10 reasons why siganids are attracting attention of mariculturists according to T.J. Lam:

1. Siganids (or at least some species) are considered excellent foodfish by many peoples in the Indo-Pacific and Eastern Mediterranean. The fish is meaty and tasty, and shows a relatively high protein content. The existing demand and market potential are high.

2. They are primarily herbivorous in nature but may turn to other diets readily. Thus, in captivity they can feed on a wide variety of foods offered.

3. During certain seasons, large numbers of siganid fry can be collected from coastal waters for cultivation in coastal ponds, enclosures, tanks or floating cages.

4. Some (if not all) species are gregarious (schooling) and thus may be able to tolerate crowded conditions.

5. They appear to be tolerant of changes in salinity and temperature.

6. They appear to adapt well to captivity and grow rapidly on a diet of natural food (algae or other plant materials) or artificial feed pellets.

7. They can tolerate any type of pond soil, provided vegetation is present.

8. Some species have already been traditionally farmed in coastal ponds either in monoculture or, as is generally the case, with milkfish.

9. Two species has been induced to spawn in captivity, both of which have even spawned spontaneously in captivity. Mature fish are available from natural source for this purpose predictably at certain times of the year.

10. One species has been raised from eggs to adults in the laboratory in Japan, although in other species larval mortality remains a major problem.

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Fish using fine scoop and suspension nets at early dawn or at night. Make sure that the fish are not overcrowded in containers, and that the pond water is not turbid or freshwater.

Never transfer fish when these are undernourished or during inclement weather. If the pond is fully filled with algae, provide a path for the fish.

An ideal siganid pond is one that directly draws brackishwater from a river. A fishpond that relies on an adjacent fishpond for water supply will fail. A fish farmer who wants to raise siganid must also bear in mind that a slight rain or even a shower can kill the fish if pond water is shallow and not replenished with brackishwater.

Harvesting the siganid. Harvest siganid 90-120 days after stocking in the rearing pond. To do this, use joined screens made of woven bamboo splits, one meter tall and six meters long, supported by bamboo poles. Place the screens at one end of the pond, and push these slowly toward the opposite end. Put shading materials - small tree branches and grasses - on the corner of the pond where the catching chamber will be erected, so you won’t disturb the fish.

Never allow your pond workers to go in front of the screens because siganids tend to hide in foot holes made in the muddy pond bottom. Water depth of not less than one-half meter is preferred during screening of pond.

As the screens get near the catching chamber, start removing tree branches and grass. By the time the last shading material is removed, the fish will be trapped in the catching chamber. The screens or a purse net, held up like a hapa net by bamboo poles, may serve as the catching chamber.

Catch the trapped fish with a scoop net and transfer them to big baskets (kaing). The fish will reach the market fresh and command a high price if you immediately transfer them to a container filled with ice water.
Growing filamentous algae as the major food source

The green algae are the most common food of bangus and siganid. They grow luxuriantly in some fishponds. There are three species of filamentous green algae: *Enteromorpha tubulosa*, *Cladophora* and *Chateomorpha*.

*E. tubulosa* is light green and resembles chicken intestines. Its fine narrow and glossy tubes can be easily mistaken for *jusi*. It has no spores or sexual gametes, and dies when directly exposed to sunlight and high temperature.

*Cladophora* and *Chaetomorpha linum* (locally known as *lumut jusi*) are almost identical. These are light golden green when very young, and show no evidence of spore or gamete formation. Maturing *Cladophora linum* is dark green, with parts of its filament becoming black and coarse textured.

At all stages of growth, they grow better under diffused light and low temperature. Their color changes at every growth stage and with their physical condition.

Aside from fishponds, these water plants grow wild in rivers and streams, the lushness of their growth depends on the water's condition and the fertility of the soil on the pond bottom. These multiply fast - eight times in 24 h under very favorable conditions and grow in patches due to frequent changing of pond water.

These algae also grow in ponds with turbid water coming from rice paddies and rivers during the rainy season. But too much turbidity and rain water can kill young algae.

Fish farmers usually buy planting materials from other farmers who are already growing the algae. The best time to plant the algae is late afternoon or at night when the water is cool. When planted at the right time, algae will settle down on the pond bottom.

Another planting method is to drain the pond entirely and plant small fragments of algae right on the muddy pond anytime of the day. Flood the pond immediately after planting. If you fail to let in water after planting, the algae will dry up and if they grow at all, their growth will be retarded.

To plant algae, set clumps as big as your palm on the pond bottom. If planted in bigger fragments, the algae will die and decay. Don't use black, floating algae as planting materials because these are dead.

Four to five days after planting, broadcast ammonium sulphate at the rate of 1-2 bags/ha, depending on the fertility of pond soil. Never apply nitrogenous fertilizer on a dry pond. Use a banca when broadcasting fertilizer so you won't disturb the plants.

To make sure that you use the right kind and amount of fertilizer, ascertain the fertility of your pond soil. Get soil samples (10-15 cm deep) in several portions of the pond bottom, air-dry and submit these to the Bureau of Soils for analysis. One-half kilogram of soil samples will do.

You may also fertilize your pond with animal manure, which is as effective as inorganic fertilizers. Apply it at the rate of 500-1,000 kg/ha before planting algae. Don't use animal manure excessively; lab-lab or microbenthic organisms will grow and overwhelm the green algae.

To conserve fertilizer for algal growth, don't drain the pond for 7-10 days after fertilizer application.

Culture systems compared: sea cages vs fishpens

(This study compares the difference in growth of *S. guttatus* a large-growing species, in two different rearing structures and the growth of some other members of the family siganidae with respect to their potential for mariculture. Abduraji Sw. Tahil discusses ways to improve the cultivation of this meaty species in the fishpen).

The experiments were conducted in a shallow water area (0.25-2.0m deep). Maximum diurnal salinity and temperature fluctuations were 4.69 ppt and 7.8°C, with maximum values of 29.92 ppt and 25°C, respectively.

Live juveniles of *S. guttatus* were caught at night and divided into two groups of 101 each. One group was reared in a sea cage with initial sizes ranging from 7.1-30.1 g (ave.:15.49 g) in weight and 6.5-10.2 cm (ave.:7.89 cm) in length. The other group, stocked in a fishpen, ranged from 7.2-30.3 g (ave.:15.47 g) and 6.5-10.1 cm (ave.:15.47 g).

The two rearing structures were identical in size-1.75 m x 1.75 m x 1.5 m. The cage was built of mangrove sticks held together by nails and nylon rope, while the fishpen consisted of netting stretched between the four corner posts. The main difference was that the sea-cage had a bottom net, fastened to the wooden frame whereas the pen used the natural sea floor as its bottom.

The fish were fed solely with benthic algae (composed of *Chaetomorpha crassa*, *Cladophora sp.*, *Gelidiella acerosa*, *Gigartina tenella*, *Gracilaria salicornia*, *Laurencia undulata*, *L. grevillea*, *L. sp.*, *Microcladia sp.*) and the main filaments of siphoneous algae.

After 24 weeks of rearing, the fish in the sea cage grew to an average of 33.56 g in weight and 10.31 cm. In the fishpen, the fish grew to an average of 34.37 g and 10.42 cm. These figures represent about 117% increase in weight of the fish in the sea cage, and 124% in the fishpen. The fish continued to grow steadily during the 168-day experimental period.

The fish in the sea cage were more affected by the wave action than those in the fishpen. The nylon netting material at the bottom of the cage prevented the fish from seeking shelter in the natural substratum.

The difference in growth increments of the fish in the sea cage and those in the fishpen were small as shown in the figure. Statistical comparisons revealed that the disparities were insignificant, with a probability of 99.9%. Although reared in different rearing structures, under similar semi-natural conditions, no significant differences were noted in their length/weight relationship.

Juveniles started to display distinct territorial behaviour with bigger individuals chasing and biting smaller ones. The caudal fin rays were bitten and at times are even gnawed off, almost down to their base. The fish bites on the body surface of smaller fish resulted to skin lesions which later became inflamed and infected.

The growth of juvenile *S. guttatus* fed entirely with benthic algae, whether in a sea-cage or fishpen, is slow. However, stocking of the fish in the fishpen is preferable, because the fish could seek shelter at the bottom of the fishpen.

Rabbitfishes accidentally ingest considerable amounts of limestone from rocks and algae while browsing on epiphytes, thus maintaining a definite pH value in their digestive tracts. This circumstance may account for the good physical conditions as well as the slightly better growth of the fish stocks kept in a fishpen compared to those in a sea-cage.

Scientists found that most siganid species need about one year to reach a weight of 150 g. Both juvenile and adult siganids, although naturally herbivorous, feed on a variety of food stuffs when reared in captivity. There were even indications that some siganid species grew better on a mixture of natural (algae and other marine plants) and artificial or supplementary feeds (e.g., commercial pellets, chopped fish, kitchen leftovers, mussels, and others). Better growth was obtained for *S. canaliculatus* fed a mixture of *Enteromorpha* and trout feed than with *Enteromorpha* alone. *S. rivulatus* was also reported to grow fast if fed on a mixture of algae and fish pellets.
S. guttatus readily feed on many kinds of food (even fish scraps) and becomes omnivorous in captivity. This was observed when the fish fed voraciously on one species of brittle star and even on the dead specimens of their own stock.

The growth of S. guttatus is slow until it reaches marketable size (150 g) whether in a sea cage or fishpen. Feeding captive juvenile S. guttatus with benthic algae does not yield very promising results with respect to growth and survival. The fish's distinct chasing and biting behavior is another obstacle for successful culture of this species. Stocking of juveniles in a fishpen with a bigger area is advantageous, because the fish will thus live over the natural substratum and would have more freedom to swim around without colliding with the netting material of the fishpen.

The preferred area for siganid farming is the sea grass community, or one where suitable species of benthic algae, seaweeds, and other marine plants can be easily collected for the fish stocks. In addition, it would be well to consider the applications of inexpensive supplementary feeds, such as kitchen left-overs, fish scraps of non-commercial species, and others. The site must be free from destructive activities such as strong turbulence due to wave action or winds, and intensive fishing activities of the villagers.

If a fishpen is used, the bottom part of the netting should be carefully mounted close enough to the ground, to prevent the escape of the fish stocks. It would be well to provide a separate structure, where injured or infected fish stocks could be treated, so as to prevent the spread of infectious diseases in the rearing system. It is advisable to use coarser nylon netting and clean frequently the netting material to prevent the thick growth of algae on the twine.

Growth increments of the fish stocks (S. guttatus) reared in a sea-cage and fishpen.

Why not try this?

Siganid culture in floating cages

(As a preliminary guide for fish farmers on the culture of siganids in sea cages the following techniques were lifted from the Manual for Culturing Siganids in Floating Cages prepared by E. Carumbana and J. Luchavez, Marine Laboratory, Silliman University, 1979).

The scarcity of siganid in the market reflects the need for wise resource management and improved fishery. The culture of siganid can augment the market demand thus fishing pressure is decreased.

Siganid culture can be done in sea cages. The size of the cage may be big or small, depending upon how much money the fish farmer can afford for this project.

Materials needed for sea construction

A sea cage measuring 4 x 3 x 3 cm can be constructed using the following materials:

- 3 bamboo poles
- 4 m nylon fish net (5 mm mesh)
- 1/4 kg nylon cord (No. 100)
- 1/4 kg nylon cord (No. 15)
- 1/4 roll nylon rope (No. 12)
- 1 bag cement
- 20 m rubber line (cut from old tires)
- Labor expenses for 5 days

The cage should be anchored firmly to the bottom with bamboo framing as its float. The opening at the center on the upper side of the cage should be kept closed, except when feeding the fish. At least two sea cages will be needed for a ten-month rearing period.

The sea cages should be placed in an area that is protected from strong wave action and where the water is at least three meters deep during the lowest tide, preferably land-locked bays, lagoons, and sheltered coves. The water should not be warm (it may vary from 28° to 32°C but should never be higher than 36°C) and salinity should be 30-34 ppt or lower. It has been found that this fish can grow faster at 5-17 ppt. To ensure healthy growth of the fish, the selected site should be free of excessive wastes of any human activity.

Fry Collection

Siganid fry may be collected from mangrove swamps or sea grass communities at night when the tide is low. A small dip net or "sikpao", constructed of soft netting material (so that the fish are not injured), may be used to scoop the fry, after which they are placed in a big, fine basket submerged in water. During transport, they should be placed in large plastic bags filled with air. Care must be taken in collecting and transporting the fry. The fish should be handled gently, for excessive disturbance may make them susceptible to disease.

Stocking the fry

The fry may be stocked directly from the collecting site into the sea cage, or they may be placed first in large holding tanks with fresh, clean sea water at room temperature for about one week. With siganid fry measuring 62 mm from the snout to the base of the tail, the initial stocking rate in one sea cage (4x3x3 m) should be 1000. After three months, half of the siganids may be transferred to another sea cage. The fish may then be kept until ten months from the original date of stocking. The bigger individuals may be harvested at periodic intervals.

Feeding

Siganids are primarily plant eaters; they feed on green filamentous algae, or "lumot", (and possibly the small animals trapped in the lumot). They also readily feed on leaves of terrestrial plants, particularly malunggay (horseradish), kangkong (water spinach), camote (sweet potato) leaves, and also boiled squash. These vegetables are good sources of vitamins and minerals which can contribute to the healthy growth of the fish inside the cage.

The siganids should be fed every day. About 4-5 kg of green algae will be enough to feed 1000 juveniles in one sea cage. After
Diseases and parasites of siganids
(From the lecture notes for Fish Hatchery Training Course by Dr. T. Bagarinao)

Captive siganids sometimes develop exopthalmia, cataracts, abnormal coloration, bloated abdomens, body lesions and fin rot that lead to mortality. *S. argenteus* juveniles developed exopthalmia in supersaturated (11%) water with 6.7 ppm oxygen at 33 °C. Cataracts can be due to Vit. B deficiency. Pathogenic bacteria are responsible for some cases of mortality among siganids. Mass mortality of cage-cultured *S. canaliculatus* occurred in northeast Singapore due to a Gram-positive bacterium similar to *Streptococcus faecium*. The fish changed body color, moved sluggishly, and later became blind. They exhibited violent movements, convulsion and seizure just before death. Another bacterium *Pseudomonas purrefaciens* also caused a disease outbreak among the *S. rivulatus* stock in the Saudi Arabian mariculture facility in the Red Sea. Chief clinical signs of the disease were discoloration, exopthalmia, hemorrhagic necrosis on the body and mouth, and frayed fins.

There are 35 reported species of parasites in *S. argenteus*, *S. luridus*, and *S. rivulatus* in the Red Sea. Of these, the myxosporean *Ceratomyxa* and *Zschokkella* produced acute desquamation of gallbladder epithelium and chronic congestion and distention of the hepatic biliary canaliculi, while the larval nematode *Hysterohylacium* caused massive necrosis and fibrosis of the liver. The acanthocephalan worm *Scherocollum* also parasitizes these three siganid species, especially during intensive grazing prior to spawning of the fish. Sporozoans also cause nodular enlargement of the liver in *S. rivulatus*.

Parasitic monogenean trematodes found in siganids have caused tissue ischemia in *S. canaliculatus* and heavy mucus secretion in gills followed by suffocation among *S. spinus*. Infestation of the gills by a microsporidian also leads to death in *S. canaliculatus*. At SEAFDEC/AQD, *S. guttatus* broodstock are sometimes infested with nematodes that cause the fish to feed poorly, as well as with the ectoparasitic copepod *Caligus epidemicus*.

Cleaning the sea cage

In order to promote growth and feeding efficiency, the sea cage must be cleaned at least three times a week. Fouling organisms growing on the cage nets may be removed by using a nylon brush or an inexpensive broom. Excess food and fecal matter may be removed by scooping them out through the cage opening. The cleaner should inspect for holes around the cage walls to prevent the fish from escaping.

Harvesting

The siganids may be harvested selectively. After 5-6 months, the big fish may be harvested, leaving the small ones to grow further. Marketable sizes of siganid range from 200 to 300 g in weight. Subsequently, selective harvesting may be done every two-months.

Economics of siganid mariculture

Studies showed that fry weighing 4.55 g grow to an average weight of 52.06 g after four months. The total fish yield will be 46.85 kg if the stocking rate in the two sea cages is 1000, assuming a mortality rate of 10%. The fishfarmer will have a minimal profit after four months but if he allows the fish to grow to a bigger size and harvest selectively, more profit may be expected after ten months. The sea cages can be used for 4-5 ten-month rearing periods, if the bamboo floats and nylon cords are replaced every two years. The fishermen can therefore realize more profits after the first rearing period.
The rapid advancement of aquaculture technology has brought a tremendous damage to our ecosystems. Aquaculture development has been very fast to the extent that the limited natural resources have been overlooked. SEAFDEC/AQD recognizing this problem will include sustainability issues in all its programs.


It also bared the prioritized aquaculture species for research at SEAFDEC/AQD and outlined research and development plans for 1995-97.

ADSEA's recommendations are summarized as follows:

A. Specific Research
1. to incorporate the principles of sustainability in all phases of research and development process;
2. to give high priority to sustainability issues in the field of feed formulation, feed preparation and feeding; use of drugs and agro-chemicals; and in developing culture techniques for indigenous species;
3. to conduct multi-disciplinary research covering socioeconomics, marketing and equity issues, e.g., community fishery resources management project of SEAFDEC/AQD;
4. to give importance to seafarming and searanching over pond, cage, and pen culture systems because of environmental concerns, with increased activities on broodstock development and hatchery work on candidate species for seafarming and searanching; and
5. to collaborate with institutions in order to assemble efficient research teams that will undertake the multi-disciplinary research approach.

B. Other Matters

Environmental Commitment Fund
1. to collaborate with institutions in the implementation of the Environmental Commitment Fund which will be established at SEAFDEC/AQD for projects whose objectives include: dissemination of information on the proper use of the aquatic environment; development and implementation of the aquatic environment; and conduct of conferences and workshops to discuss the use of, damage to, and rehabilitation of the aquatic environment.
Meetings/conferences

Second World Fisheries Congress
Developing and Sustaining World Fisheries Resources: The State of the Science and Management
28 July-2 August 1996
Brisbane, Australia

The Australian Society for Fish Biology will host the Second World Fisheries Congress in July 1996. With its theme "Developing and Sustaining World Fisheries Resources: The State of Science and Management," the conference will focus on international policy, research, and scientific issues.

The First World Fisheries Congress held in Athens, Greece in May 1992 was attended by international scientists and researchers to consider the state of the world's fisheries.

The deadline for submission of presentations for the second congress will be in October 1995.

Write to: The Secretariat
Second World Fisheries Congress
P.O. Box 1280
Milton Qld 4064
Australia
Tel. (07) 369 1512 Int. (+617) 369 0477
Fax (07) 369 1512 Int. (+617) 369 1512

Larvi '95
Fish and Shellfish Larviculture Symposium
5-8 September 1995
University of Ghent, Belgium

Larvi '95 aims to bring together researchers and professionals to evaluate recent progress, identify problem areas, and stimulate future cooperation in research and industrial production of freshwater and marine fish and shellfish larvae. The location and format in Larvi '91 have been maintained for Larvi '95.

The scientific program covers the following sessions: Broodstock, egg, and larval quality; Microbiology and disease control; Nutrition; Larviculture economics and process technology; and New species and hybrids.

Write to: The Secretariat
Laboratory of Aquaculture & Artemia Reference Center
University of Ghent
Rozier 44, b-9000
Ghent, Belgium
Tel. +32-9-2643754; Telefax: +32-9-2644193
E-mail:Internet"magda.vanhooren@rug.ac.be"

Reminder

Second International Conference
on the Culture of Penaeid Prawns and Shrimps
14-17 May 1996, Iloilo City, Philippines

SEAFDEC/AQD convenes the conference to review the status of research on penaeid culture, to identify problems and research directions, and to provide a forum for interaction between scientists and industry practitioners. The scientific sessions will cover: biology, ecology, and physiology; seed production; grow-out; nutrition and feeds; diseases and environmental issues; genetics and biotechnology; and socioeconomics, processing, marketing.

Registration fee: US$200 for international participants and US$100 for local participants. Students get a $50-discount. Fee covers conference materials, lunch, snacks, cocktails, and banquet.

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AFN is a production guide for fishfarmers and extension workers. It discusses the technology for cultured species and other recent information excerpted from various sources.

In citing information from AFN, please cite the institutional source which is not necessarily SEAFDEC/AQD. Mention of trade names in this publication is not an endorsement.


Subscription rate: P40 per year (local), US$15 per year including air mail postage (foreign). Please make remittances in check/bank draft or postal money order payable to SEAFDEC/ Aquaculture Department.

1995 Training Courses

| Coastal Aquaculture | 16 Jan-15 Mar |
| Culture of Natural Food | 07 Mar-06 Apr |
| Seaweed Culture | 20 Mar-11 Apr |
| Fish Health Mgt. | 18 Apr-29 May |
| MarineFish Hatchery | 06-Jun-25 Jul |
| Larviculture | 02 Aug-19 Sep |
| Freshwater Aquaculture | 04 Sep-13 Oct |
| Aquaculture Mgt. | 21 Aug-20 Sep |
| Fish Nutrition | 24 Oct-08 Dec |

Coastal Aquaculture and Freshwater Aquaculture are new courses.

**Coastal Aquaculture** covers small-scale technologies for coastal areas including brackishwater pond culture; their economic, social and ecological considerations.

**Freshwater Aquaculture** covers breeding, hatchery, nursery, and grow-out of tilapia, carp and catfish. Also includes feeds and feeding, disease prevention and control and ecological impact of culture.