CULTURE OF SIGANIDS IN FLOATING NET CAGES IN A *Eucheuma* FARM

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INTRODUCTION

With the increasing population of the Filipino people, one of the thrusts of the hilippine government now is to enhance and develop the fishing industry. This can e realized by improving our fishing techniques as well as the farming and processing f potential marine resources to supplement other food products. However, studies f the mariculture potentials of certain marine resources should be done prior to heir commercial cultivation to avoid waste of money, time and effort.

Siganids or rabbitfish locally known as "danggit", "samaral" or "barangan" comprise one group of fishes with mariculture potentials. They are represented by bout 25 species and are widely distributed in the Indo-West Pacific region. They are nportant food fishes and have been the subject of many mariculture studies (Wood-nd and Allen, 1972).

In the Philippines, around 15 species of *Siganus* have been recorded (Horst-nann, 1975 and Herre and Montalban, 1928). These fishes are abundant in the oastal reef areas of the archipelago where diverse vegetation abound.

Siganids are one of the favorite, highly-priced delicacies among Filipinos. The ıveniles are soaked in concentrated salt solution and sold in the market as "tinabal" r "ngisi-ngisi". The young and mature ones are salted, dried and sold in the market t prices which range from ₱ 35 to ₱ 50 per kilo. Fresh siganids are also sold in the ıarket at ₱ 30 to ₱ 40 per kilo.

Siganids are known to be voracious herbivorous feeders and could significantly :duce the production of seaweed farms where they are found in profusion. Thus, at ertain seasons of the year, they are considered pests in these farms since they can eplete the number of *Eucheuma*. However, considering the mariculture potentials nd the great demand in the market for siganids, the culture technology for these sh may be developed.

In such Eucheuma farms, where farmers usually remove other seaweeds, these ish are utilized for food, and therefore, may be cultured in floating cages within ıe farm. Seaweeds which compete with *Eucheuma* may be used as food sources of ıese fish. If the culture technology for siganids will be developed, it would mean dditional income to seaweed farmers. Consequently, fish production in our country ill be increased.

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The objective of this study is to determine and investigate a) the species composition of siganids in a *Eucheuma* farm and neighboring areas; b) the availability and seasonal abundance of siganid fry in different areas; c) the gut content of the species of fry which are abundant and could best be the subject of culture studies; and d) the growth rate, feeding, stocking density and gonad maturity of siganid species cultured in the floating cages in the *Eucheuma* farm.

Formal discussion on siganid mariculture potentials started in Hawaii in 1972 (Lam, 1974; Westernhagen and Rosenthal, 1975). Several studies on the culture of siganids have been conducted all over the world since then. The results were quite suggestive for the culture of these fish. Siganids can be used for fish farming (Ablan and Rosario, 1961; Ben-Tuvia et al., 1975). Ben-Tuvia and Kissil reported on the use of *Siganus vermiculatus* and *Siganus oramin* for commercial cultivation (Soh and Lam, 1973). Pillai reported that *Siganus vermiculatus* has successfully been cultured in coastal ponds. However, no commercial farming of siganids has yet been established in Southeast Asian countries particularly in the Philippines.

Most of siganid culture experiments have been conducted under controlled laboratory conditions. Westernhagen and Rosenthal (1975) studied the growth of *Siganus spinus* in a closed seawater system. Ben-Tuvia et al. (1974) studied *Siganus rivulatus* in a shallow table aquarium. May, et al. (1974) also used outdoor tanks for their culture experiments in *Siganus oramin*. Lavina (1974) studied the gonadal cycle of rabbitfishes in the laboratory. Popper, et al. (1976) conducted an investigation on the spawning of *Siganus vermicularis* in fishponds.

MATERIALS AND METHODS

Description of the Study Area

The culture of siganids and field studies were conducted in a Eucheuma ("guso") farm situated in Denahon Reef, Bohol (14° 17.4' N and 124° 31,25' E) (Fig. 1). This farm, which covers an area of 30 hectares, was leased by Genu Products, Inc., the co-sponsoring agency for this study. Only about 50% of the area, though, is utilized for the culture of the seaweeds which are dried and transported to Cebu City and are in turn sent to the mother company in Denmark for processing. The Genu farm is one of the big farms that are operated in the area along with smaller privately-owned farms which line the reef. The Genu farmhouse can be reached after approximately an 8-hour ride from Mactan Island, Cebu.

Siganid species are usually abundant in this farm and the nearby farm sites. At certain times of the year, the population of these fishes grows quite high so that it may threaten the production of the *Eucheuma* farms.

This study was conducted for a duration of one year from May 1983 to April 1984.

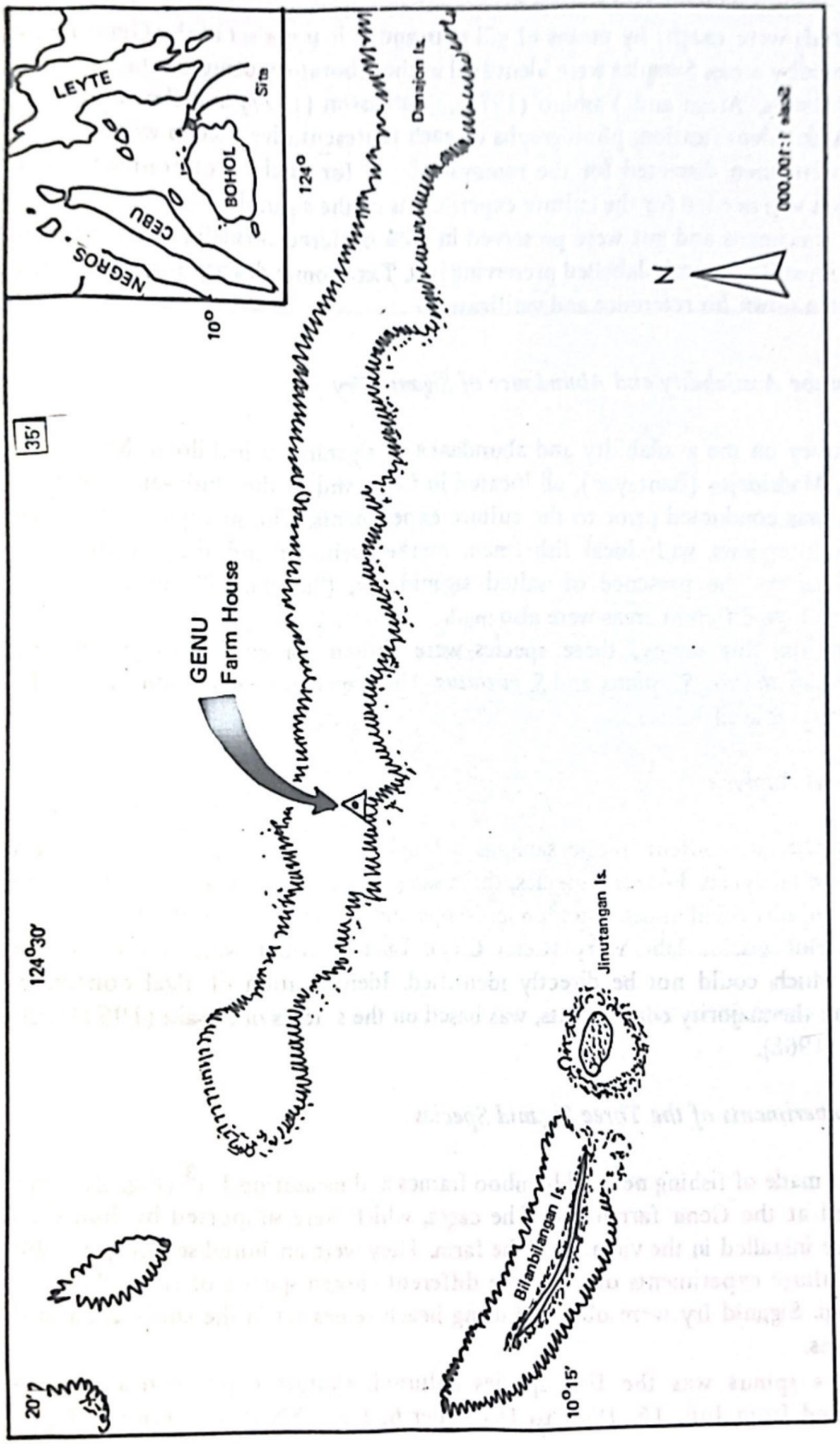

Fig. 1. Map showing the location of the study area in Danajon Reef, Bohol and its relative location in Central Visayas, Philip pines.

Survey on the Species Composition of Siganids in the Study Area and Vicinities

Siganids were caught by means of gill nets and fish traps set at the Genu farm site and nearby areas. Samples were identified in the laboratory using the taxonomic keys of Masuda, Araga and Yashino (1975), Carcasson (1977) and Rau and Rau (1980). After identification, photographs of each representative species were taken. Samples were then dissected for the removal of gut for analysis of content. This information was needed for the culture experiments of the siganids.

The specimens and gut were preserved in 10% buffered formalin solution and placed in separate properly-labelled preserving jars. Taxonomic description and notes were written down for reference and verification.

Survey on the Availability and Abundance of Siganid Fry

A survey on the availability and abundance of siganid fry in Liloan, Maribago (Mactan), Madridejos (Bantayan), all located in Cebu and in the study area and its vicinities, was conducted prior to the culture experiments. The survey results were based on interviews with local fishermen, market vendors and fishpen owners. Observations on the presence of salted siganid fry, ("ngisi-ngisi") in the local markets of these different areas were also made.

Based on this survey, three species were chosen for culture experiments: *Siganus canaliculatus, S. spinus* and *S. guttatus.* These species were chosen primarily because of their availability.

Gut Content Analysis

Only the gut content of the samples belonging to each of the three chosen species were analyzed. For each species, three samples were used. Gut contents were observed and identified under a stereomicroscope and a microscope in the University of San Carlos marine laboratory (Cebu City). Line drawings were made of the contents which could not be directly identified. Identification of algal contents, which were the majority constituents, was based on the studies of Arsaki (1964) and Chapman (1968).

Culture Experiments of the Three Siganid Species

Cages made of fishing net and bamboo frames and measuring $1m^3$ (Fig. 2) were constructed at the Genu farmhouse. The cages, which were supported by bamboo floats, were installed in the vicinity of the farm. They were anchored securely to the bottom. Culture experiments of the three different chosen species of siganids were then started. Siganid fry were obtained using beach seines set in the study area and nearby farms.

Siganus spinus was the first species cultured. Culture experiments of this species lasted from July 15, 1983 to December 6, 1983. Six cages were used and

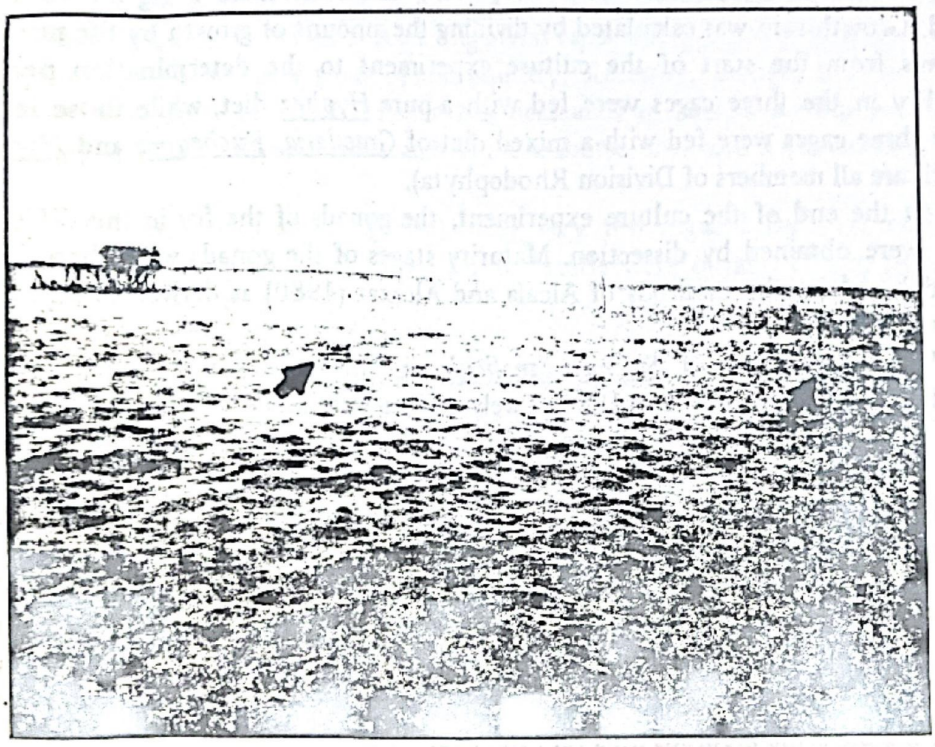

Fig. 2. **Floating net cages anchored in the vicinity of the Genu farm house.**

stocking density was 100 fry per cage. The initial average weights and lengths of the fry were determined before placing them in each of the cages. Monthly measurement of growth rates were made. For such determination, ten siganid fry were obtained at random by means of a dip net. The fry from each cage were placed in a basin of water and constantly aerated prior to the weighing. The weight of a small container with seawater was determined initially by using a sensitive balance. Fish fry to be weighed was blotted quickly on a piece of absorbent paper and placed in the container with seawater. The weight of each fry was then obtained from the difference of the container plus water plus fish and the weight of the container plus water only.

After weighing, the sizes of the fry were also determined using a measuring board. Growth rate was calculated by dividing the amount of growth by the number of days from the start of the culture experiment to the determination period.

Fry in the three cages were fed with a pure *Hyphea* diet, while those in the other three cages were fed with a mixed diet of *Gracilaria*, *Eucheuma* and *Hypnea* (which are all members of Division Rhodophyta).

At the end of the culture experiment, the gonads of the fry in the different cages were obtained by dissection. Maturity stages of the gonads were then determined based on the methods of Alcala and Alcazar (1980) as derived from Macer (1974).

With the season of *Siganus canaliculatus*, this species was cultured from October 7, 1983 to April 9, 1984. Twelve cages were stocked with fry; six cages were stocked with 100 fry each and the other six cages were stocked with 50 fry each. The fry in all of the twelve cages were fed with mixed algal diet, due to the scarcity of *Hypnea*. At the end of the culture period, growth rates and gonad maturity were determined using the same procedures used for *Siganus spinus*.

Culture experiments of *Siganus guttatus* took place from December 15, 1983 to April 9, 1984. Due to the small number of fry collected, only one cage was used for this species, with a stocking density of 50 per cage. The fry were also fed with the mixed algal diet. Growth rates and gonad maturity stages were also determined following the same methods used for *Siganus spinus*.

RESULTS AND DISCUSSION

Species Composition

From the fish catch in Genu farm and nearby areas, a total of ten species of rabbitfish was collected and identified, namely: *Siganus canaliculatus*, *S. spinus*, *S. punctattissimus*, *S. guttatus*, *S. corallinus*, *S. virgatus*, *S. puellos*, *S. lineatus*, *S. autor* and *Lo vulpinus*. These species all belong to the Family Siganidae.

Seasonal Abundance of Siganid Fry

The survey of the availability and abundance of siganid fry revealed that these fish are seasonally abundant. Only three species (*Siganus spinus, S. canaliculatus* and *S. guttatus)* of fry were observed to be abundant during certain months within the vicinity of the study area. *Siganus spinus* occurred in great numbers from April to June. In the study area, species were caught by fishermen and coastal residents using beach seines. Some fry even got inside fish pens and fish corrals.

It was also during the months of April to June when the salted siganid fry, locally known as "ngisi-ngisi" and dried species of these fish were abundantly sold in the market of noted fishing towns, especially those in Cebu and Bohol. Bantayan Island, situated north of Cebu, is also noted for its relatively large volume of fish catch which includes siganid species. Siganids, especially *Siganus spinus,* are salted, dried and sold in various parts of the country. Recently, though, the number of catches of siganids and other fishes has decreased in this area, thus people are resorting to new marine ventures such as the seahorse, shell and sea cucumber industries.

In Maribago and Liloan (Cebu), only very few Siganid fry were observed. Consequently, most of the fry used for the study were obtained from the Genu farmhouse and its vicinities.

Siganus canaliculatus was abundant in the Danahon reef and nearby areas between the months of September and October, while fry of the *Siganus guttatus* were observed to be abundant during the months of November and December.

All the three species seemed to exhibit lunar periodicity. Their numbers were relatively high two to three days before and after a new moon and full moon. Johannes (1978) and Alcala and Alcazar (1980) have made a study of the lunar periodicity of the *Siganus canaliculatus.*

Based on the results of the survey and convenience in transporting the fry to the study area, the three species of siganid fry were obtained from the vicinities of the Genu farmhouse.

Gut Content Analysis

Analyses of gut content of samples of the three siganid species chosen for the culture experiments revealed that their diet consisted mainly of a mixture of algae (Table 1). Most of these algae were *Dictyota, Hypnea, Gracilaria* and *Eucheuma.* These genera were also observed to be found in the *Eucheuma* farm. Except for *Eucheuma* which is cultured in the farm, these species exhibited seasonal abundance.

Results of this aspect thus revealed the herbivorous diets of siganids. Tahil (1978) stated while feeding on benthic algae, the juveniles of *Siganus guttatus* were also observed to feed on eel grasses. However, he further observed that there were some indications that the species do not live exclusively on plants. The juveniles were seen feeding voraciously on the brittlestar, *Ophiothrix* sp., which accidentally got into their culture cages. Ben-Yami (1974) also observed juvenile rabbitfish feeding on the algae growing on the nylon netting of the sea cages in which the rabbitfish were reared.

Table 1. Gut content analyses of *Siganus canaliculatus*, *Siganus guttatus* and *Siganus spinus* caught from the wild.

GUT CONTENT	*Siganus canalicalatus*	*Siganus guttatus*	*Siganus spinus*
Hypnea sp.	+++	+	++
Eucheuma sp.	+++	++	+++
Gracilaria sp.	+++	+	++
Caulerna sp	+	–	+
Dictyota sp.	++	+	+++
Sargassum sp.	+	+	+
filamentous bluegreen algae	+	–	++
phytoplankton	+	++	+
foramineferans	+	–	+
copepods	+	+	+
nematodes	+	++	++

Legend:

+++ most abundant
++ abundant
+ occur occasionally

Growth Rates and Gonad Maturity of Cultured Siganid Species

Table 2 shows the average daily increases in size and weight of *Siganus spinus* fed with pure diet and mixed diet, respectively. Although results revealed a higher average increase in size and weight of samples fed with the mixed diet than those fed with the pure diet, the difference is insignificant, based on the computation of the Analysis of Variances (at .05 level of significance).

The effects of two stocking densities (100 fry/cage and 50 fry/cage) on the average increases in weight and size of *Siganus canaliculatus* are shown in Table 3. Although the data revealed that siganids in the cages stocked with 100 fry/cage had faster growth rates, Analysis of Variance showed that such a difference is insignificant (at .05 level of significance). Thus the stocking densities had no significant effects on the average daily increase in weight and size of *Siganus canaliculatus.*

Table 4 summarizes the average daily increases in size and weight of the different species of siganid fry used in the experiments. *Siganus canaliculatus* exhibited the highest average daily increase both in terms of weight and size, while *Siganus spinus* showed the least average daily increase.

Table 2. Weight and size increases of *Siganus spinus* fed with a pure diet and mixed diet.

FEEDING	NUMBER OF DAYS	WEIGHT INCREASE (g)	SIZE INCREASE (mm)	Average Daily Increase WEIGHT (g/day)	Average Daily Increase SIZE (mm/day)
Pure Diet*	145	5.30	37.7	0.037	0.260
Mixed Diet**	145	6.07	40.6	0.042	0.280

*Hypnea diet
** Gracilaria, Eucheuma and Hypnea diet

Table 3. Effects of stocking density on the average daily increase in weight and size of *Siganus canaliculatus.*

STOCKING	WEIGHT INCREASE (g)	SIZE INCREASE (mm)	AVERAGE DAILY INCREASE WEIGHT (g/day)	AVERAGE DAILY INCREASE SIZE (mm/day)
50 fry/cage	16.07	81.81	0.087	0.445
100 fry/cage	16.87	87.51	0.092	0.475

Table 4. Growth rates of *Siganus spinus, Siganus canaliculatus,* and *Siganus guttatus* fry cultured in floating cages in Genu Farm, Danahon, Bohol.

SPECIES	NUMBER OF DAYS	WEIGHT INCREASE (g)	SIZE INCREASE (mm)	AVERAGE DAILY INCREASE WEIGHT (g/day)	AVERAGE DAILY INCREASE SIZE (mm/day)
S. spinus	145	6.07	40.63	0.042	0.280
S. canaliculatus	184	16.47	84.66	0.090	0.460
S. guttatus	115	7.72	43.10	0.067	0.375

Table 5. Average final weights and sizes of the three cultured siganid species at the end of their respective culture periods.

SPECIES	AVERAGE WEIGHT (g)		AVERAGE SIZE (mm)	
	Final	Initial	Final	Initial
S. spinus	0.20	5.88	31.8	70.80
S. canaliculatus	0.30	16.76	28.5	104.79
S. guttatus	0.75	8.47	35.4	78.50

Westernhagen and Rosenthal (1975) revealed that *Siganus guttatus* appears to be slower in growth than the *S. canaliculatus* (Tahil, 1978). Horstman (1975) also stated the relatively higher growth rates of *S. canaliculatus*.

Gonad analyses of the different samples of the fry of the three species showed that all of them were still immature. Gonads were even difficult to identify because most of them were thread-like. According to Alcala and Alcazar (1980), *S. canaliculatus* appeared mature at a standard length ranging from 111-115 mm for females and from 100-105 mm for males. Manacop (1937) and Westernhagen (1975) reported that sexually mature *S. canaliculatus* caught in the wild measured 110-150 mm (males) and 130-210 mm (females). Table 5 shows that none of the species used in the culture experiments reached these size ranges. Although *S. canaliculatus* reached an average final size of 104.79 mm and its maximum average weight was only 16.76 g. Westernhagen and Rosenthal (1975) maintained that females measuring 135 mm standard length and weighing 50 g. have reached maturity.

CONCLUSIONS AND RECOMMENDATIONS

Results of this experiment revealed one of the drawbacks in the culture of siganid fry, that is, they usually exhibit slow growth rates. However, taking into consideration that these fish, at some months of the year, may become pests in a *Eucheuma* farm, they might as well be cultured in cages rather than left to feed on the cultured seaweeds. Seaweeds which compete with the cultured species may be tapped for food sources to minimize cost. Thus, siganid culture may just be considered secondary to the culture of *Eucheuma* in the seaweed farm. It may be done primarily to lessen the infestation of the rabbitfish and secondarily, to augment the income and food materials of the seaweed farmers.

Culturing siganids starting from the fry stage may not yet be very feasible since its growth rate is very slow. Several studies have still to be conducted to assess the rewards of siganid mariculture. Such studies may include:

a) different culture techniques for siganids;
b) initial sizes and stages of siganids to be used for culture to maximize growth rate and lessen operational expenses;

c) feeding preferences of siganids and their effects on growth rate;
d) ages at which siganids attain the peak increases in sizes and weights or the peak growth rate.

Information on the feasibility of siganid culture would be very useful, considering the demand of these fishes in the market. Seaweed farms may be prioritized as areas for culture of these fishes. This study thus serves as a basis for future researches on siganid culture in seaweed farms.

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