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Juvenile-Adult Rearing of Siganus (Pisces: Siganidae) in Guam[1]

by

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Introduction

For the past two years, we have been investigating the feasibility of rearing Siganus in Guam waters. The technique of collecting, holding, and rearing these fishes from juveniles to marketable adults is similar to those currently used for the Japanese yellow-tail (Seriola quinqueradiata) in Japan. The information presented here summarizes the results obtained on the biology of this fish and the problems encountered as related to the goal of juvenile to adult rearing.

Species Survey

Only five species of Siganus (Kami et al., 1968) are present in Guam's waters. The five species are S. argenteus (Quoy and Gaimard), S. canaliculatus (Park), S. doliatus (Valenciennes), S. punctatus (Bloch and Schneider) and S. spinus (Linnaeus). Only two of these species, S. argenteus and S. spinus, are common on the reefs of Guam. Sub-adults and adults of S. argenteus are commonly seen beyond the reef margin in deeper water; S. spinus inhabit the reef flats and channels. The other three species are rare in Guam.

The interest in this fish for juvenile to adult rearing is the observed phenomenon that schools of juvenile Siganus argenteus and S. spinus swarm onto the reef flats around Guam each year during the months of April and May, and occasionally during June and October. Even the time of schooling is predictable and occurs plus or minus two days of the third quarter moon during these months. Each run lasts for about one week. Although the predictability of the occurrence of these juveniles is accurate, the quantity of juveniles swarming the reef flats varies each year to an extent that only a negligible amount was observed in 1973. Figure 1 shows the amount of juveniles estimated each year for a ten-year period. The data was taken by the Division of Fish and Wildlife through Creel Census.

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To compound our problems in collecting the juveniles for rearing purposes, we found ourselves competing with the local residents in acquiring enough of the juveniles for our rearing experiments. The juveniles or "manahac" are prized by the Guamanians as a delicacy. The majority of the fishermen would not even consider selling the fish and, if they did, at a price of $10 for a 1.5 quart can.

Thus, it seemed more imperative that the production of fry under laboratory condition must be perfected before this maricultural venture is feasible. Recently larval spawing and rearing have been carried out successfully in Palau (May, Popper and McVey, In Press). If mass production of larvae can be perfected, there is a possibility of a market on Guam for juvenile Siganus.

Food Habits

Since Siganus are known herbivores, the obvious initial step in rearing the fish was to gather information on their food habits. Observations of juvenile Siganus spinus and S. argenteus in the field in 1972 revealed that these fish will feed on any algae which they could physical bite and ingest. This was confirmed by a more detailed stomach analyses (N=70) of adult S. spinus (Bryan, 1974) which showed that algal availability, and size and behavior characteristics of the fish determine what kinds of algae were ingested in the field. Westernhagen (1973) also obtained similar results in his report on the natural food of S. striolata (=S. spinus) in the Philippines. Stomach content analyses on 105 specimens of S. canaliculatus, another species which schools in Palau, reveal a different diet. The stomachs of this fish contained predominantly seagrass - Enhalus acoroides and Halophila ovalis. This was not too surprising since all of these specimens were caught in the seagrass beds.

The fact that these fishes are opportunist in their food habits prompted us to investigate which algae they preferred. Approximately 250 juveniles, consisting of an equally mixed population of S. argenteus and S. spinus, were held in a 1000-liter circular plastic tank with running seawater. Forty-five of the common plant genera inhabiting the reefs during the months of schooling were collected and fed individually to the juveniles each morning (0900 to 1000) and evening (1600 to 1700). The amount of plant material used in each trial varied slightly in quantity depending on the consistency of the thallus, but was enough to be consumed by the fishes in less than a minute. Only 10 of the 45 plant genera were always consumed by the juveniles of both species. When the species were separated into two holding tanks, the only difference observed between the food preference of the two species was the avoidance of the green siphonaceous alga Chlorodesmis fastigiata by S. spinus. On the other hand, S. argenteus devoured the alga as soon as it was introduced into the tank. The second difference was the rejection of a matted form of Polysiphonia, a red alga, by S. argenteus; S. spinus actively ingested this alga. The most preferred food of the juveniles (Tsuda and Bryan, 1973) and for adult S. spinus was Entermorpha, a green alga which grows luxuriantly in the intertidal zone on certain beaches of Guam.

Growth Rates

Since we were not able to obtain any juveniles in 1973 on Guam, the growth rate studies focused on S. canaliculatus which was kindly sent to us by Dr. McVey of the Micronesian Mariculture Demonstration Center in Palau. Growth rate measurements (fork length and weight) were taken every two weeks for 42 weeks on two groups of fish (initially, 50 fish per 1000 liter tank). One group of fish was fed only Enteromorpha; the second group was fed Enteromorpha supplemented

by a handful of trout chow (40% protein). The purpose of this experiment was to compare the growth of the fish on only an algal diet, which is more or less their natural diet in the wild, and a diet supplemented with a high protein source. The latter diet should provide some indication of their maximum growth under our holding conditions. After 42 weeks, the group fed Enteromorpha and trout chow increased in weight from 0.5 g to 65 g. This was nearly double the weight of those fishes whose diet consisted only of Enteromorpha.

Preliminary growth studies on S. spinus and S. argenteus, which were placed in the same circular 7000 liter pool and fed on both Enteromorpha and trout chow, indicate that S. argenteus grows much faster than S. spinus. Over a 21 week period, S. argenteus increased in weight from 3 g to 88 g; S. spinus increased in weight from 1.5 g to 14.6 g. Crowding was definitely not a factor since only 30 fishes were present in this tank.

Weight-length data of S. canaliculatus held in tanks show a good log-log relationship.

$$W = 0.0163\ L^{2.96}$$

W = grams L = fork length (cm)

A diet based on a mixture of Enteromorpha, green alga, and Leucaena ~~Leucaena~~ leucocephala, high protein legume - 35% protein in leaves as denoted by Oakes (1968), in pellet form is presently being tested in a comparative growth experiment with duplicate populations (50 fishes each) of S. argenteus and S. spinus fed Enteromorpha and trout chow. Preliminary results after eight weeks indicate there is an adverse effect on the fishes fed on the legume.

	S. spinus		S. argenteus	
	Enteromorpha + Trout Chow	Enteromorpha + Leucaena	Enteromorpha + Trout Chow	Enteromorpha + Leucaena
Initial Measurements	63.8 mm / 4.1 g	45.8 mm / 1.55 g	8.56 mm / 5.02 g	6.76 mm / 4.97 g
Eight week Measurements	94.7 mm / 12.08 g	56.37 mm / 2.9 g	103.9 mm / 17.45 g	71.7 mm / 5.19 g

S. argenteus and S. spinus fed Enteromorpha and Leucaena grew 1/3 and 1/4 respectively slower than the S. argenteus and S. spinus fed Enteromorpha and trout chow. Mortality rate was high.

Discussion

Our studies have thus far shown that of the two species which show a schooling behavior on Guam, S. argenteus seems to have the faster growth rate than S. spinus. Although these fishes are basically herbivores and feed strictly

on marine plants in the natural environment, an additional protein source must be included in their diet to promote a higher growth rate. Since trout chow is simply not economically feasible at 30 cents a pound as a high protein food supplement, other sources of local food must be tested. Until this is found, the mariculture of Siganus will not be economically feasible.

Literature Cited

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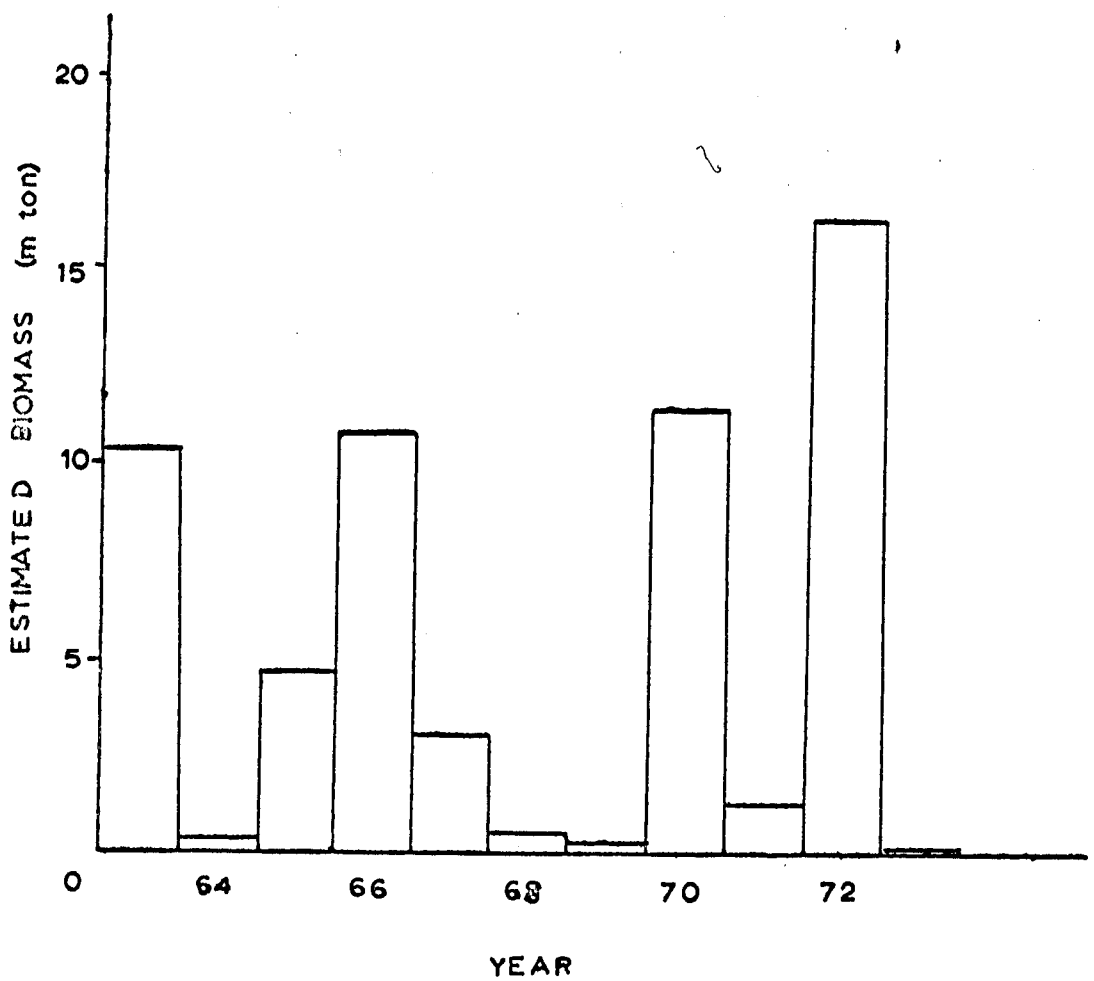

Figure 1. Yearly Biomass (m-tons) estimated from Creel Census taken by personnel of the Guam Division of Fish and Wildlife.

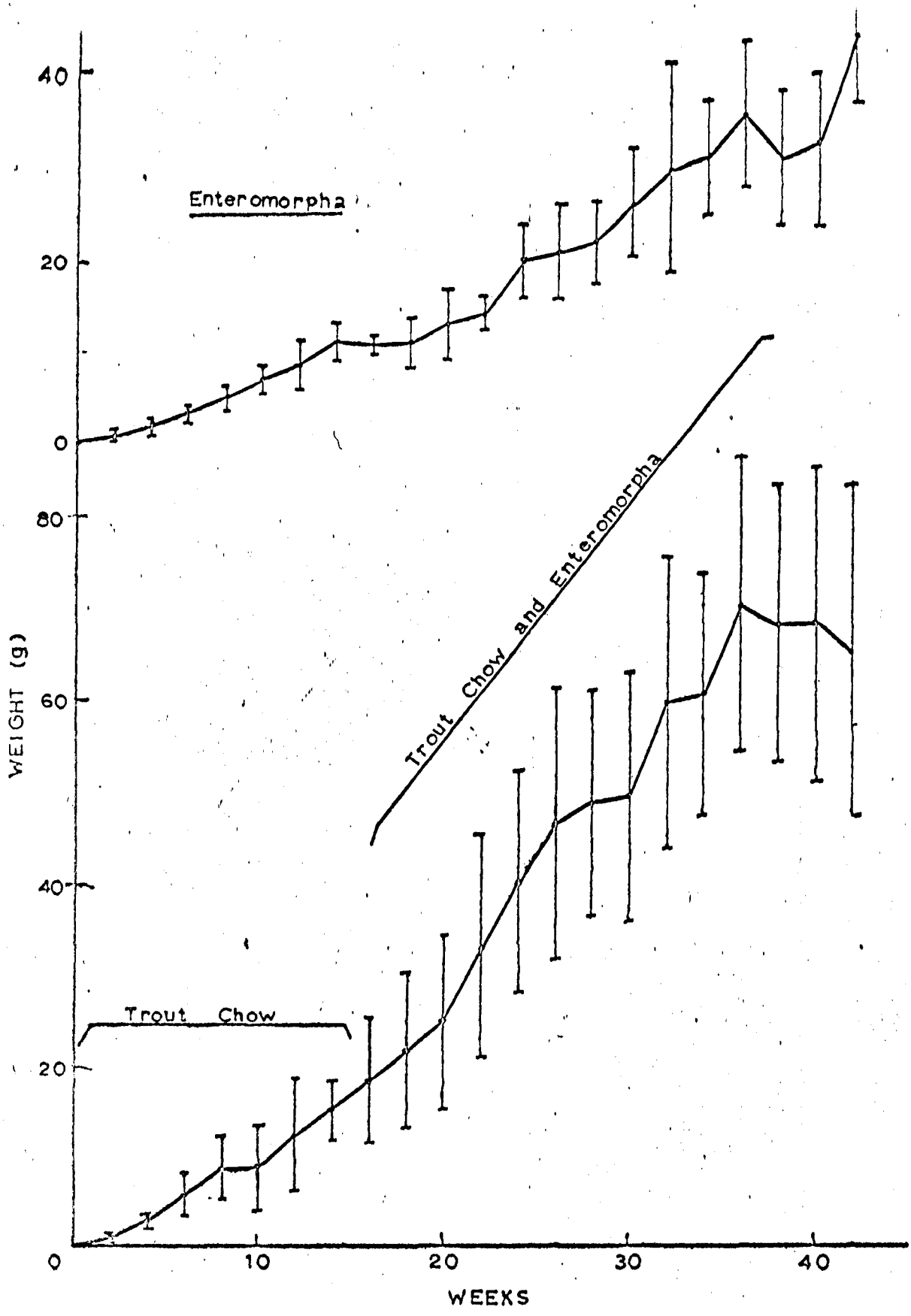

Figure 2. Growth rate of Siganus canaliculatus fed different diets. Each point represents mean of 10 fish; vertical line represents + or - 1 S.D.