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Mariculture potential of siganids: the choice of species

by

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Introduction

Although the possible suitability of siganids for tropical aquaculture has already been mentioned by Ablan and Rosario (1961) it was only recently that this widely distributed tropical fish group has attracted the attention of several aquaculturists throughout the world. An integration of efforts on the investigation into the aquaculture potential of siganids was first called for by a working group on the occasion of the Siganid Mariculture Implementation Conference at the Hawaii Institute of Marine Biology in 1972 (Anonymous, 1972). Since this time several reports on the food requirements of Siganidae (Ben-Tuvia et al., 1973; Tsuda and Bryan, 1973; Westernhagen, 1973a, b, 1974) and controlled artificial fertilization (Fujita and Ueno, 1954; Popper et al., 1973; Soh and Lam, 1973; Westernhagen and Rosenthal, 1975) appeared in the literature, and larvae to juvenile rearing on natural diet was first reported by May et al. (1974) for Siganus canaliculatus.

From these and other reports it appears that the species which stimulated the most interest and yielded the most promising results for successful rearing and breeding in the past was Siganus oramin (Schneider) frequently also called S. canaliculatus (Park). The present study tries to evaluate the possible importance of members of the family Siganidae for aquaculture purposes.

Material and methods

This study is partially based on data obtained from siganids reared from juveniles to adults in a closed sea water system for 320 days and fed artificial diet. Live juveniles were shipped from Manila (The Philippines) to Hamburg in autumn 1974 (details available in Westernhagen and Rosenthal, 1975). The other specimens used were collected in June 1975 on Cebu Island, The Philippines, and, preserved in a 4% sea water- formaldehyde mixture, airshipped to Hamburg, Germany, where they were immediately weighed and measured.

Since there is no consistency and agreement as to the nomenclature of siganids, in this report we shall use the names employed by Herre and Montalban (1928) in their work on the Philippine siganids. In order to facilitate species identification for the reader the names of the species that are being dealt with as well as some explanatory remarks are given below.

Names of species

Siganus oramin (Bloch and Schneider). This species is frequently called S. canaliculatus (Park) (Fowler, 1928; Marshall, 1964; Lam, 1974, Tsuda et al., 1974, May et al., 1974). In The Philippines it is the most abundant rabbitfish species where it grows up to 220 mm in length. It is olive green in colour with characteristic small white spots on the sides. A common fish also on the Ceylonese (Munro, 1955) and Indian coast (Day, 1958) where it grows to around 250 mm, as well as in the tropical Indo Pacific (Smith, 1965; Herre and Montalban, 1928).

Siganus concatenata (Cuvier and Valenciennes). This species is also called S. guttatus (Bloch) (Munro, 1958; Lam, 1974). This handsome fish is very common in the Philippines. It is reported to grow more than 500 mm in length. Cuvier and Valenciennes (1835) described it as occurring in the Moluccas and Java, and Fowler (1928) and Day (1958) found it in the Malay Archipelago, the Andaman Islands and the East Indies.

Siganus striolata (Günther). This species is usually called S. spinus (Linne), and is very common in The Philippines. It has been described by Fowler (1928), Munro (1955), Marshall (1964), and Tsuda et al. (1974) as a rather small (max. 220 mm) but common species in India, Ceylon, the East Indies, and east Australia.

Siganus virgata (Cuvier and Valenciennes). This unmistakeable species is fairly common in The Philippines but appears to be confined to the southeast Asian region. Cuvier and Valenciennes (1835) reported it from Java; Day (1958) from South India and Munro found it in west New Guinea. It does not grow very large; Herre and Montalban (1928) reported only 190 mm.

Siganus hexagonata (Bleeker). This species is also called S. chrysospilos (Bleeker) by Munro (1958). It belongs to the larger ones of the rabbitfish family and attains a length of over 300 mm (Herre and Montalban, 1928).

Siganus fuscescens (Houttuyn). This species is obviously identical to S. rivulatus (Forskal) when comparing the description of both forms. This has already been suspected by Cuvier and Valenciennes (1835) when under the description of Amphacanthus fuscescens they wrote: "...rapporté du Japon un amphacanthe encore très semblable par les formes et les proportions á ce siganus d'Egypte" which was S. rivulatus. The same deductions have been made by Ben-Tuvia (1964). The species is common on the east coast of Australia (Marshall, 1964), and Fowler (1928) reported it separated as rivulatus and fuscescens from the East Indies, Japan and Australia. According to Smith (1965) it is distributed throughout the tropical Indo-Pacific. Recently it has invaded the Mediterranean through the Suez Canal as reported by Ben-Tuvia (1964, 1966). It is said to be a fairly large species attaining a maximum length of about 350 mm and even 400 mm (Ben-Tuvia et al., 1973) then weighing close to 500 g.

Results

On the basis of their body proportions the 6 species can be devided into two groups. Group 1 comprising the more slender species with S. oramin, S. striolata and S. fuscescens, and Group 2 contains S. concatenata, S. hexagonata and S. virgata, species that generally exhibit deeper bodies than members of Group 1.

S. striolata appears to be the smallest species dealt with in this study (Fig. 1). The maximum size of the specimens examined was only around 16 cm total length corresponding to about 70 g wet weight. The bulk of the fishes sampled was much smaller; about 80 % of the fish measured 8 to 14 cm and weighed 10 to 45 g, respectively. Out of 251 fishes measured only 8 were heavier than 50 g. S. oramin (Fig. 2b), S. virgata (Fig. 1) and S. fuscescens

(Fig. 3) were of moderate size with maximum total lengths between 200 mm to 240 mm and corresponding weights of 160 to 230 g. Again the majority of the fishes measured 8 to 14 cm in total length.

The largest species of this study were S. hexagonata (Fig. 3) and S. concatenata (Fig. 4b) with maximum lengths of 360 to 380 mm and corresponding weights of 750 to 1100 g. Due to their fairly rare occurrence in Cebu (The Philippines) sample size of S. fuscescens, S. virgata, and S. hexagonata were small allowing only limited interpretation of their length/weight ratios.

Data shown in Fig. 2a and 4a are derived from specimens reared in a closed sea water system on commercial feeds. There was only little difference in the length/weight relationship of fishes reared in captivity (Fig. 2 and 4) and wild catches.

S. oramin reared in captivity on artificial diet grew to a greater weight than did wild catches of a given length.(total length 16 cm : reared fish = 65 g; wild fish = 50 g).

S. concatenata showed a similar difference between wild catches and pellet reared specimens (total length 16 cm : reared fish = 95 g; wild fish = 80 g).

Figure 5 shows growth rates of S. concatenata and S. oramin fed commercial feeds over a period of more than 300 days. While growth of S. oramin appears to level off at 16 cm total length, there is still growth increment to be expected in S. concatenata of this length. These results were obtained with commercial rabbit feeds not specially developed for the dietary requirements of siganids.

Differences in length/weight ratio of all species under study are shown in Fig. 6, demonstrating the large size and weight of S. concatenata and S. hexagonata.

Discussion

Maximum length and weight

From the above it becomes evident that not all if any of the siganids have a real potential as fish to be introduced into aquaculture. Due to its small maximum size, mentioned also by Fowler (1928), Herre and Montalban (1929), Munro (1955) and Marshall (1964), S. striolata is by no means a suitable species for aquaculture purposes. With an indicated maximum length of 240 mm the largest individuals would ultimately weigh only 150 g (taken from Fig. 1A, S. oramin which has a similar length/weight ratio). Most individuals though would be expected to weigh less, since they are already mature at around 120 mm (Westernhagen, 1973) and growth slows down. Another drawback for the culture of S. striolata is the fact that according to local fisherman this species frequently tastes slightly bitter.

Although S. oramin, S. virgata, and S. fuscescens grow to a greater size than the former species, and the biggest specimens of S. oramin and S. fuscescens reached around 240 mm, approximately 230 g (S. virgata remains smaller), the bulk of the specimens measured and observed by us was considerably smaller. Similar to S. striolata, S. oramin reaches maturity at 110 to 140 mm (Manacop, 1937; Westernhagen, 1973; Lam, 1974; Westernhagen and Rosenthal, 1975), which as can be seen from Fig. 5 slows down growth considerably. Maximum attainable length of S. oramin probably lies between 250 mm (Day, 1958; Marschall, 1964) and 350 mm (Munro, 1955). The largest specimen found by us during this study was 240 mm long, which is in good agreement with data given by Herre and Montalban (1928) for The Philippines.

As for S. fuscescens no exact data are available on its size at maturity. Popper et al. (1973) describe S. rivulatus specimens of 120 to 170 g to be already mature. After Fig. 4 this would be around 220 mm total length, Ben-Tuvia et al. (1973) found that S. rivulatus grew up to 150 g (210 mm) at the end of its first year then probably being already mature. This species does not grow much larger than S. oramin as can be seen from literature records. Herre and Montalban (1928) indicated a maximum length of 290 mm and Smith (1965) gives 350 mm as maximum length of S. rivulatus. Ben-Tuvia et al. (1973) mentioned that the species: "... may reach an approximate size of 400 mm ..." but no exact data were available to them. As can be seen from Fig. 3 the length/weight relationship of this species is very much the same as in S. oramin.

S. virgata as one of the medium sized siganids, does probably not grow much larger than 250 mm, as deducted from reports of Philippine fishermen. The biggest specimen examined by Herre and Montalban (1928) was 190 mm long and during this study a 210 mm specimen was the largest individual encountered. Due to its deep body it grows heavier than S. oramin or S. fuscescens of the same length (Fig. 6), reaching about 170 g at 200 mm.

S. concatenata and S. hexagonata were the largest species found in this study, attaining more than 350 mm and weighing between 750 and 1100 g. From Fig. 5 it can be derived that S. concatenata is likely to grow larger than S. oramin. There was still growth increment over the rearing period of 300 days in S. concatenata. The fishes did not show signs of maturity, some reaching 280 mm. Due to their deep bodies, S. concatenata and S. hexagonata, at a given length, are heavier than members of Group 1. Both species at 200 mm weigh around 140 g while S. oramin and S. fuscescens of the same length weigh only 100 g.

Feasibility of farming and its profitability

From the above it appears that S. concatenata and S. hexagonata have certain potentials for being introduced into fish farming. Yet data obtained in the course of rearing experiments with S. concatenata indicate that there are still some obstacles to be cleared away before any of the siganids could be successfully introduced into mariculture programmes. The major impediment to this endeavour is certainly the slow growth of these fishes as shown in Fig. 5, for laboratory reared specimens. As for S. oramin, growth of S. concatenata is relatively slow. After 200 experimental days the fishes reached a total length of 130 mm, which amounts to a weight of about 50 g. These data are in good agreement with growth rates reported by Lavina and Alcala (1973) for S. oramin from The Philippines, thus we can assume that growth rates in our sea water system compare favourably with growth obtained in a natural environment. Growth of S. rivulatus, as reported by Ben-Tuvia et al. (1973), appears to be equally slow. The authors reported that S. rivulatus in the Mediterranean grows to about 150 g at the end of its first year. The same growth was displayed by S. concatenata reared in our sea water system (Fig. 4 and 5).

If we compare growth rates recorded for siganids with those known for milk-fish Chanos chanos (Forskal) under culture, prospects for future large scale culture of siganids do not look very promising (Table 1), although prices for small S. oramin appeared to be fairly high. Yet this is due to the fact that prices are somewhat overestimated because small fishes are sold singly on the market (Table 2). As already mentioned one major disadvantage of siganids is their slow growth. Milkfish reared in The Philippines from fry may reach marketable size (300 g) after 90 days (Blanco, 1972) although it usually takes four months (Villadolid and Villaluz, 1950; Villaluz, 1953). After 90 days siganids would measure only 70 to 80 mm weighing 10 g. Similar results were obtained by Tsuda et al. (1974) rearing S. oramin (canaliculatus) in Guam. The data given by Ben-Tuvia et al. (1973) are of the same order of magnitude. S. rivulatus (fuscescens) reared in sea cages over a period of 84 days only showed an increase in weight from 7.3 to 28.5 g.

Even the higher prices of siganids compared to those paid for milkfish on Philippine markets (Table 1) would not compensate for the slower growth unless this can be remedied, by the choice of more adequate cheap artificial feeds.

Polyculture of milkfish and siganids does not appear to be a means of enhancing production of fishponds over the introduction of rabbitfishes, since siganids have the same diet als milkfish (Herre and Mendoza, 1929; Esguerra, 1951; Tsuda and Bryan, 1973; Westernhagen, 1973a, b, 1974), even showing the same preferences for agarophytes such as Gracilaria confervoides (Abagon et al. 1951; Domantay, 1959). Thus siganids in milkfish ponds are usually considered unwanted competitors (Rabanal et al. 1951) reducing profit, even though they can be readily sold on the markets at considerable prices when they are still small (Table 2).

The vast areas still available for aquaculture development in The Philippines can not possibly converted exclusively into milkfish ponds. For one reason they do not meet the particular requirements nessessary for raising milkfish. Yet siganids could possibly be reared in ponds which are not suitable for milkfish culture (Ablan and Rosario, 1961). Experiments conducted by Ben-Tuvia et al. (1973) also showed the feasibility of culturing siganids in sea cages which would reduce operational costs substantially.

The advantage siganids have over milkfish is the possibility of propagating the former in captivity (May et al. 1975; Westernhagen and Rosenthal 1975). This would secure unlimited seed provision, a major impedement in the further expansion of milkfish culture (Delmendo, 1972).

The gist of the discussion indicates that intentions to utilize members of this family for cultivation in warm water effluents of temperate regions will not materialize.

Summary

1. Names of several species of siganids are discussed and compared with names employed by different authors.

2. Six species of siganids Siganus oramin, S. concatenata, S. striolata, S. virgata, S. hexagonata and S. fuscescens were collected in The Philippines and their length/weight ratio determined.

3. Live S. oramin and S. concatenata were airshipped from The Philippines to Hamburg and reared on commercial feeds for more than 300 days in a closed seawater system and their length/weight ratio determined.

4. Length/weight ratio of wild and laboratory-reared specimens were different. Reared S. oramin and S. concatenata being heavier than wild catches of the same length.

5. Maximum lengths and weights of siganids and their feasibility as aquaculture objects are discussed. S. concatenata and S. hexagonata are the only species that grow sufficiently to be worth considering them for aquaculture endeavours.

6. Growth rates of siganids and milkfish (Chanos chanos) are compared and it is concluded that unless some means to induce growth in siganids is found, members of this family would not be suitable for extensive aquaculture purposes.

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Table 1

Some marketing characteristics of *Siganus* spp. and milkfish.
7 Pesos = 1 $ US.

	Siganus	Milkfish
Palatibility	excellent	good
Possibility to farm	+	+
Growth until marketable	12 months	3 months
Weight at marketable size	150 g	300 g
Price/kilo	7-10 Pesos	2-4 Pesos
Fry production in captivity	+	-
Food	algae	algae
Sellability of small fish	good	fair

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Table 2

Prices of siganids and milkfish on Cebu Island (The Philippines). Prices for milkfish strongly depend on weather conditions. Bad weather - high prices. 7 Pesos = 1 $ US.

Species	Length (cm)	Weight (g)	Price/fish (Peso)	Price/kilo (Peso)
oramin	5	5	0.05	10.0
	7-11	7-20	0.1	14.3.-5.0
	11-14	20-35	0.2	10.0-5.7
	14-16	35-50	0.3-0.5	11.4-8.0
concatenata	5	5	0.05	10.0
	15	80	0.50	6.2
	20	150	1.00	6.7
	25	300	1.80	6.0
	28	450	3.00	6.7
	38	1100	7.00	6.4
hexagonata	5	5	0.05	10.0
	20	150	1.00	6.7
	32	550	3.50	6.4
	37	830	4.50	5.4
virgata	17.5	100	0.50	5.0
Chanos chanos		330	1.0-1.5	3.0-4.5

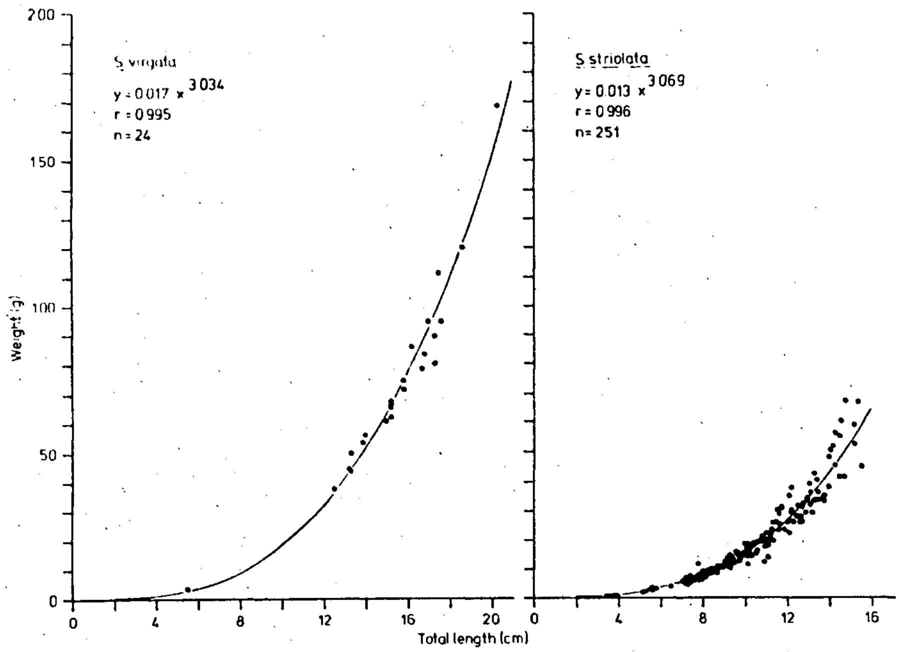

Fig. 1 Length/weight relationship of Siganus striolata and S. virgata from Cebu (The Philippines).

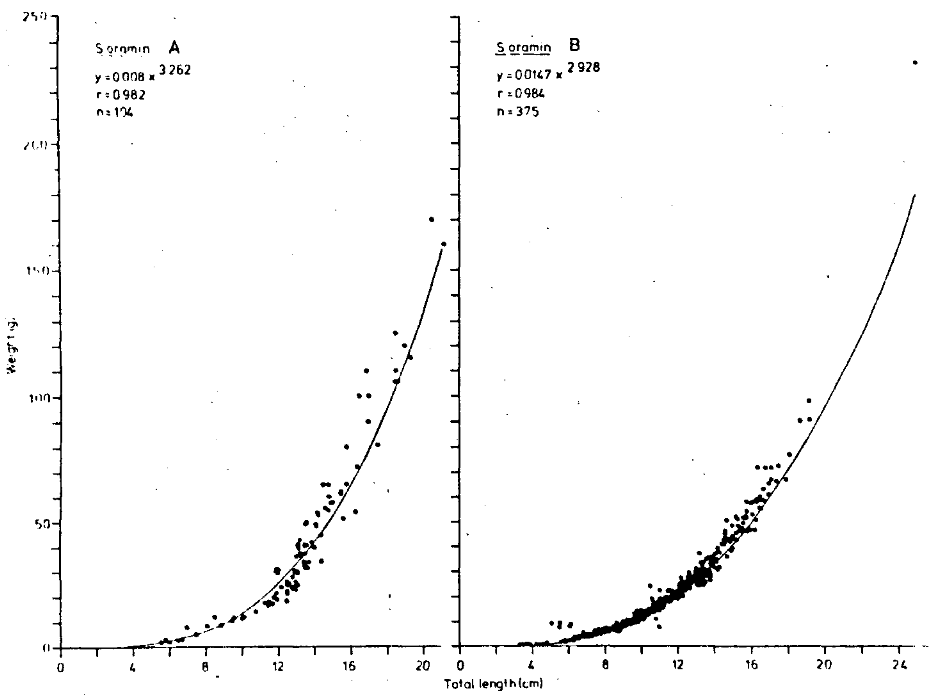

Fig. 2 Length/weight relationship of Siganus oramin. A - laboratory reared specimens; B - wild catches from Cebu (The Philippines).

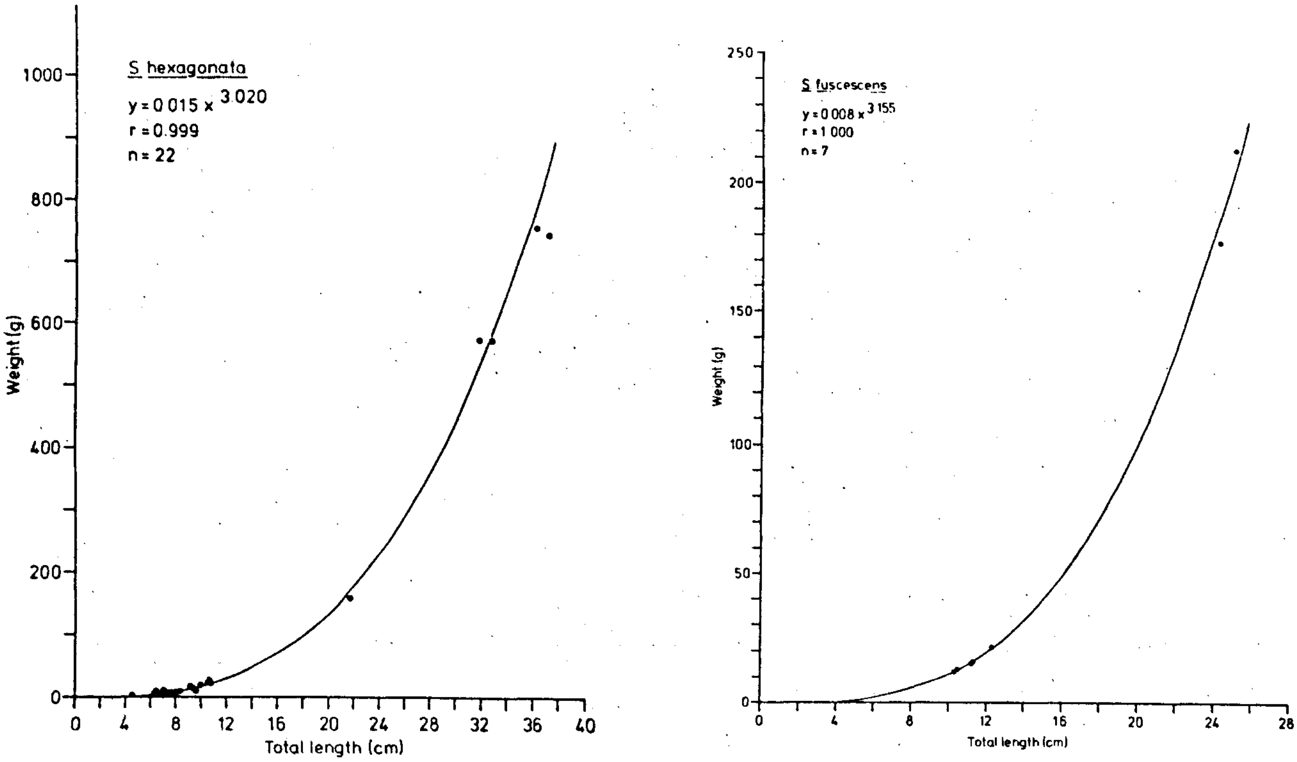

Fig. 3 Length/weight relationship of Siganus fuscescens and S. hexagonata from Cebu (The Philippines).

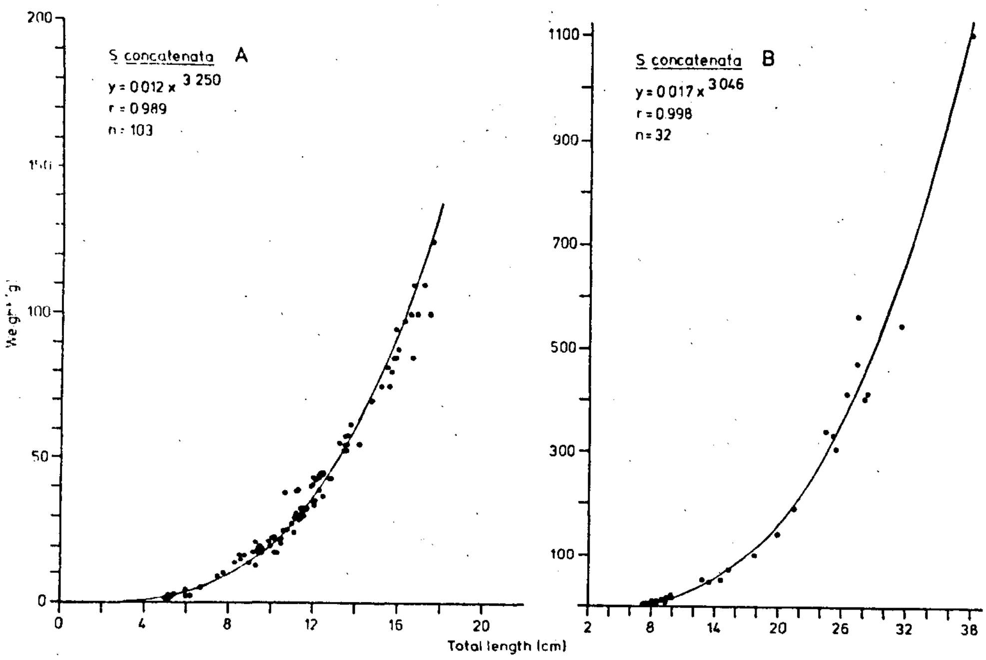

Fig. 4 Length/weight relationship of Siganus concatenata. A - laboratory reared specimens; B - wild catches from Cebu (The Philippines).

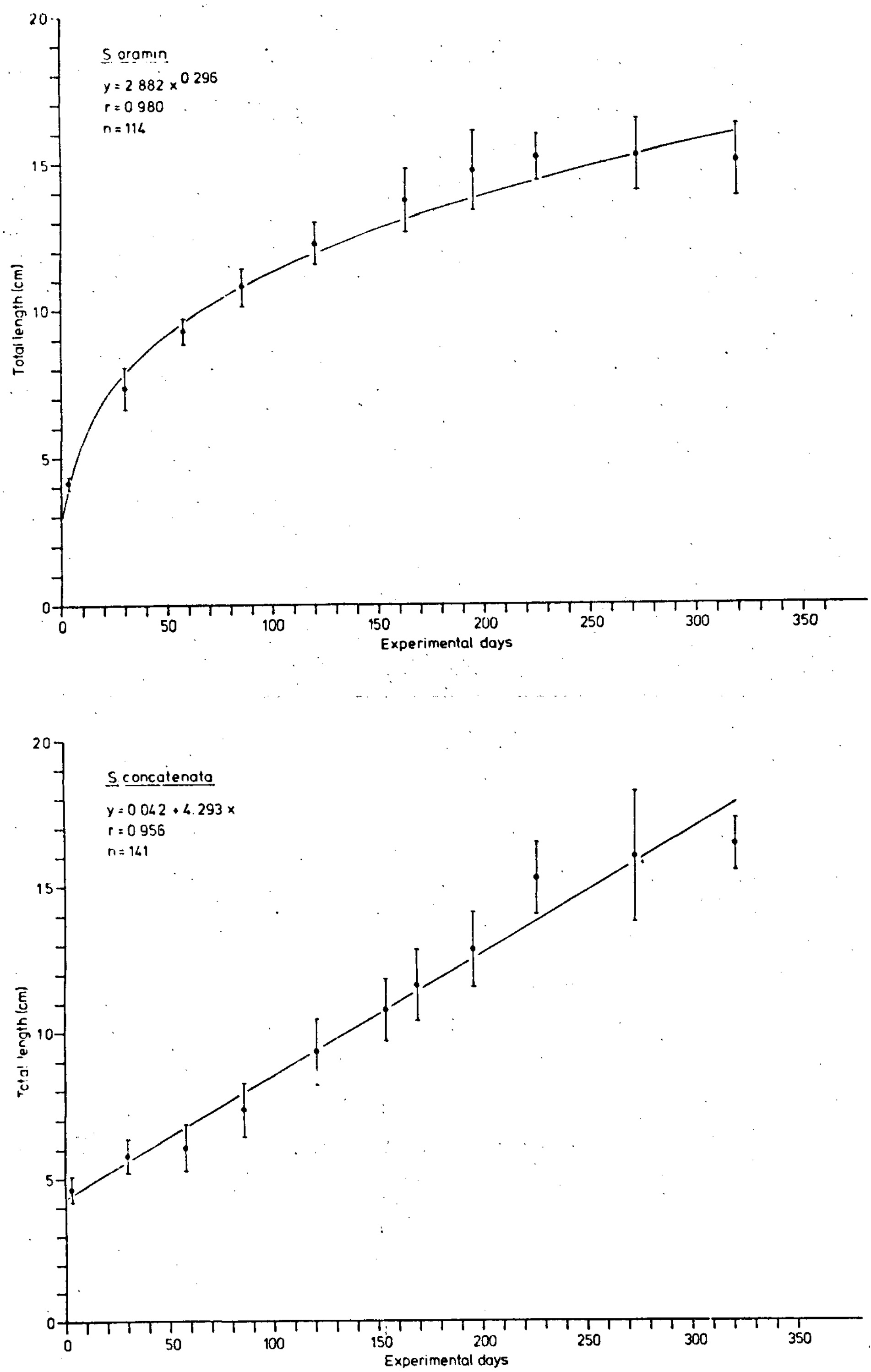

Fig. 5 Growth of pellet fed *Siganus oramin* and *S. concatenata* reared in a closed seawater system.

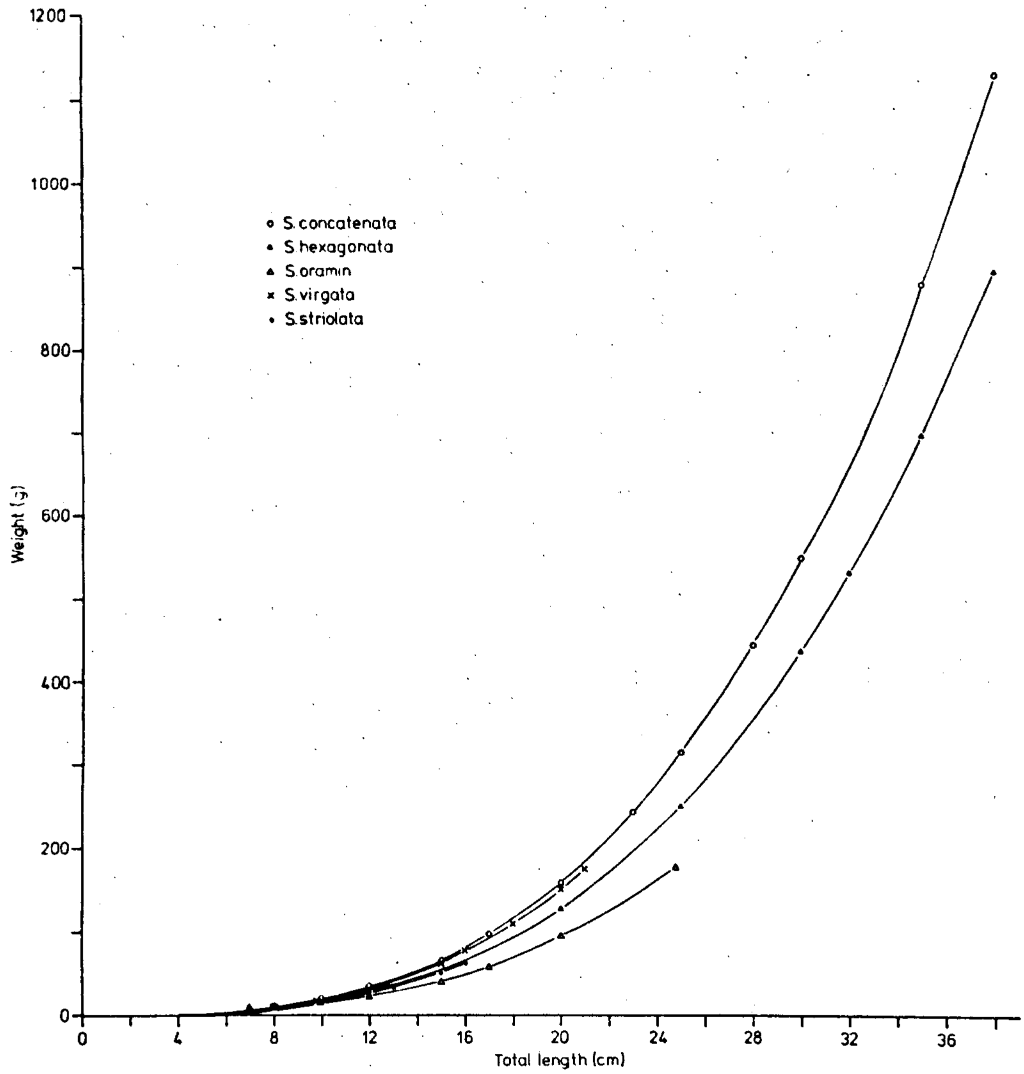

Fig. 6 Length/weight relationship of Siganus concatenata, S. hexagonata, S. oramin, S. striolata and S. virgata from Cebu (The Philippines).