Hormone Induced and Natural Spawning of Captive *Siganus canaliculatus* (Pisces: Siganidae) Year Round

PATRICK G. BRYAN, BECKY B. MADRAISAU,
and JAMES P. MCVEY

Micronesian Mariculture Demonstration Center, P.O. Box 359, Koror, Palau, W. Caroline Islands 96940

Abstract—Captive *Siganus canaliculatus* reared and held in 3 m diameter circular tanks with running sea water were induced to spawn each month during 1974 by one or two intramuscular injections of human chorionic gonadotropin at dosages of 500 units per treatment. Natural spawnings occurred, without the use of hormone, only during the months of April, June, July, and August.

Introduction

The use of hormones in fish culture has received widespread attention (Atz and Pickford, 1959; Sneed and Clemens, 1959; Chaudhuri, 1968; Clemens, 1968), particularly with fresh water fishes, i.e., catfish (Sneed and Clemens, 1960; Boonbrahm, 1968), carp (Boonbrahm, 1968; Chen *et al.*, 1969), and bass (Stevens, 1966). Only recently have hormones been applied to induce spawning in rabbitfish (Siganidae). Soh and Lam (1973) induced spawning in *Siganus oramin* (=*S. canaliculatus*)* by injections with human chorionic gonadotropin. Others have artificially spawned siganids (Manacop, 1937; Popper *et al.*, 1973). May *et al.* (1974) reported using human chorionic gonadotropin to induce spawning in *S. canaliculatus* and succeeded in rearing the larvae through metamorphosis.

This study shows that *Siganus canaliculatus* (Park) will spawn in captivity on a year round basis by using human chorionic gonadotropin to augment the natural spawning cycle. Preliminary results of this work were presented at the SPC Seventh Technical Meeting on Fisheries, Nuku'Alofa, Tonga (Bryan *et al.*, 1974).

Materials and Methods

Brood stock ($\bar{x}$ SL=170 mm) used for spawning were captured as juveniles ($\bar{x}$ SL=24 mm) in May 1973 and raised in 3 m diameter (7,700 l capacity) round cement tanks with running sea water. A "wild" stock of adults ($\bar{x}$ SL=122 mm) was captured in March 1974 and held under identical conditions. All brood fish were fed exclusively on a commercial fish pellet (Ralston Purina, Trout Chow).

* Siganid nomenclature is presently in a state of chaos. We agree with Woodland (Lam, 1974) that *S. oramin*=*S. canaliculatus*.

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Males and females were selected for hormone treatments on the basis of appearance, i.e., females are usually deeper bodied than males. The fish were netted, anesthetized by submersion into a mild quinaldine solution, and injected intramuscularly near the dorsal fin with either 250 or 500 units of human chorionic gonadotropin (Parke-Davis, Antuitrin "S"). Injected males and females were released into a common 500 l round tank with running sea water for development and observation. One to three fish of each sex were used for each spawning trial. Subsequent treatments (injections) were administered at intervals ranging from several days to over a week, based on the appearance (development) of the test fish. After spawning, the fish were removed, the running sea water stopped, and gentle aeration applied to the tank. Subsamples of eggs were usually taken immediately, after gently stirring the water. The samples were counted under a dissecting microscope and fertilization percentages were estimated after several hours of development. Temperatures averaged 30°C, salinity 33‰.

During the natural spawning season (April–August) ripe females and males were captured from the brood tank and released into the 500 l spawning tank without undergoing hormone treatment. Ripe females were visually fat in the brood tank before feeding in the mornings. Ripe males were chosen by trial and error on the basis of expressed milt by gently compressing their lower abdomens.

Results

Siganus canaliculatus spawned during each month of 1974 (Table 1), an average of 1.7 spawnings per month. Egg production varied considerably. However, spawnings usually occurred late in the evening or early in the morning and it is assumed that many of the eggs were lost before the outflow could be discontinued. Acquiring accurate subsamples (aliquots) of the eggs for counting was difficult since the eggs are demersal and adhesive after fertilization.

Hormone spawnings took place in January through June and in September through December. Although hormone treatments were administered to two fish groups in July and August, power failures resulted in the overnight deaths of both groups. There were 15 hormonal spawnings and the eggs were fertilized in 13 of these. Fertilization was not completed in the 2 April spawning because the male did not spermiate. However, both fish were disturbed and frightened by observers at the moment of spawning. In the 13 November trial, the female extruded undeveloped eggs in a stringy mass and the male failed to spermiate. In all other hormone trials, when dosages were administered to the fish at 500 units per treatment, some or all of the treated fish spawned after the first injection or one to several days after the second (an exception was in June when eight days were required after the second injection). Ten groups spawned after one injection and five groups spawned after two injections. The maximum accumulated dosage required per fish to induce spawning during 1974 was 1000 units (two injections).

Two trials were run comparing the effectiveness of 250 unit hormonal treat-

Table 1. Monthly induced and natural spawnings by captive *Siganus canaliculatus* during 1974.

Month	Dates of injection	No. fish injected ♀	No. fish injected ♂	Accumulated units/fish	Date of hormonal spawn	Date of natural spawn	No. fish spawning ♀	No. fish spawning ♂	No. eggs produced	Percent fertilized
January	24	2	1	500	28		2	1	600,000	90
February	24	2	1	500	25		2	1	600,000	90
March	13, 15	3	2	1000	17		1	1	300,000	70
April	1	1	1	500	2		1	0	50,000	unfertilized
	3, 7	1	1	1000	8		1	1	70,000	80
	13	2	3	500	17				30,000	50
	22	1	1	500	26		1	1	80,000	70
						29			>2,000,000	90
						30	2	1	>1,000,000	90
May	13, 25	3	2	1000	27		?	?	800,000	90
June	10, 12	2	2	1000	20		2	2	200,000	90
						24	1	1	800,000	90
July	18	2	2	500	fish killed					
						24	2	2	>1,000,000	90
August	25	1	2	500	fish killed					
						28	1	?	500,000	90
September	17	3	2	500	22		?	?	30,000	90
October	10, 14	2	1	1000	15		2	1	600,000	90
November	6	1	1	500	13		1	0	?	unfertilized
	13	3	2	500	18		1	1	?	50
	19	1	1	500	22		1	1	?	90
December	10	1	1	500	15		1	1	300,000	80

ments (not shown in Table 1) verses 500 unit treatments. One group of five fish was injected with 250 units per fish on 20, 26 November, 7 and 20 December 1973. The other group (five fish) was injected with 500 units on the same dates. Both groups were held in a common 500 l container with running sea water. The lower caudals of the 500 unit group were clipped for identification. Three fish in the 500 unit group spawned on 25 December with completed fertilization. An identical experiment was conducted in March 1974. After two injections (13 and 15 March), one female and one male, both from the 500 unit group, spawned; the eggs were fertilized. In both experiments, all fish were released after spawning occurred and it is not known whether the 250 unit groups would have eventually spawned.

There were four natural spawnings (April, June, July, and August), all with successful fertilization. In these cases, spawning usually commenced within several minutes after the fish were released into the spawning tank. On the morning of 29 April, a massive spawning by many fish took place in the brood tank. This agrees with the natural peak spawning time of *S. canaliculatus* in Palau (Bryan *et al.*, 1974).

Discussion

During the off-spawning months (January–March; September–December) when the brood stock showed no signs of sexual activity, *S. canaliculatus* was induced to spawn by treatment with human chorionic gonadotropin. The fish usually spawned after one injection (500 units) and always (except once in 1973) after two injections (1000 accumulated units). Only those fishes treated with hormone spawned; the remaining brood stock did not spawn during these times. Shehadeh (1970) describes the advantages of using pharmaceutical hormones in fish culture.

During the natural spawning season (April–August), sexually ripe *S. canaliculatus* (untreated with hormone) usually spawned within several minutes after transfer from the brood tank to the spawning tank, probably as a response to the stress and excitement caused by handling. Although brood fish were frequently handled during the off-spawning months, spawning did not occur during these times. Handling promoted spawning only with sexually ripe fishes. Lam (1974) reviews other reports of this phenomenon.

Lam (1974) stated that *S. canaliculatus* would mature sexually in captivity given good water and adequate food. An earlier study (Soh and Lam, 1973) reported that *Siganus oramin* (=*S. canaliculatus*) could not be bred in captivity. Our brood fish were held in 3 m diameter tanks with running sea water and fed a high protein diet of trout pellets. Those fish captured as juveniles matured and bred under these conditions. Furthermore, captive reared spawners can reach sexual maturity in less than one year (May *et al.*, 1974) and probably earlier than in nature (Lam, 1974). Our brood fish, captured in May 1973 as juveniles, were first induced to spawn in December 1973. Assuming that they were approximately two months old at capture, their age at first spawning was around ten months.

Their F_1 progeny, hatched in May 1974, were induced to spawn at approximately ten months of age.

Lam (1974) suggests that *S. canaliculatus* might die after spawning. We had no mortality after spawning and almost all of the fish used as spawners during 1974 are alive as of this writing, March 1975. One female was induced to spawn during two consecutive months and was ripe 1.5 months later when she was accidentally killed. Repeated spawnings by a single male or female may be advantageous for hatcheries having limited facilities to hold large numbers of brood stocks.

Combining natural and induced spawning techniques throughout the year enables control of larval output to accomodate rearing capacities in the hatchery. Being able to spawn *S. canaliculatus* on a monthly basis makes larval production efficient since hatching to metamorphosis takes approximately one month (May *et al.*, 1974). Producing larvae for hatchery rearing eliminates the need to capture large numbers of juvenile stocks from the field, which is possible only during a few days out of the year in Palau. It also allows for the domestication of this species.

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