ARTIFICIAL SPAWNING OF SNOOK

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ABSTRACT

Satisfactory procedures were developed for the artificial propagation of snook, Centropomus undecimalis, *as were methods for capture, care, transport, and handling of the broodfish. Milt stored at 40° F. up to 12 hours was satisfactory for fertilization. Fecundity was determined to be approximately 45,000 eggs per pounds of body weight. Fertile eggs were bouyant at salinities greater than 20‰. Lack of agitation during the first 6 hours of incubation proved critical for consistent embryo development. Hatching occurred between 24 and 30 hours after fertilization at incubation temperatures between 82° and 87° F. Fry culture efforts were limited to intensive culture techniques in the laboratory.*

The common snook, *Centropomus undecimalis* (Bloch), is one of the most popular sportfish in South Florida. They strike artificial and natural baits readily, put up a spectacular fight, and are highly desirable table fish. Although the snook is a highly acclaimed gamefish throughout the tropical Americas, a paucity of information exists concerning its life history.

Spawning has been observed near the mouths of rivers and in estuarine passes along Florida's southwest coast. The height of spawning activity reportedly occurrs in June (Marshall, 1958 and Volpe, 1959). A recent study identified tidal streams as a major nursery area for young snook and provided information concerning foods of juveniles (Fore and Schmidt, 1973).

Adult snook demonstrate an affinity for freshwater and are found far inland at all times of the year. Though a common fish throughout the estuaries of southern Florida, snook occur in lesser abundance as far north as North Carolina on the Atlantic Coast and around the entire Gulf Coast. Cool water temperature is probably the limiting factor on northern distribution.

Power plant cooling reservoirs, which provide water temperatures 10 to 15 degrees above ambient, afford suitable environments for experimental introduction of this predator species. Earlier studies have demonstrated excellent survival and growth of fingerling and sub-adult snook when stocked into sub-tropic freshwater ponds (Ager, 1974).

Spawning of snook in freshwater has not been indicated nor expected. Therefore, the establishment of snook as a supplemental predator and gamefish in freshwater would necessitate artificial propagation to provide a dependable supply of fish. In the spring of 1974, the Florida Game and Fresh Water Fish Commission initiated a project to develop procedures for artificial propagation of common snook, for purposes of freshwater introduction.

MATERIALS AND METHODS

Capture. Adult snook were collected during the months of April through August during 1974 and 1975. Sportfishing gear was used as the principal collection method, fishing in and around the smaller passes on the southwest coast of Florida.

Sex Differentiation. During most of the year, external sex differentiation of snook is not possible. However, during peak spawning season of late May through July, the vent area of sexually mature females is slightly swollen and distended providing a means of determining probable sex externally. The female genital opening develops a crescent-shaped slit with point of the crescent oriented posteriolaterally. Males are recognizable by expulsion of milt with abdominal palpation.

Transportation and handling of Broodfish. Captured fish were placed into a 100-gallon boat mounted hauling tank with agitator and checked for gonadal condition to ascertain whether fish were ovulating females or "flowing" males. When one to five fish were collected, depending upon size and sex, they were transported to holding facilities and

transferred into 200 or 500-gallon tanks. The distance of transport did not exceed 10 miles. In order to facilitate transfer, broodfish were frequently anesthetized by administering a 5 percent solution of quinaldine to the hauling tank water to visibly relax the fish. This required 3 to 5 minutes.

Fish were sexed by observing secondary sex characteristics when possible, or by sampling gametes with a catheter; a hypodermic syringe fitted with a blunted 18 gauge needle one inch in length or a 2 mm O.D. glass tube 4 to 5 inches in length. This procedure provided egg samples which could be examined under magnification to determine eligibility for spawning.

Males and females were segregated in the holding tanks. Antibiotics were not usually administered. Tank water was changed approximately every 24 hours using bay water at high tide. Initially, 110-volt agitators were used for aeration. Later, due to the frequent exposure of fish, personnel, and incubating eggs to electrical shocks, bottled oxygen bubbled through airstones was substituted for agitation. Temperature of the water in the holding tanks varied as much as 5° F. during a 24 hour period. Dissolved oxygen levels were usually maintained between 5 to 7 ppm. On several occasions, however, dissolved oxygen decreased to between 1 and 2 ppm in tanks containing females awaiting ovulation. This suggested an increased metabolic rate during the latency period.

Injection. During transfer of broodfish to holding tanks, all females were injected with 125 to 500 I.U. HCG per pound. Injections were made with 6 and 12 cc disposable syringes fitted with 22 gauge needles one inch in length. Hormone was administered intramuscularly into the muscles of the back adjacent to the dorsal fin.

Initially, males were injected with either 125 to 500 I.U. HCG or 1 to 5 mg carp pituitary per pound of body weight. Because both hormones resulted in quite variable gonad response, injection of male snook was discontinued.

Ovulation. Firm hand pressure applied to the abdomen of female snook was used to determine ovulation. Light to moderate pressure resulting in a stream of free flowing eggs indicated ovulation was complete. Females were checked initially at 24 to 30 hours following injection. If response was negative, an egg sample was taken with a catheter to assess development and predict probable spawning time. Stage VI (transparent) eggs throughout the sample indicated that ovulation would occur within 1 to 2 hours. Samples containing only a few Stage VI eggs occurring with lesser staged eggs (IV and V) indicated another 4 to 5 hours would be required.

Fertilization. Initially, both "dry" and "wet" techniques of fertilization were evaluated. Variable gonad response in males coupled with positive results obtained by refrigerating sperm resulted in modification of established techniques to achieve fertilization. Seminal fluid was extracted by applying suction to one end of an artificial insemination tube and placing the other end in close proximity to the genital opening of the fish. Milt was refrigerated in the tube at 40° F. until needed.

Eggs were stripped from an ovulating female into a shallow fertilization pan. Milt was added by gently blowing on the end of the artificial insemination tube containing the seminal fluid. Saltwater was then added slowly to activate the sperm. Only enough water was added to allow a complete mixture of eggs and sperm to ensure a high percentage of fertilization.

Later in the project, agitation of eggs was determined to be detrimental to viability. Thereafter, milt and a small amount of saltwater were added to the fertilization pan and mixed thoroughly prior to deposition of eggs.

Egg Incubation. During 1974 egg incubation was performed in aquaria and MacDonald hatching jars without water exchange due to egg buoyancy. All on-site incubation attempts were conducted out-of-doors subjecting developing eggs to various uncontrolled environmental changes. Oxygen was typically bubbled in the incubating vessel with various degrees of agitation. Several experimental combinations of water source, salinity, temperature, and aeration were evaluated with negative results.

RESULTS AND DISCUSSION

Hormone Response. Gonadal response in males was quite variable. Rates of 125,250, and 500 I.U. of HCG per pound or multiple injections failed to produce consistent satisfactory

response in males. Injections of 1 to 5 mg carp pituitary per pound caused a pronounced negative response. Thereafter, only uninjected gravid males were used for fertilization.

Based upon early results with males brought to ripeness with a dose rate of 500 I.U. HCG per pound of body weight, a 13.5 pound female was injected at the same rate. Egg samples taken at the time of injection consisted of opaque, yellowish-white eggs with granular yolk material and a faintly distinguisable oil globule somewhat centrally located within some ova. This fish was checked for ovulation 33 hours after injection by abdominal palpation without positive results. The vent and genital opening were noticeably swollen. distended, and showed evidence of rupture of the epidermal layer. At this point, the fish could be catheterized with a 4 mm O.D. glass catheter. An egg sample provided ripe eggs which were transparent containing clear, crystalline-like yolk material and a uniform singular oil globule (Stage VI egg classification). This fish was inspected again at 36.5 hours after injection and was found to be ovulating in the holding tank. Evaluation of dosages of 150 and 250 I.U. HCG per pound of body weight indicated that these lesser dosages produced inconsistent responses (Table 1). The dosage of 500 I.U. HCG per pound of body weight was used on all subsequently injected females.

Of 16 adult female snook injected with HCG during 1974, ovulation was successfully induced in seven (43.8%). Handling stress was believed responsible for the death of two females; two showed no response; one was sacrificed to determine if ovulation had occurred; and four died of suspected dissolved oxygen deficiency in holding tanks. Ovulation occurred at an average of 33.9 hours after injection. The latency period ranged from 30 to 38 hours. The two females which died of apparent handling stress demonstrated egg advancement 24 to 30 hours after injection, but both had failed to ovulate after more than 40 hours and succumbed. One female was captured in the process of natural ovulation.

As shown in Table 1, 58 female snook were injected during 1975 and ovulation was successfully induced in 24 (41.4%). One female ovulated in the holding tank and two additional females were ovulating when captured. Egg stage advancement did not occur in ten females injected. Five females died in 9 to 25 hours after capture and appeared spent. Seven females succumbed to low dissolved oxygen. Ten females died of unknown causes, probably attributable to low dissolved oxygen, and two died of handling mortality due to their slow response to dose rates of 150 I.U. and 250 I.U. HCG per pound of body weight.

Fertilization. During 1974, hormone induced ovulation occurred in seven broodfish. Eggs from four of these fish (57%) were fertilized. One female was in the process of ovulating when captured and eggs from this fish were successfully fertilized. Fertilized eggs floated in saltwater at salinities greater than 20 °/₀₀. This facilitated assessment of percentage fertilization of each spawn.

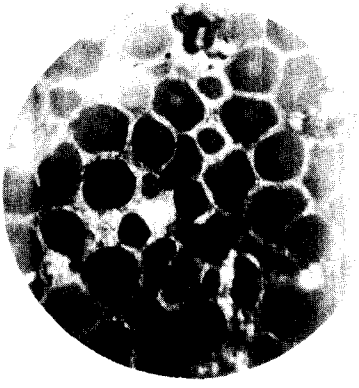
Of the 24 females spawned in 1975, eggs were successfully fertilized from 19 (79%). Two additional females were in the process of ovulating when captured and eggs from both of these fish were also fertilized (Table 1).

The foremost contributing factors responsible for better results during 1975 were experienced personnel, refinement in handling males, lack of egg agitation, and sperm storage under refrigeration.

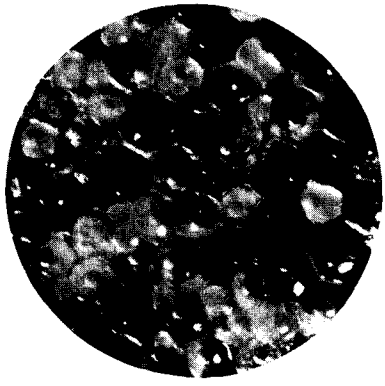
Sperm Life. Snook sperm activation required saltwater contact. Motility was not observed when milt was dry stripped from the fish or with the addition of freshwater. Addition of saltwater (35°/₀₀) however, resulted in vigorous motility of approximately 80% of the sperm for about 1 to 2 minutes. Motility ceased after 20 minutes. Satisfactory storage life of refrigerated (40° F.) sperm contained in a sterile syringe was determined to be 10 to 12 hours. After this period sperm motility was reduced to 20 to 30 percent. Refrigerated storage for 26 hours decreased motility to 10 percent. Attempts to store sperm using liquid nitrogen were unsuccessful.

Fecundity. Using volumetric displacement, samples of unfertilized ripe eggs from each of two fish were counted to determine the number of eggs per cubic centimeter. Approximately 2,500 to 4,000 Stage VI eggs were contained in one cubic centimeter. The ovaries from a 16 pound female displaced 300 cc. indicating the production of from 750,000 to 1,200,000 eggs. Ovaries from a 13 pound female displaced 225 cc. indicating the production of 562,500 to 900,000 eggs. Based on this limited information, a minimum of approximately 45,000 eggs could be expected per pound of body weight.

PL. 1 SNOOK—HORMONE INDUCED EGG DEVELOPMENT

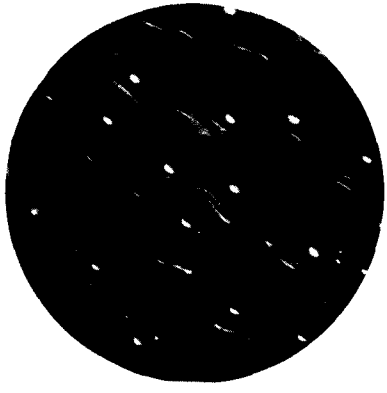


STAGE 1 (20X) TYPICAL EGG STAGE AT CAPTURE (PRIOR TO INJECTION)



STAGES IV, V, & VI (20X) 26 HOURS AFTER INJECTION

STAGE VI (30X) 33 HOURS AFTER INJECTION



STAGE VI (30X) 33 HOURS

Egg Stage Classification. Plate 1 illsutrates snook egg development. Descriptive stages are given using the classification provided by Stevens (1965) and Bayless (1972) for white bass and striped bass ova.

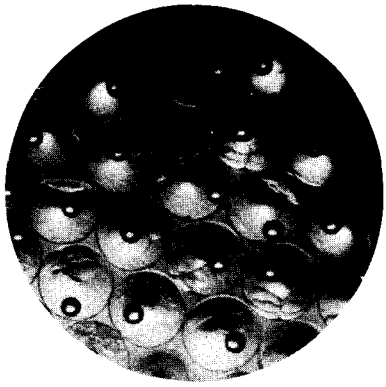
Stage I—Eggs are small irregularly shaped, yellowish-white in color with granular yolk material. These staged eggs are generally opaque in appearance with a translucent area centrally located in at least some eggs. Stage I is commonly found in ova samples from females collected at the spawning grounds. Females at this stage are eligible for hormone induced spawning.

Stage II—Eggs irregularly shaped with a translucent area centrally located. These staged eggs contain small, multiple oil globules randomly dispersed.

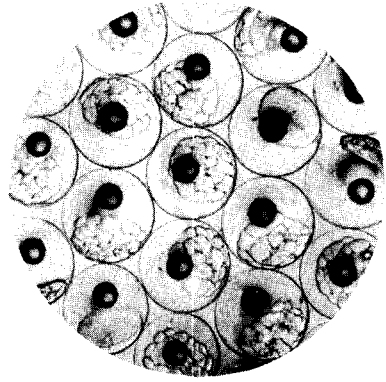
Stage III—Eggs have become more rounded and translucent. Oil globules coalescing but dispersed throughout egg.

Stage IV—Eggs are generally spherical with translucent yolk material. Oil globules polarized into a single sphere and discernable.

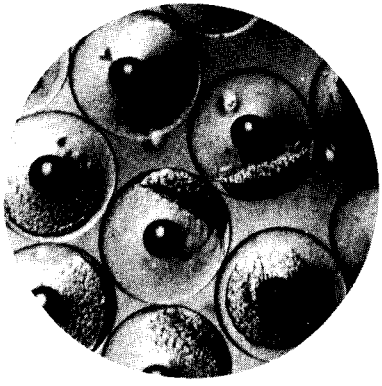
PL. 2 SNOOK—FERTILIZED EGG DEVELOPMENT



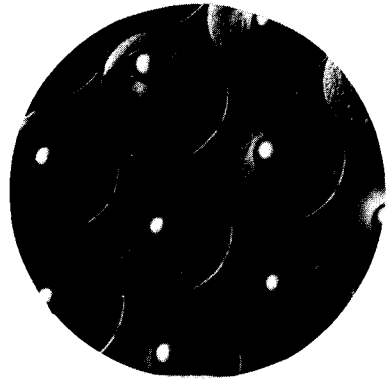
CLEAVAGE—1 HOUR (30X)



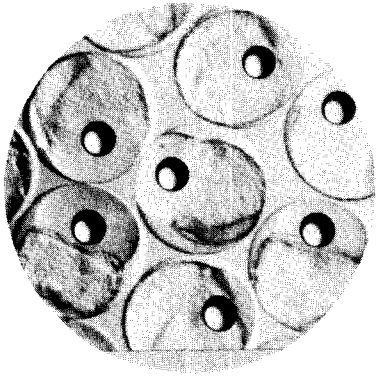
CLEAVAGE—1½ HOURS (30X)



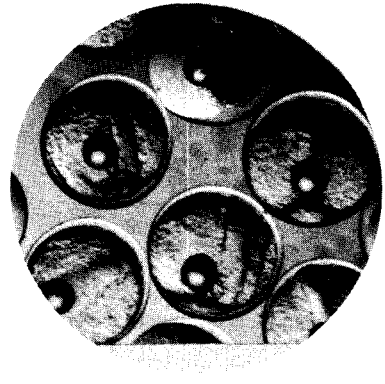
BLASTULA—2½ HOURS (40X)



GERM RING—7½ HOURS (40X)

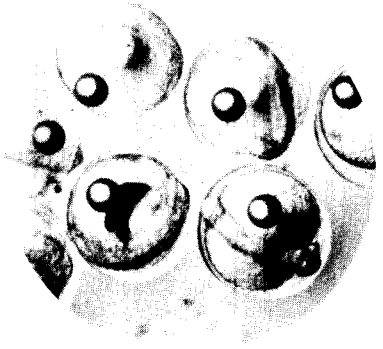


GASTRULA—11 HOURS (40X)

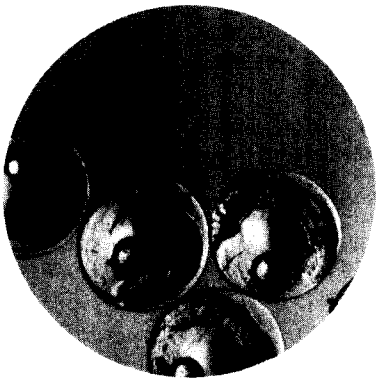


NEURAL PLATE—13 HOURS (40X)

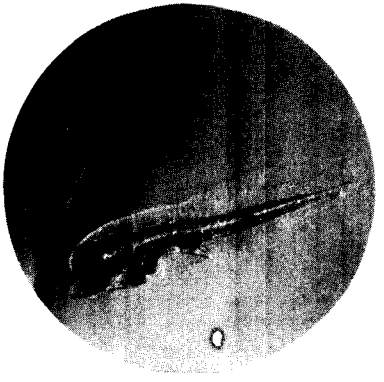
PL. 3 SNOOK—ADVANCED EGG AND FRY DEVELOPMENT



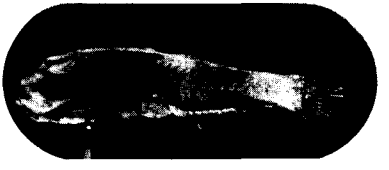
16 HOURS—EARLY EMBRYO (40X)



21½ HOURS—EMBRYO



48 HOURS—LARVAE



16 DAY OLD—LARVAE

Stage V—Eggs enlarging and yolk material more than one-half transparent. Oil globule readily apparent.

Stage VI—Yolk material transparent throughout with a single well-defined oil globule. Eggs should be rolled with a probe under magnification to determine clearness. Cloudiness or multipleoil globules indicates probable non-viable eggs. A few Stage VI eggs in the sample indicate about 4 to 5 hours until ovulation. Stage VI eggs throughout the sample indicate ovulation should occur within 1 to 2 hours.

Egg Incubation. During all experiments in 1974, fertile eggs underwent rapid mortality approximately 6 hours after fertilization. Hatching success was limited to one spawn in which fertile eggs were allowed to water harden for two hours before being transported by truck in sealed plastic bags with oxygen. Fry survival was estimated between 24 and 30 prolarva from approximately 500,000 fertile eggs.

An evaluation of the effects of agitation on fertile eggs was initiated in 1975. Lack of agitation during the first 6 hours of incubation proved critical for consistent embryo development. Typically, eggs were left undisturbed in the shallow fertilization pans and placed in a water bath to maintain temperature stability. After 6 hours, fertile eggs were carefully scooped from the water and placed in incubating vessels within a mobile hatchery facility. This facility allowed for good environmental control.

Table 1. Results of hormone induced ovulation of snook, 1975.

Date	Wt. (Lbs.)	Egg Stage at Injection	Time to Stage VI	Stage VI to Ovulation	Total Latency	Viable Eggs 2-4 hrs.	Comments
5-9	5	I	—	—	—	—	HCG 150 I.U./lb. Dead 39 hrs.
5-9	5	I	—	—	43	50,000	HCG 250 I.U./lb. 5,000 fry.
5-10	20	VI	—	1.5	—	750,000	Agitated eggs dead—static eggs viable.
5-10	3	I, II, & III	—	—	—	—	HCG 500 I.U./lb. No Advancement 24 hrs.
5-10	4.5	I & II	—	—	—	—	HCG 500 I.U./lb. Dead 19 hrs.
5-10	4.5	I & II	32.5	—	—	—	HCG 500 I.U./lb. Dead 32 hrs. Stage VI.
5-10	4	I & II	—	—	—	—	HCG 500 I.U./lb. Dead 9 hrs.
5-10	3	I & IV	31.5	4.0	35.5	None	No fertilization obtained.
5-11	3	IV, V, & VI	—	—	21	100,000	Refrigerated sperm used.
5-12	3	I	—	—	—	—	HCG 500 I.U./lb. Dead 27.5 hrs.
5-12	5	I	—	—	—	—	HCG 250 I.U./lb. No advancement.
5-12	1.5	I	—	—	—	—	HCG 250 I.U./lb. Dead 20 hrs. No advance.
5-12	3	I	—	—	—	—	HCG 500 I.U./lb. No advance. 30.5 hrs.
5-12	2	I-IV	—	—	21.5	20,000	HCG 150 I.U./lb. Forced ovulation. Fry def.
5-12	3	—	—	—	—	30,000	Ovulating at capture.
5-12	3	I-IV	—	—	—	—	HCG 150 I.U./lb. Dead 24 hrs.
5-24	8	I & II	—	—	—	—	HCG 150 I.U./lb. Dead 65 hrs. Advanced to V.
5-25	3	I, II & III	—	—	—	—	HCG 500 I.U./lb. Dead 16 hrs.
5-25	2	No sample	29.5	3.75	32.75	20,000	Advanced fry obtained.
5-25	2	No sample	36	0.5	36.5	10,000	HCG 250 I.U./lb. Forced ovulation.
5-25	2	No sample	—	—	37.5	10,000	Injected twice at 150 I.U./lb. High deform.
5-25	2	No sample	—	—	—	—	HCG 500 I.U./lb. Dead 31 hrs.
5-25	2.5	No sample	—	—	—	—	HCG 500 I.U./lb. Dead 25 hrs.
5-25	2	No sample	—	—	37	None	HCG 250 I.U./lb.
5-27	2	No sample	—	—	—	—	HCG 500 I.U./lb. Dead 16 hrs. O_2 off.
5-27	13	No sample	—	—	—	—	HCG 500 I.U./lb. Dead 30 hrs.
6-7	1.75	No sample	—	—	36.5	None	
6-8	2	No sample	—	—	—	—	Double HCG 500 and 250 I.U./lb. 30 hrs. later; ovulated in tank.
6-8	18	II	—	—	43	None	Multiple oil globules.
6-9	15	I & II	—	—	—	—	Double HCG 250 and 500 I.U./lb. 31 hrs. later, no advancement.
6-9	13	I & II	—	—	—	—	No advancement at 30 hrs. Sacrificed.
6-11	2.5	I	—	—	—	—	Dead 15 hrs.; eggs advanced.
6-11	1.75	I	—	—	—	—	No advancement; dead 27 hrs.

Table 1. Results of hormone induced ovulation of snook, 1975.

Date	Wt. (Lbs.)	Egg Stage at Injection	Time to Stage VI	Stage VI to Ovulation	Total Latency	Viable Eggs 2-4 hrs.	Comments
6-11	3.0	I & II	—	—	—	—	Dead 25 hrs.; spent.
6-11	2.25	I	—	—	—	—	Dead 24 hrs.; spent.
6-11	2.0	I	—	—	—	—	Dead 13 hrs.; spent.
6-11	1.75	I	40.5	—	—	—	Dead 41 hrs.; Stage VI
6-12	2.5	I - VI	—	—	—	—	Dead 9 hrs.; spent.
6-12	2	I & II	30.0	1.5	31.5	20,000	Obtained fry.
6-13	2	I & II	—	—	35.5	20,000	Furacin treated. Advanced fry obtained.
6-22	2	II	36	1	37	20,000	Obtained fry.
6-22	2	I - III	—	—	—	—	Dead at 22 hrs.; O_2 off. Spent.
6-23	7	I - VI	30	6	36	150,000	Obtained fry.
6-24	17	I & II	30	2.5	32.5	500,000	Obtained fry.
6-24	2	—	—	—	—	10,000	Ovulating at capture.
6-25	3	II	—	—	—	—	Dead 35 hrs. Low D.O.
6-25	16	I & II	36.5	0.5	37	300,000	Fry obtained.
6-25	18	II	—	—	—	—	Dead 26 hrs. Low D.O.
6-25	13	II	—	—	32	150,000	Fry obtained.
6-25	17	No sample	—	—	—	—	Dead 5 hrs.; Low D.O.
6-26	3	No sample	—	—	—	—	Dead 5 hrs.; Low D.O.
6-26	3	No sample	—	—	—	—	Dead 5 hrs.; Low D.O.
6-27	2	I	—	—	—	—	Dead 24 hrs.
6-27	2.5	I	—	—	—	—	Dead 24 hrs.
6-27	2	I - VI	30	2.5	32.5	10,000	Good fertilization. Partially spent.
6-27	2.5	No sample	30	4	34	15,000	Eggs probably over-ripe.
6-28	3	No sample	33.75	2	35.75	20,000	Good fertilization. Obtained fry.
6-28	4	No sample	30	1.5	31.5	25,000	Good fertilization. Obtained fry.
6-28	3	No sample	30	1.5	31.5	20,000	Good fertilization. Obtained fry.
7-6	3	I & II	—	—	37.0	None	No male available at ovulation.

During 1975 refined egg incubation techniques provided consistent hatching success. Plates 2 and 3 provide photomicrographs of fertile egg developmental stages and prolarva. Hatching typically occurred at about 24 to 30 hours after fertilization at incubation temperatures between 82° and 87° F. Approximately 2.25 million fertile eggs from 21 broodfish were incubated without agitation in both static and flow-through systems. An estimated 325,000 larvae were hatched.

Extensive larval mortality occurred during shipping operations. One and two-day old larvae were transported by automobile in sealed plastic bags containing 2 gallons of water and oxygen to rearing facilities at the Exotic Fish Laboratory. Transport time was approximately 4 hours. Shipping mortality varied between 75 and 100 percent.

Fry Culture. Attempts to rear snook fry for stocking purposes were unsuccessful during the first two years of the project. Efforts were limited to intensive culture techniques at the Exotic Fish Research Laboratory due to lack of suitable rearing ponds. Rotifer cultures (*Brachionus plicatilis*) were maintained as food for snook fry. Laboratory culture systems included flow-through and filtered re-circulating systems, and static systems at various salinities. Although food ingestion by fry was confirmed on several occasions

heavy mortality usually occurred between 6 and 10 days of age. During the 1976 spawning season 42 fingerling snook were produced in the intensive culture system. Supplemental feeding with wild zooplankton was believed to be a principal factor in success.

Through the use of earthen rearing ponds excellent success has been obtained in striped bass fry culture, and particularly in the culture of hybrids between white bass and striped bass (Brasler, 1974). Recently there has been similar success in Texas with redfish and seatrout (Robert Stevens, personal communications). Snook fry culture in saltwater ponds prepared accordingly should provide similar results.

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