LABORATORY REARING OF THE COMMON SNOOK[a]

PAUL L. SHAFLAND, Florida Game and Fresh Water Fish Comm., 801 N.W. 40th St., Boca Raton, FL 33431

DUANE H. KOEHL, Florida Game and Fresh Water Fish Comm., 801 N.W. 40th St., Boca Raton, FL 33431.

Abstract: Culturability of snook (*Centropomus undecimalis*) was evaluated in laboratory studies during the summers of 1975-1977. This is the first report of snook being reared from artificially fertilized eggs. No snook survived longer than 11 days in the 1975 experiments, although about 50 and 250 were reared through metamorphosis and beyond in the experiments of 1976 and 1977, respectively. These snook were reared in closed saltwater rearing systems for 14-16 days, after which they were converted to fresh water and stocked in 0.01 ha ponds. In our studies, snook were not cannibalistic at sizes less than 20 mm TL; withstood low overnight dissolved oxygen concentrations of less than 1.0 ppm; and could be converted to fresh water at 15 days of age. Snook 15 days and older are relatively hardy, and if procedures could be developed to rear them to this age in large numbers, culture of fingerling snook could become a routine matter.

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Snook, one of the most sought after gamefish in south Florida, are a euryhaline, Neotropical-subtropical species that exhibit a strong affinity for fresh water. Historically, snook have coexisted with largemouth bass (*Micropterus salmoides*) and other freshwater fishes in Florida (Marshall 1958, Ager 1971, Dineen 1974).

Preliminary investigations into artificial propagation, rearing and use of snook in fresh water were begun by the Florida Game and Fresh Water Fish Commission several years ago (Ager 1976). If produced in sufficient quantities, it is hypothesized that freshwater sport fisheries for snook could be established in those areas where they were once abundant. Many of these areas are presently overcrowded with foreign and roughfish species. Snook stockings would increase predator pressure on these less desirable species and thereby assist in their management while providing a unique freshwater recreational resource.

Snook are unable to reproduce in fresh water since their sperm is activated only by salt water (L.A. Ager, Florida Game and Fresh Water Fish Commission, personal communication). Therefore, use of snook in freshwater fish management requires that they be mass produced, converted from a saltwater fertilization medium to fresh water sometime during their early life, and stocked in selected freshwater lakes and canals on a put, grow and take basis.

This report discusses procedures used and observations made during the summers of 1975-1977 when snook were cultured at the Non-Native Fish Research Laboratory in Boca Raton, Florida. These studies were performed in conjunction with saltwater pond rearing studies conducted by the Commission's Sportfish Introduction Project (Chapman 1978).

MATERIALS AND METHODS

Snook eggs were obtained from broodfish collected and spawned at the Collier County Conservancy Research Station, Rookery Bay, Florida. Broodfish collecting and induced spawning procedures followed those developed by Ager et al. (1978) and

[a]Contribution Number 20, Non-Native Fish Research Laboratory, FL Game and Fresh Water Fish Comm. Boca Raton, FL 33431

modified by Chapman (1976, 1978). Egg histories for the 3 rearing trials in 1977 are summarized in Table 1. All eggs were obtained by inducing ovulation with human chorionic gonadotropin (HCG). Eight to 10 hours after fertilization, eggs were placed in a 45 liter Igloo® cooler[a], fitted with styrofoam baffles, and transported about 225 km to Boca Raton.

TABLE 1. Female broodfish weight and egg histories for snook larvae reared in 1977. All times are given in hours after injection with human chorionic gonadotropin (HCG). Data provided by P.G. Chapman, Florida Game and Fresh Water Fish Commission, Lakeland.

TRIAL NUMBER	1	2	3
Weight (kg)	1.4	1.4	5.4
Egg Stage at Injection	I	I	I
HCG Injection Rate (IU/kg)	1100	1100	1100
Time of Ovulation	32	30	34.5
Number of Eggs Ovulated	100,000	122,000	261,000
Percent of Eggs Fertilized	90	90	80
Percent of Eggs Hatched	20	75	--
Time Eggs Began Hatching	17.5	--	18.5

Several hours prior to hatching (about 15 h after fertilization) floating advanced embryos were dipped from the cooler with a glass beaker and stocked in rearing tanks. Rearing tanks consisted of a 300 liter glass aquarium, an undergravel biological filter and four 8 liter rearing chambers (Fig. 1). Rearing chambers were made from 20 cm diameter acrylic tubing friction-fitted to a styrene funnel. Water entered the bottom of the funnel and flowed up and through screened (53 micron mesh) openings cut into the tubing (Fig. 2). Flow rate through a chamber was controlled by adjusting the air pressure to the rearing chamber air lift with a needle valve.

A layer of 5 cm unprocessed aragonite (Marcona Ocean Industries, Fort Lauderdale, Florida) was used as the undergravel filter medium. Rearing tanks were filled with natural sea water filtered through a 53 micron sieve. Addition of a protein skimmer and submersible heaters completed the basic water quality control apparatus. About 250 ml of the unicellular marine alga *Dunaliella primolecta* (mean density = 1.07×10^6 cells/ml), was added twice daily to each rearing chamber.

Temperatures and salinities in the rearing systems were maintained at 28 ± 1C and 33-38 ppt, respectively. Rearing chambers were kept static until the snook had hatched and dropped into the water column, at which time the upwelling current was turned on. Current was adjusted to maintain an even distribution and gentle movement of the larvae.

Snook were fed natural zooplankton (53-130 microns), consisting mostly of copepod nauplii, in combination with the laboratory-reared rotifer *Brachionus plicatilis* (less than 130 microns) for the first 7-8 days, beginning 25-35 h after hatching. Natural zooplankton was collected from the Boca Raton Inlet during both daily incoming tides by pumping sea water through a serial sieve (Shafland et al. 1979). Zooplankton between 53 and 225 microns was retained and taken to the laboratory where it was rinsed, separated into two size classes, concentrated and fed to the snook within 10 h of being collected.

[a]Reference to trade names does not imply endorsement by the Florida Game and Fresh Water Fish Commission.

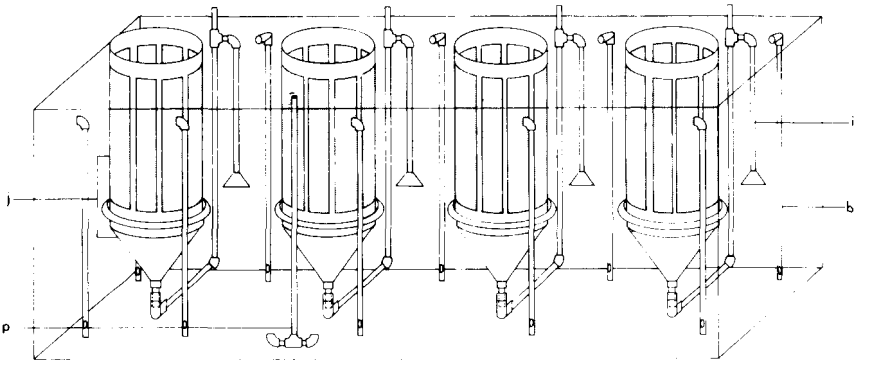

Fig. 1. Diagram of larval fish rearing system without an undergravel biological filter: (b) UG filter air lift, (i) rearing chamber and (p) inverted tee for filling tank (from Shafland 1979).

The ratio of natural zooplankton to laboratory-reared rotifers fed to the snook varied daily depending upon the availability of the zooplankton. Food densities were maintained at 3-10 organisms/ml and generally consisted of 30-40% natural zooplankton. Rotifers were used to supplement the diet of snook and were not offered as the sole food unless natural plankton was unavailable.

The size of natural zooplankton fed was increased when the snook were 9-10 days old to include organisms less than 225 microns and unsieved *B. plicatilis*. After the snook were 12 days old, their diet was converted to 24 h old San Francisco Bay ® brine shrimp (less than 225 microns) over a 2 day period.

Snook larvae were fed several times each day beginning shortly after lights were turned on at 0700 h. All food was added to the rearing chamber air lift and thus delivered to the bottom of the chamber. Food density in a rearing chamber was checked every 2 hours between 0700 and 1800 h by visually comparing it with a known density in a reference chamber.

Water quality parameters measured daily in the rearing tanks included ammonia, nitrite, nitrate, temperature, salinity and pH. A Hach model DR-EL/2 diagnostic kit ® was used to measure concentrations of ammonia, nitrite and nitrate. Procedures given by Hach Chemical Company for determining ammonia were modified to use an additional 5 ml of Rochelle salts. This modification prevented formation of a precipitate which had previously caused erroneous readings. Partial water changes were initiated if ammonia concentration was 0.08 mg/l or greater. A Corning model 610 portable pH meter ® and an American Optical temperature compensated refractometer ® were used to determine pH and salinity, respectively.

A second upwelling system was used to convert 14-16 day old snook from salt to fresh water over a 14-24 h period. The salinity-conversion system was identical to the rearing tanks except that Chattahoochee River rock was used as the undergravel filter medium. Salinities were decreased by adding fresh water to an undergravel air lift where it was evenly mixed with the conversion tank water. Rearing and conversion tanks were illuminated by double fluorescent lights.

Snook were converted from salt water to fresh water when they were 14 or 15 days old and immediately stocked in small (0.01 ha) ponds. These ponds were fertilized with alfalfa pellets (2.7-5.4 kg/pond) and hay (0.9-2.7 kg/pond) 8-11 days prior to stocking the snook. Snook survival was checked by shining a light just above the pond's surface where the water was about 1 m deep, and then counting the number of snook that were attracted.

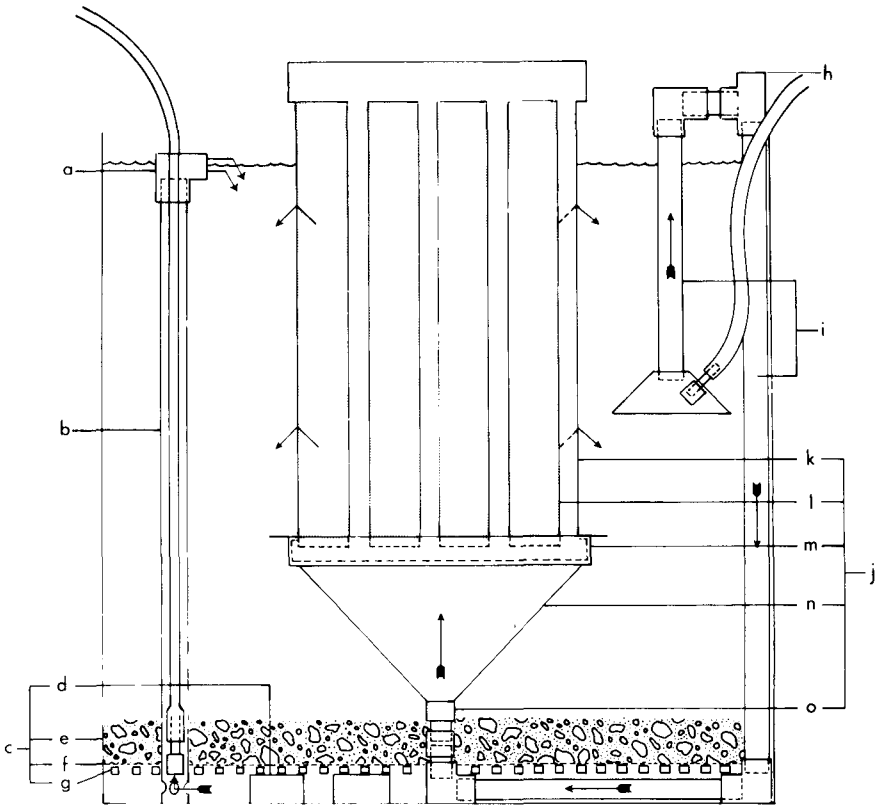

Fig. 2. Diagram of a rearing chamber and details of the larval fish rearing system: (a) ell for directing outflow of the undergravel (UG) filter air lift, (b) UG filter air lift, (c) UG filter, (d) filter plate support, (e) filter medium, (f) fiberglass window screening, (g) filter plate, (h) highest point that water can be air lifted in system, (i) rearing chamber air lift, (j) rearing chamber, (k) removable upper screened portion, (l) screened opening, (m) funnel-coupling joint, (n) funnel portion, (o) air lift to rearing chamber coupling joint (from Shafland 1979).

Approximately 2 kg of forage fish (*Gambusia affinis*) were stocked in the ponds when the snook were 30-40 days old.

Three attempts were made to convert newly hatched prolarvae from salt water to fresh water beginning when they were less than 1 day old. Initial salinities of 34-35 ppt were gradually decreased to less than 5 ppt over periods of 18-40 h. Freshwater zooplankton (53-130 microns), consisting mostly of copepod nauplii, was first fed to these larvae 27-50 h after hatching.

RESULTS

Snook were reared for the first time from artificially fertilized eggs to fingerlings during the course of this study. No snook survived longer than 11 days in the 1975 experiments, although about 50 snook were reared in 1976. In 1977, about 250 snook were reared to 14 or 15 days of age in 3 rearing trials. Of these, about 150 were converted to fresh water and stocked in outdoor ponds, which yielded 45 fingerling snook 85-117 mm TL (Table 2).

TABLE 2. Number of snook reared through various stages in three 1977 rearing trials.

STAGE	TRIAL I	TRIAL II	TRIAL III
14-15 Days	65	30	150
Stocked in Pond	63	12	71
Harvested from Pond	27	1	17
Age at Harvest (Days)	117	108	89
Total Length (mm)	85-177	118	121-137

Mortality associated with transporting fertilized eggs from Rookery Bay to Boca Raton was minimal although transportaion of 1-2 day old snook resulted in high mortalities. Natural zooplankton, consisting mostly of copepod nauplii between 53 and 130 microns, is a suitable first food for snook. Although snook larvae consumed laboratory-reared rotifers, they did not grow well and eventually died when these were provided as the only food.

Attempts to convert newly hatched snook larvae (1.4-1.5 mm SL) from salt water to fresh water were unsuccessul although a few lived for 8 days. Typical larval S-flex feeding behavior was observed in these larvae when they were 4 days old and some of these larvae were successful in eating copepod nauplii. One 6 and one 8 day old larvae measured 2.73 and 3.43 mm SL, respectively.

Ammonia, nitrite and nitrate levels were generally less than 0.05, 0.03 and 5.0 mg/l, respectively. The pH ranged from 7.8-8.2

DISCUSSION

The primary factor limiting the number of snook reared in this study was the general unavailability of a suitable first food. Although no snook were reared through metamorphosis on rotifers alone, rotifers are thought to have had a beneficial effect because of the limited amount of natural zooplankton available.

Snook larvae began to orient horizontally for short periods of time within 24 h of hatching, becoming predominately horizontally oriented by Day 3. Development of the eyes and jaws of larval snook was completed 32-48 h after hatching. Typical larval fish S-flex feeding behavior was first observed when snook were 2-3 days old. At this time, snook still had some of their oil globule present.

Ten day old snook were observed feeding on zooplankton in a 5 stage feeding pattern consisting of (1) a short horizontal approach into a position below and to the side of a prey; (2) elevation of head to about a 45 degree angle pointing directly at the prey, and movement into a position with the head oriented directly below the prey; (3) capture of the prey organism while in a vertical position, head pointed up; (4) return to the 45 degree position; followed by (5) the typical horizontal resting position.

Natural zooplankton measuring 130-225 microns was not utilized when offered to snook on Day 7. Similarly, brine shrimp nauplii were rejected by 8 day old larvae. Natural zooplankton up to 225 microns were utilized starting between Day 9 and 11, and brine shrimp were first eaten between Days 12 and 14.

Three attempts were made to convert newly hatched snook prolarvae to fresh water, before they required an exogenous food source. Nearly all of these prolarvae survived the transition to fresh water although most died within 4 days. These fish behaved differently than larval snook reared in salt water, in that they would alternately lie on the bottom and

move up into the water column 2 or 3 times per day for the first 3 or 4 days. Although none of these snook survived longer than 8 days, the possibility of converting prolarval snook to fresh water should not be totally ignored.

Fifteen day old snook in good condition were not excessively stressed by handling and physiological strain associated with converting them from salt water to fresh water over a 24 h period (97% survival). The 15 day old snook converted to fresh water in 14 h were not in good condition, and only about 40% survived the transition process. We feel that 15 day old snook in good condition could be converted to fresh water in 14 h or less without any significant mortality.

Cannibalism is an important consideration when intensively culturing larvae of predatory finfishes. No cannibalism was observed in any of our rearing trials. When several 6 day old snook were placed in a chamber containing 14 day old snook, the older, larger snook paid little or no attention to the smaller snook. Snook do become piscivorous at 25-30 mm TL (Fore and Schmidt 1973), and if a suitable forage species is not available, snook will presumbaly become cannibalistic at this time.

Survival of snook in one of the ponds was not confirmed until they were 60-70 mm TL, at which time forage fish were added to the pond. No survival of 12 snook stocked in another pond was noted until the pond was drained. Poor survival of snook in these ponds may be partially due to cannibalism. Given sufficient zooplankton until the snook are 20-25 mm TL followed by a suitable forage fish, it is believed that the 40% yield of fingerlings (85-177 mm TL) from the third pond is a practical yield to expect when ponds are stocked with 15 day old fish.

A final characteristic which may make snook a potential culture fish is their tolerance to low dissolved oxygen concentrations. Snook survived minimum sunrise dissolved oxygen concentrations as low as 0.4 ppm in the small grow-out ponds.

In our studies, 2 periods of mortality occurring at 4-6 and 9-12 days of age were particularly significant. The first of these was associated with the disappearance of the yolk sac and oil globule, at which time larvae become completely dependent on an exogenous food source. Some snook dying during this period had previously begun to feed on copepods and rotifers. The second major mortality period was associated with the time immediately preceding metamorphosis. Since size is often used as a general indicator of larval condition or health, it was interesting to note that various sizes of snook entering this mortality period seemed to be nearly equally affected.

Snook may be successfully cultured in the future since they do not appear to be cannibalistic at sizes less than 20 mm TL, can withstand dissolved oxygen concentrations of less than 1.0 ppm for short periods of time, and can be converted to fresh water when they are 14-16 days old. The principal difficulty in rearing snook, as with other marine finfishes, is high larval mortalities. Snook 15 days and older are relatively hardy, and if procedures could be developed to rear them to this age in large numbers, culture of fingerling snook could become a routine matter.

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