Induced Maturation and Spawning of Common Snook, Centropomus undecimalis

DANIEL E. ROBERTS, JR.
Florida Department of Natural Resources
Division of Marine Resources
Bureau of Marine Research
100 Eighth Avenue, S.E.
St. Petersburg, Florida 33701-5095

ABSTRACT

Common snook (Centropomus undecimalis) stocks have declined drastically over the last decade in Florida waters. The State of Florida is dedicated to development of innovative management practices including aquaculture and stock enhancement. Recently, development of a large scale stock enhancement program accelerated the need for production of fry and fingerlings for research. Previous and new methods of fry production are described. Snook eggs were produced by exogenous hormone application and sourcing wild broodstock. Early spawning work resulted in large broodstock mortality and low fry and fingerling production. Limited success of induced gametogenesis was achieved by manipulation of photoperiod and temperature both in summer and winter. Source spawning was achieved by collecting broodstock during new and full moon phases and strip spawning. Wildstock source spawning occurred between 1800 hours and midnight; 1.0×10^7 eggs were produced. Average number of eggs and fry per female was 6.98×10^5 and 4.67×10^4, respectively. Snook in Tampa Bay, Florida, were found to spawn on diel and lunar cycles during new and full moon phases.

INTRODUCTION

The common snook (Centropomus undecimalis) is a popular game and food fish in south Florida, south Texas, the Caribbean Basin and the coasts of Central and South America.

Despite the widespread popularity, economic and recreational importance of snook, there is a severe paucity of information concerning its biology, life history and population structure. The height of spawning activity in south Florida occurs around June (Marshall, 1958), near passes and the mouths of estuarine rivers. Snook are asynchronous pelagic spawning fish that produce planktonic eggs about 1 mm in diameter. Hatch time is 16 hours at 29°C resulting in a prolarva less than 2 mm TL. Gut, mouth and eye development are complete by 96 hours and the larva begins its predatory existence. After about 20 days metamorphosis is complete. In Florida the spawning cycle is annual. Spawning occurs in summer, while mitotic proliferation of oogonia and spermatgonia occurs throughout much of the year. Vitellogensis in females begins in mid to late April and continues through September. Lunar periodicity apparently affects final maturation and spawning. Systematic studies of the

reproductive biology of snook are lacking. Satisfactory methods for capture of ripe fish (seasonally) and induction of ovulation in females with ovulatory chemicals (HCG), extension of sperm viability and strip spawning/fertilization techniques were outlined by Ager et al. (1976). The structure of the testis was described by Roberts and Grier, 1983.

The Florida Department of Natural Resources (FDNR) is currently beginning construction of a marine finfish fingerling production research facility. The site covers 53.5 acres of upland on the southern shore of Tampa Bay, Florida. The complex, when completed, will consist of twentyfour-0.5 hectare earthen ponds for production of common snook (Centropomus undecimalis), red drum (Sciaenops ocellatus), and possibly other estuarine predatory game and food fish. Based on current egg viability estimates for snook and red drum, operation of the new facility will require approximately 1.00×10^8 snook eggs and 3.67×10^7 red drum eggs per year, respectively, to stock ponds at 600,000 fry per hectare. Currently, viability of snook embryos is poor due to the spawning methodology employed, thus the large number of eggs required. Conversely, viability of red drum eggs is very good with induced natural spawning of eggs as the method of choice. In 1976, researchers at the National Marine Fisheries Service (NMFS), Port Aransas Marine Laboratory, Port Aransas, Texas, and the FDNR Bureau of Marine Research, working independently, simultaneously developed methods for induced maturation of gametes, and command spawning of captive red drum broodstock (Arnold et al., 1977; Roberts et al., 1978). These methods, though refined, are still used today. Viability of the naturally spawned eggs is usually high and results are predictable and repeatable. No such technology exists for production of eggs of common snook. Snook have been spawned about 160 times (Table 1). Ovulation was induced in most of these spawns by exogenous application of human chorionic gonadotropin (HCG). Experiments to induce maturation and spawning in snook using exogenous environmental stimuli such as variations in photoperiod and temperature have been continuing at FDNR BMR in St. Petersburg. A reliable methodology has not been developed. With fingerling production research beginning in July, 1986, a reliable method for production of eggs is paramount. This report summarizes the current technology utilized for production of common snook eggs and indicates directions for future research.

METHODS

Fish were collected in Tampa Bay using a 60 m bag seine and transported to the laboratory by live-well trailer. Some fish were tube-biopsid and released.

Fish were anethetized with MS-222, and held unconscious in a hydrorespirator. Seawater containing anesthetic was aerated and delivered to the gills during surgical procedures.

Controlled maturation experiments were conducted in separate computerized 20,000 l closed system facilities (Roberts and Schlieder, 1983). Water temperature was maintained to 0.1°C by a

computerized HVAC (liquid brine, steam) system. Photoperiod regimes were programmed and computer controlled in 30-day segments. Fish were fed a monospecific diet, whole penaeid shrimp. Water quality was maintained by submerged biological, settling and mechanical filtration devices.

RESULTS

Three methods were investigated to spawn common snook (Table 1).

1) Hormone-induced strip spawn.

2) Natural ovulation/strip spawn of wildstock.

3) Manipulation of environmental parameters in controlled laboratory conditions.

Hormone Induction

The Florida Game and Fresh Water Fish Commission (FGFWFC) attempted mariculture of snook (Chapman et al., 1982). Fish were collected during the natural spawning season (April through August) by hook and line and spear gun near passes along the southwest coast of Florida and were transferred to holding facilities. Anesthetized females were tubed for ovarian biopsy, and male ripeness was determined by visceral massage.

Hormone spawning is summarized in Table 1. In 1974, 17 females were injected with HCG (300-1100 IU/kg); 500,000 eggs were produced from one spawn. No fry were hatched. All broodstock failed to survive the stress. Likewise, in 1975, 60 females were sacrificed to produce 2.25×10^6 eggs; no fry were produced. In 1976, 7.5×10^5 fry were produced from 25 females. In 1977, results were better and about 8.71×10^5 fry were produced from 21 females. The FGFWFC project was terminated in 1978 and mariculture of the species was not attempted until development of experimental fish hatchery projects at the University of Miami, Harbor Branch Foundation, and initiation of a five year reproductive physiology study at FDNR BMR in 1984. In summer 1984, BMR spawned 10 female snook using the previous technology and produced 7.0×10^5 fry. Prophylactic measures and reduced stress on females (through use of a respirator) yielded better survival of broodstock. However, it was obvious that refinement was needed to make this method suitable for stocking a production scale hatchery.

Source Spawning

During summer 1985, BMR was studying environmental factors that affect the reproductive cycle of snook. Adults were collected in their spawning habitat and eggs and larvae in the plankton. Precise temporal and spatial parameters involved in the spawning cycle were identified. A total of 576 fish were collected in June, July and August; 178 females and 398 males.

Table 1. Results of Induced Spawning Research in female common snook 1974-1985.

HCG

Year	No. of Fish	No. of Eggs	No. of Eggs Per Fish	No. of Fry	No. of Fry Per Fish	Broodstock Mortality
1974	17	500M	29.4	0	0	100%
1975	60	2250M	37.5	0	0	100%
1976	25	2041M	81.6	750M	30M	100%
1977	21	3500M	167.7	871M	41M	100%
1984	10	5000M	500.0	700M	70M	70%
1985	3	650M	216.6	31M	10M	100%

SOURCE

Year	Fish No.	No. of Eggs	Viability (%)	No. of Fry	Broodstock Mortality
1985	1&2	400M	50	31M*	Live
1985	3	3420M	86	432M*	Dead
1985	4	3200M	86	-	Live
1985	5	1000M	-	-	Live
1985	6	800M	95	-	Live
1985	7	300M	40	-	Live
1985	8	-	-	-	Live
1985	9	250M	10	-	Live
1985	10	100M	23	-	Live
1985	11	800M	23	191M*	Live
1985	12	-	-	-	Live
1985	13	-	-	-	Live
1985	14	-	-	-	Live

*Produced 89,000 fingerlings

Very few females were caught in these areas at quarter moon phases. Most were only found during the new and full moon. In fact, total catch was much reduced at quarter moon phases (Figure 1). Males were precocious and were producing hydrated milt during the entire spawning season. Female snook caught on the spawning site and at other locations in the bay during quarter moon phases demonstrated oocytes in the tertiary yolk stage (TYS) only. Females caught two days before and on the day of the new and full moon had oocytes undergoing maturation in the morning and a high percentage of ovulated eggs in the afternoon (Figure 2). Oocyte stage frequency of live oocytes around the periods of new and full moon demonstrated all oocytes to be in TYS in the morning, and migratory nucleus (clearing) stage beginning around noon. By 1600 hours meiosis had resumed in 100% of the females sampled. Two hours later ovulation began. This pattern was observed in all mature females collected on these spawning sites at the new and full moon. Peak activity was actually two days prior to new and full moon periods. This model was used to test the hypothesis that precise time of natural ovulation of females could be predicted on selected lunar days, and that fish could be strip spawned after ovulation without the use of hormones. Prediction was that 1) meiosis would resume in oocytes (from meiotic prophase) near slack high tide of the day (within 2-3 hours of noon), 2) ovulation would begin about five hours after slack high tide, and 3) be complete six hours after slack high tide (Figure 3).

Using this model, BMR spawned 14 fish in August and September without using hormones. Average egg viability to gastrulation was low. However, the low figures were mostly from September when a large portion of the spawning population had become refractory. Overall, 1.0 x 10 eggs were produced; ninety-two percent of broodstock females survived; average number of eggs and fry per female was 6.98 x 10 and 4.67 x 10 , respectively and from these fry 96,000 fingerlings were raised.

Photoperiod/Temperature Control of Maturation and Spawning

Attempts to induce maturation in the hatchery were made. Male and female snook were held at a constant temperature of 27°C and three different photoperiods; 8HL:16HD, 16HL:8HD, and 12HL:12HD for 120 days. Only those fish on long photoperiod, 16HL:8HD, showed reproductive potential (Figure 4). After 120 days males would produce milt after visceral massage. One female had oocytes in TYS, but was not functionally mature, however, as the frequency of (TYS) oocytes was too low. That spermiation in males and vitellogenesis in females occurred indicates a response to this regime.

SUMMARY

Snook demonstrate a circadian rhythm of annual spawning. Females can be spawned by exogenous application of HCG and by sourcing pre-ovulatory females at selected spawning sites. Wet and dry strip-spawning can then be applied. Photoperiod and

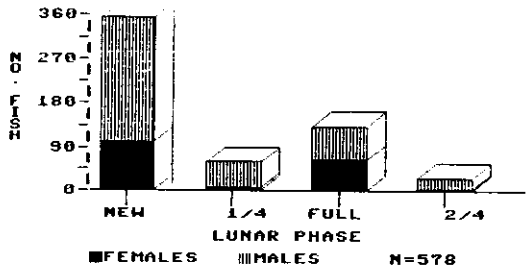


Figure 1. Total snook catch by sex and lunar phase.

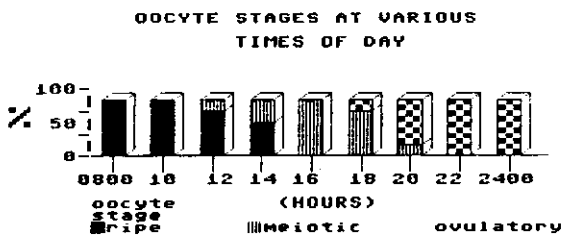


Figure 2. Daily maturation cycle of female snook (new moon, July, 1985).

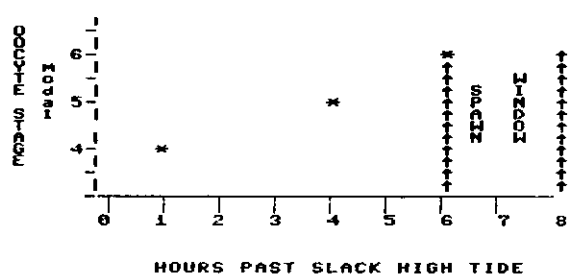


Figure 3. Predicted and observed source spawning regime, new and full moon, July, 1985.

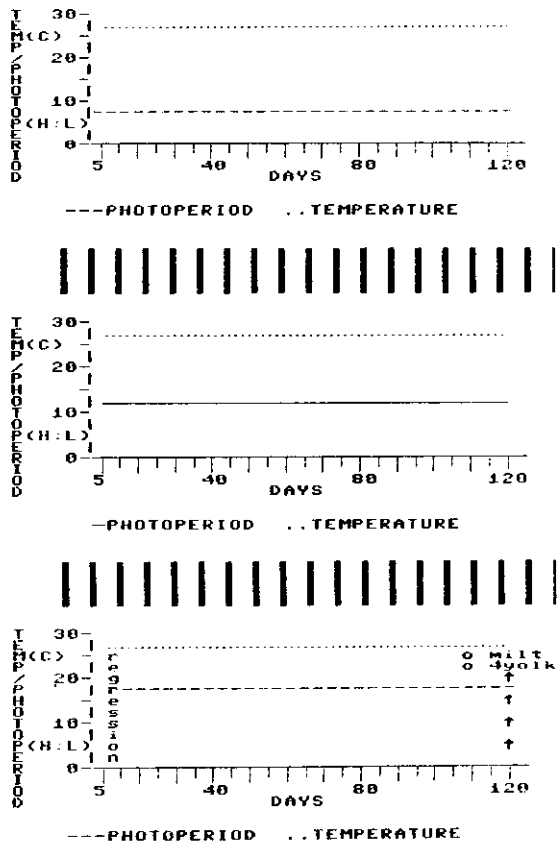
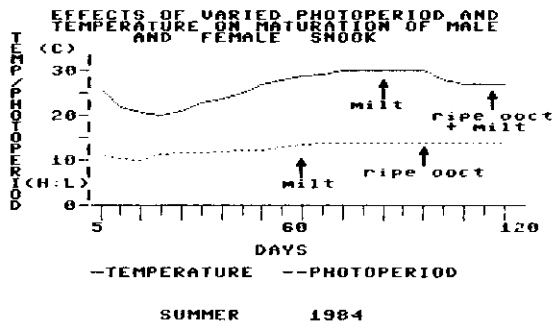


Figure 4. Results of photoperiod/temperature treatments on snook.



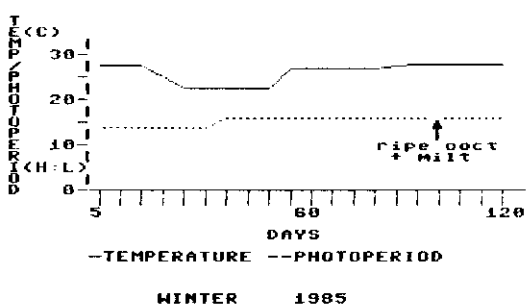


Figure 4. (cont.) Results of photoperiod/temperature treatments on snook.

temperature regimes demonstrate limited success, inducing gametogenesis under long days and warm temperature. Natural spawning of captive broodstock has not been successful. Further research needs to be done to produce repeatable reliable results and to determine the physical/chemical parameters that induce natural spawning. Studies of the reproductive biology of wildstock will be repeated in summer, 1986. Until two years of data are analyzed, these results should be considered preliminary.

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