Snook culture

John W. Tucker, Jr.[1]

Snook (*Centropomus* species) are in the subfamily Centropominae of the family Centropomidae (Rivas 1986). Although not well known in most of the U.S., snook are popular game and food fish from Florida and southern Texas southward and have been exported from South America to the U.S.

Two other centropomids have become better known to consumers outside their natural ranges. Barramundi (*Lates calcarifer*) are exported from Australia and Asia and Nile perch (*Lates niloticus*) from Africa to the US and other countries. Snook culture research has been conducted since the 1970s (Ager *et al*. 1978, Shafland and Koehl 1980, Chapman *et al*. 1982, Lau and Shafland 1982, Edwards and Henderson 1987, Tucker 1987, Kennedy *et al*. 1998, Alvarez-Lajonchére 2001, Tucker 1998 in press) but not with the same intensity as for barramundi, the Australian/Asian snook, for which farming is fully developed (Tucker 1998, Tucker *et al*. in press). Common snook (*Centropomus undecimalis*) and barramundi have many similar life history and culture characteristics. For barramundi, harvest densities of up to 2.2 kg/m^2 in ponds, 40-60 kg/m^3 (25 kg/m^3 optimal) in cages, and about 100 kg/m^3 in super-intensive tanks have been reported. Market size usually is in the range 250-1000 g, but it is economical to raise them to 3 kg or more.

*Fig. 1. Common snook (*Centropomus undecimalis*), fat snook (*Centropomus parallelus*) and tarpon snook (*Centropomus pectinatus*) in Florida. (Photo by Tom Smoyer, HBOI)*

Six species of snook reside in the eastern Pacific and six in the western Atlantic and Caribbean. Common snook (Figure 1) is the largest and fastest-growing member of the family in the western Atlantic. Of four species in Florida, it is by far the most abundant (more than 90 percent of individual fish). Maximum size in Florida is about 130 cm total length (TL) and at least 24 kg, with reports of larger fish in Latin America. Common snook occur in southern Florida, southward through the Caribbean Sea, along the east coasts of Mexico and Central America and as far south as Rio de Janeiro, Brazil. They occasionally are taken in southern Texas and as far north as Pamlico Sound, North Carolina, but are rare north of Cape Canaveral, Florida. Other names include: snook, robalo común (Spanish, Portuguese), camuripeba (Portuguese), sergeantfish, pike, loubine (French), and brochet de mer (French).

Food quality and consumer acceptance of common snook are high (Tucker *et al*. 1985). Skinless, boneless fillet yield from snook weighing 350-500 grams is 57-60 percent, compared with 40 percent for barramundi and sunshine bass. Fat content is 0.5-0.8 percent, and baked fillets have a fresh or delicate aroma, bland taste and a juicy, meaty, firm texture.

Smaller Atlantic species are: Mexican snook (*C. poeyi*), Gulf coast of Mexico, up to 900 mm fork length (FL), 8 kg; fat snook or smallscale fat snook (*C. parallelus*; Figure 1), southern Florida to Florianopolis, Brazil, 634 mm TL, 3.1 kg; tarpon snook (*C. pectinatus*, Figure 1), southern Florida to Bahia, Brazil, 515 mm TL, 1.5 kg; constantino or largescale fat snook (*C. mexicanus*), Gulf coast of Mexico to Porto Alegre, Brazil, 430 mm TL; swordspine snook (*C. ensiferus*), southern Florida to Rio de Janeiro, 356 mm TL.

In the Pacific, both the black snook (*C. nigrescens*), Baja California to Colombia, and the white snook (*C. viridis*), Baja California to Peru and the Galapagos Islands, reach about the same size (117 cm, 24 kg) as common snook. Smaller species are: blackfin snook (*C. medius*), Baja California to Colombia, 465 mm TL; longspine snook (*C. armatus*), Mazatlan to Ecuador, 370 mm TL; humpback snook (*C. unionensis*), El Salvador to Peru, 366 mm TL; little or yellowfin snook (*C. robalito*), Gulf of California to Panama, 345 mm TL.

Because of their growth rates, common, black, white and, possibly, Mexican snooks are the best candidates for aquaculture. Snook aquaculture research has been conducted in Florida, Texas, Mexico (east and west) and South America (Tucker 1998 in press). Common snook have been raised on experimental pelleted feeds in tanks to 8 kg and can reach 500 g in 12 months, 1 kg in 18 months, and at least 2 kg in 24 months.

Snook must spawn and go through egg and early larval stages in salt water, but juveniles prefer fresh or brackish water. Wild juveniles of different species have been collected and raised in ponds at various locations in South America, Mexico and the Dominican Republic. FAO (2001) reported that the Dominican Republic produced 330 tons of common snook in brackish water during 1994, 287 tons in 1995, and 300 tons worth US$657,000 in 1996. Mexico produced one ton in salt water during 1994.

Nile perch are imported and sold in Florida, sometimes as "African snook." However, Florida laws protect true snook (*Centropomus* spp.) as gamefish, and their

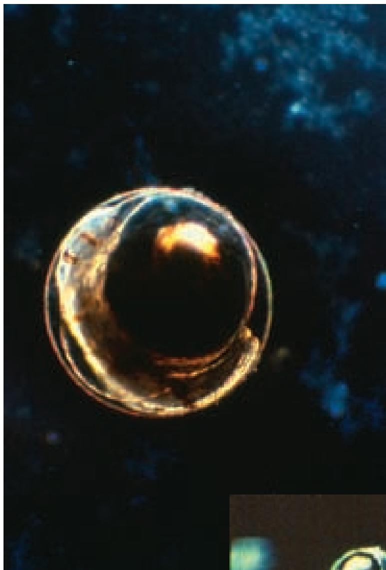

Fig. 2. Common snook egg just before hatching (750 µm diameter). (Photo by John Tucker)

Fig. 3. Common snook hatchling (1.5 mm TL). (Photo by John Tucker)

Fig. 4. Late larval common snook (30 days after hatching, 35 mm TL) just before transformation to the juvenile stage. (Photo by Tom Smoyer, HBOI; from Tucker, 1998, with permission from Kluwer Academic Publishers)

sale is prohibited. Commercial farming of snook in Florida would require special permitting. In Texas and California, permitting should be more routine.

Spawning of common snook in nature occurs mostly with water temperature at 25-31˚C, but possibly as low as 22-23˚C (Tucker and Campbell 1988, Peters *et al*. 1998, Taylor *et al*. 1998). For larvae, optimal temperature is about 26-27˚C, but they remain healthy and grow well at about 25-29˚C. Juveniles are very sensitive to temperature changes. For them, lethal limits are less than 10˚C and somewhere above 35˚C. Very little feeding and growth occur below 20˚C, but both increase sharply at 25˚C. The optimum for growth is about 28˚C, with a decrease in growth and growth efficiency at 31˚C.

Common snook spawn at high salinities, probably mostly in the range 28-35 ppt; healthy eggs usually will float at 30 ppt or higher; 28-35 ppt is good for larvae. Larvae can survive transfer to fresh water 15 days after hatching, and 0-35 ppt and higher is suitable for juveniles and adults. Salt water is needed for broodfish, eggs, and about half of the larval stage, but late larvae and juveniles can be raised in fresh water. Therefore, hatcheries require a saltwater source, but nursery and growout facilities do not, which allows more flexibility in siting. Larvae have been raised in tanks and earthen ponds. Juveniles have been grown out in a variety of tanks and ponds.

Because juvenile and adult snook are naturally adapted to living in shallow estuaries and swamps, they can tolerate relatively high turbidity, (i.e., water with zero visibility) as long as suspended solids are not so abrasive that the gills are injured. A minimum of 4 mg/l dissolved oxygen keeps juveniles healthy, but juveniles and adults can tolerate 0.9-1.0 mg/l for several hours. Juveniles and adults are gregarious and tolerate crowding very well, making a wide range of culture systems possible.

Common snook are protandrous hermaphrodites—first male, then female (Peters *et al*. 1998, Grier 2000, Taylor *et al*. 2000). Some wild males are mature by two years (≥15 cm) and all by five years (about 51 cm). Some wild females are mature by 2.5 years (≥43 cm) and all by 7-8 years (about 63 cm). Common snook spawned near inlets or just offshore along the east central Florida coast, as early as April and as late as October, with a peak in July-August (Tucker and Campbell 1988). In west central Florida, spawning occurred from April through September, near the coast, in large bays and estuaries, and around nearshore islands (Peters *et al*. 1998, Taylor *et al*. 1998).

Common snook have been caught near the time of ovulation and strip-spawned during the natural season. Induced spawning of newly caught or captive wild snook is standardized (Chapman *et al*. 1982, Roberts 1987); usually, fish are stripped, but some fertilization has occurred when eggs were released in the holding tank. We routinely obtain eggs with fertilization and hatching rates near 100 percent. Typically, at 28°C, ovulation occurs 34 h (range 28-45 h) after one injection of 500-1000 IU HCG/kg (Ager *et al*. 1978, Chapman *et al*. 1982, Tucker 1987, Neidig *et al*. 2000). More than a million eggs can be obtained from a 7 kg female. Ovulation also has been induced by implantation of GnRHa pellets (Skapura *et al*. 2000). Occasionally, males are injected with a half dose to dilute and increase the flow of milt, but this usually causes only a temporary increase, followed by premature loss of ripeness. Tank spawning has been reported to happen only after hormone treatment.

Common snook eggs (Figure 2) usually are 700-750 μm in diameter and hatch in about 17 h at 28°C; hatchlings (Figure 3) are 1.5 mm TL; larvae first feed at about 2.5 days after hatching (about 2.5 mm TL) and exhaust their yolk and oil at 4-5 days after hatching (but oil could last 1-2 days longer); transformation to the juvenile stage (Figure 4 and Figure 5) occurs at about 35 days after hatching, 35-40 mm TL (Tucker 1987). Either eggs or hatchlings can be stocked in rearing units, but survival of transferred larvae is lower. Larvae can begin eating ciliates, small rotifers, and small copepods (30-100 μm wide) at 2.5 days after hatching. They prefer copepods but find them harder to catch for at least the first few days. They will start eating *Artemia* at 8-10 days after hatching, but can die from gorging if too many are available too soon. As is true of many other marine fish, copepods increase growth and survival of snook larvae.

The main obstacle to snook farming is the need for refining larval culture techniques to improve survival, especially during the first week. In 1995-1996, we began inoculating hatchery water with probiotic bacteria isolated from healthy hatchery-reared snook and obtained large improvements in survival (7.0 percent despite cannibalism, compared with the usual <2 percent reported), growth and size uniformity (Kennedy *et al*. 1998). Snook reared with progressive hatchery methods grow fast, have not needed drugs and are not likely to; they are resistant to diseases and stress. During transport by truck for six hours followed by holding in tanks for 12 hours, survival of four batches (600-1,800 fish/load) of those juveniles was 100 percent. Then, after 2,368 of them were held in two open brackishwater ponds for 62 days, survival was 94 percent.

Fig. 5. Nursery-stage common snook juveniles (50 days after hatching). (Photo by Tom Smoyer, HBOI)

Maciorowski *et al*. (1987) raised common snook larvae extensively in earthen ponds on mixed zooplankton. When two moderately stocked (initially >217,000 three-day-old larvae/ha) 0.8-ha ponds were harvested during transformation (32 days after hatching), nearly all the snook died from handling and salinity stress; recovery would have been 17 percent and 25 percent. Recovery from two lightly stocked (39,000 larvae/ha) 0.4-ha ponds was 0.03 and 25.1 percent at 36 days after hatching (early juveniles). Recovery from two moderately stocked

(239,000 larvae/ha) 0.4-ha ponds was 0.6 percent and 5.1 percent at 42 days after hatching.

In 1999, fat snook were raised on enriched rotifers and *Artemia* in green water in two 4,000-L tanks with constant light of 2,500 to 10,000 lux for the first 15 days, then a natural photoperiod with 1,500-7,500 lux thereafter (Alvarez-Lajonchére 2001; Alvarez-Lajonchére et a. 2002). Survival from hatching to 68 days after hatch was estimated at 20 percent (13,000 fish, 45 mm TL, 0.94 g) and 31 percent (22,000 fish, 37 mm TL, 0.47 g). Juveniles in the first tank then grew to 58 mm and 2.11 g at 88 days after hatch.

Fig. 6. Common snook suitable for stocking in tanks, ponds or cages for growout (3 months, 100 mm TL, 10 g). (Photo by Tom Smoyer, HBOI)

Weaning of common snook to conventional dry crumbles is relatively easy and can be accomplished by or before 35-38 days after hatching. Cannibalism is worse in early juveniles than in late larvae and is increased by higher fish density and food shortage. Cannibals will eat other snook up to at least 70 percent of the offender's length. Weaning early and quickly, feeding well and frequently, and grading snook from transformation until they reach 100 mm TL (Figure 6) will help to control cannibalism and increase survival.

Research on specific nutrient requirements has not been reported, but our starter feeds containing 55-60 percent protein, 16-18 percent fat and 7-10 percent carbohydrate, and our grower feeds containing 50-56 percent protein, 13-14 percent fat and 13-25 percent carbohydrate (dry basis) have performed very well. Up to 30 percent soybean protein gave excellent results with common snook and other carnivorous fish such as barramundi and spotted seatrout (*Cynoscion nebulosus*).

Common snook are relatively inactive except when feeding, and therefore utilize feed very efficiently. Over the size range 16-726 g, growth rate ranged from 2.08 to 0.67 percent/day and feed conversion ratio (FCR = weight of dry feed needed to produce a unit weight of wet fish) ranged from 0.73 to 1.10. Snook in the range 504-726 g gained 4.1 g/day (0.67 percent/day) with a FCR of 1.10 and protein conversion ratio of 0.58. In 1986, a 500 g snook could be produced in 12 months with a feed cost of US$0.33; by 2002, that cost had approximately doubled, partly because the price of fishmeal had risen.

In the fish meal reduction phase of our feed development program, it was found that young juveniles benefit from some fish meal (10-20 percent) but older ones do not need any. Additional formula refinements are expected to reduce, and probably eliminate, fishmeal from starter feeds for snook, but already we have shown that other ingredients can be substituted for nearly all of the previously assumed fishmeal requirement for this carnivorous marine fish—a significant step toward cost-efficient, environmentally responsible, commercial production. The zero-fishmeal feeds also have been used successfully for Nassau groupers (*Epinephelus striatus*), spotted seatrout and striped mullet (*Mugil cephalus*).

Although common snook culture research has been conducted for more than two decades, efforts have been sporadic and less intense than those spent on barramundi, which has a similar life history but is being farmed successfully with well-developed technology in several countries. Juveniles and adults of both are gregarious and tolerate crowding. When reared in fresh well water, juvenile and adult snook at our facilities have had no disease problems (Tucker 1987). Snook have large scales, are adapted to surviving in shallow tropical swampy habitats, and seem to be relatively resistant to parasites. Improved hatchery management and nutrition will increase future survival and growth rates of common snook. With effective control of cannibalism, routine survival of at least 10-15 percent is possible. Combined with consistent egg quality and handling, this level of survival would make commercial farming of snook from eggs feasible. For commercial hatchery production to be realized, only scaling up is required.

Notes

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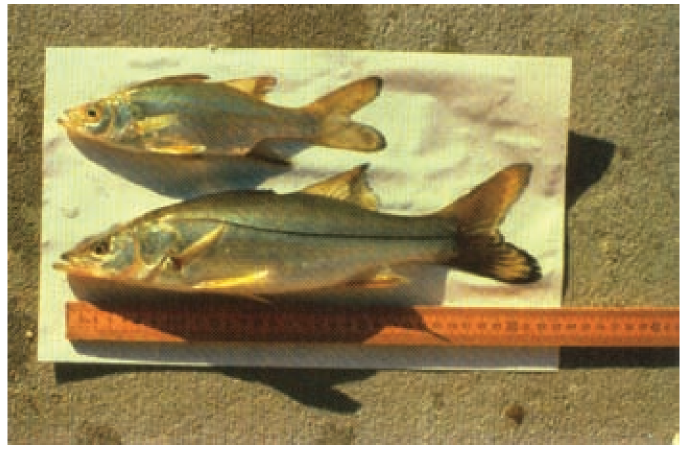
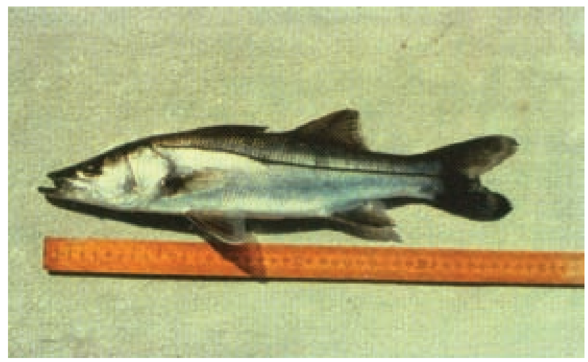


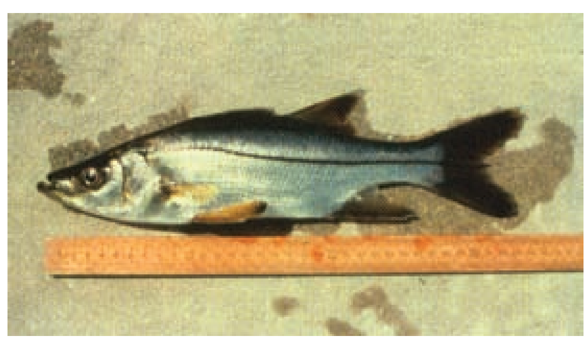
Fig. 7. Tarpon and common snook (1 year old, 8 months of feeding and growth). (Photo by Tom Smoyer, HBOI; from Tucker, 1998, with permission from Kluwer Academic Publishers)

Fig. 8. Common snook (2 years old, 15 months of feeding and



growth, 740 g). Common snook is a high-value target species for aquaculture already raised from wild juveniles in the Caribbean and Latin America. They are gregarious and easy to grow out under crowded conditions in salt or fresh water. Snook have a low energy requirement for main-tenance, leading to a very good feed conversion. They are in demand both for food and for recreational fishing. (Photo by John Tucker)

Fig. 9. Tarpon snook (2 years old, 15 months of feeding and growth, 260 g). (Photo by John Tucker)



Calendar

March 1-5, 2004 — Honolulu, Hawaii USA

Aquaculture 2004. The triennial International Annual Conference & Exposition of the World Aquaculture Society with the National Shellfisheries Association, Fish Culture Section of the American Fisheries Society, National Aquaculture Association and U.S. Aquculture Suppliers Association will be held at the Hawaii Convention Center. Contact: Director of Conferences, Tel: +1-760-432-4270; Fax: +1-760-432-4275; Email: worldaqua@aol.com.

July 22-25, 2004 — Roanoke, VA USA

Fifth International Conference on Recirculating Aquaculture, to be held at The Hotel Roanoke and Conference Center, provides a forum for sharing ideas, opportunities and technologies in recirculating aquaculture. The conference is designed for individuals in industry, government or academia who are involved in recirculating aquaculture. Contact: Ms. Terry Rakestraw, Tel: +1 540 231-6805; Fax: +1 540 231-9293; e-mail: aqua@vt.edu; http://www.conted.vt.edu/aquaculture/

October 20-23, 2004 — Barcelona, Spain

Aquaculture Europe 2004 — Biotechnologies for Quality will be held in conference facilities at the Northern Campus f the Universitat Politécnica de Catalunya (UPC). Organized by the European Aquaculture Society. www.easonline.org.

May 9-13, 2005 — Nusa Dua Beach, Bali, Indonesia

WORLD AQUACULTURE 2005. Contact: Director of Conferences, Tel: +1-760-432-4270; Fax: +1-760-432-4275; Email: worldaqua@aol.com.

May 9-13, 2006 — Florence, Italy

AQUA 2006. Contact: Director of Conferences, Tel: +1-760-432-4270; Fax: +1-760-432-4275; Email: worldaqua@aol.com.

May 19-23, 2008 — Busan, Korea

WORLD AQUACULTURE 2008. Contact: Director of Conferences, Tel: +1-760-432-4270; Fax: +1-760-432-4275; Email: worldaqua@aol.com.

Snook

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Conference

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New Brunswick, Canada. The Rhode Island event is biannual, and will be held again in the Ocean State in 2005. Next year's conference - the Northeast Aquaculture Conference and Expo - will be held in Manchester, N.H.

Sponsors for this year's event included the Rhode Island Legislative Commission on Aquaculture; Rhode Island Sea Grant; the Rhode Island Economic Development Corporation; University of Rhode Island's Cooperative Extension; the Coastal Resources Management Council (CRMC); Roger Williams University; Mohegan Aquaculture; and the Rhode Island Department of Environmental Management (DEM).

Associate sponsors and collaborators included the Ocean State Aquaculture Association; DEM; Holland & Knight; the Rhode Island Marine Trades Association; Ninigret Partners LLC; the Rhode Island Shellfishermen Association; Tillinghast Licht Perkins Smith & Cohen LLP; and Robert Goldberg, esquire.