

Candidate Species for Florida Aquaculture: Pinfish, *Lagodon rhomboides*¹

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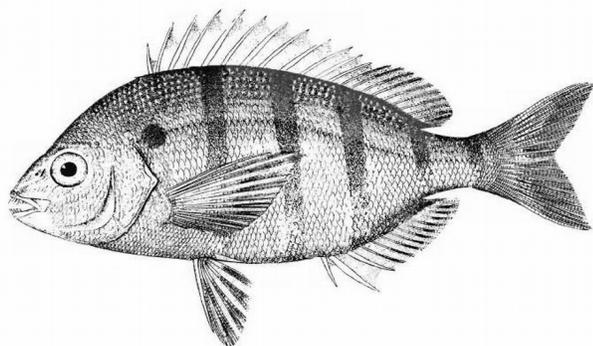


Figure 1. Pinfish, *Lagodon rhomboides*. Drawing credit: Food and Agriculture Organization of the United Nations (FAO).

General Description

The pinfish, *Lagodon rhomboides* (Figure 1), is a member of the Sparidae (porgy/sea bream) family and has been identified as one of nine marine baitfish species to have potential for culture in the southeastern United States (Oesterling *et al.* 2004). The common name is derived from the single, small, forward-projecting pin-like spine which is most anterior to the other 12 dorsal fin spines. The body is oval and compressed while the mouth is comparatively small with the maxilla reaching only

to below the anterior margin of the eye. Both jaws have eight broad, notched incisor-like teeth and 2.5 rows of molar-like teeth. Pinfish have a distinctive black spot near the origin of the lateral line behind their gill plate, and their body is a bluish-silver with alternating blue and yellow longitudinal stripes. Six dark, diffuse vertical bars mark the body. Fins are yellow with broad, light-blue margins (Muncy 1984).

Geographic Distribution and Habitat

Pinfish inhabit coastal waters from Massachusetts southward to Florida and from Bermuda westward throughout the Gulf of Mexico to the Yucatan Peninsula of Mexico (Hoese and Moore 1977). Pinfish are euryhaline, which means that they have a wide salinity tolerance. Abundant populations of pinfish inhabit vegetated marine bottoms, rocky reefs, jetties, and mangrove swamps.

Natural History

Pinfish spawn offshore from late fall to early winter with peak activity occurring from February through March in Florida (Tabb and Manning 1961). They reach sexual maturity between the end of their

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first and second years of life, with mature fish measuring at least 110 mm standard length (SL) (Hansen 1970). Post-larval and juvenile pinfish inhabit vegetated, shallow flats of estuaries, whereas adults live in vegetated areas in deeper parts of channels or on jetties and offshore reefs. Pinfish are voracious predators and are reported to consume a variety of prey at different stages of their development. Post-larval pinfish primarily feed on planktonic calanoid copepods, whereas juveniles feed mainly on shrimp, mysids, and amphipods (Stoner 1980). Food items for adults include shrimp, mysids, amphipods, fish eggs, crabs and plant matter. Changes in diet appear mainly to be a function of mouth size and tooth structure. Pinfish are an important forage item for many fish such as ladyfish, spotted seatrout, red drum, snook, bighead sea robin, and flounder (Muncy 1984).

Pinfish tolerate water temperatures ranging from 10–35°C (50–95°F) and tolerate a wide range of salinities from 0–75 g/L (ppt) (Muncy 1984; Carrier and Evans 1976). Age estimates with otoliths have revealed that pinfish can live up to 7 years (FWRI 2008).

Culture Techniques

Limited information is available on the culture methods and systems necessary to rear pinfish. However, studies have been conducted on life history, habitat, feeding, spawning, and larval development, which can aid in the development of aquaculture methods for pinfish.

Broodstock Nutrition

Although formulated broodstock diets have not been evaluated for pinfish, broodstock diets have been developed to significantly improve gamete and larval quality for other fish belonging to the Sparidae family. Broodstock diets containing essential amino acids and elevated levels of n-3 (omega-3) highly unsaturated fatty acids (HUFAs) have been shown to improve oocyte (immature egg) maturation, egg quality and percentage of live larvae after yolk reabsorption when fed to fish in the Sparidae family (Fernandez-Palacios *et al.* 1995). Gilthead and red seabream broodstock fed diets based on squid protein were found to increase both egg production (40%

more eggs/kg/female) and egg viability (Fernandez-Palacios *et al.* 1997). Furthermore, red seabream broodstock fed diets containing krill more than doubled viable offspring production (in terms of percentage of buoyant eggs, total hatch and normal larvae) (Watanabe and Kiron 1995). However, excessive amounts of krill meal (up to 20% and 30%) have been shown to reduce rather than enhance egg quality (Izquierdo *et al.* 2001). At the University of Florida's Indian River Research and Education Center (IRREC), successful induced volitional spawning of pinfish was achieved by feeding broodstock frozen squid, krill, and a 2.0-mm slow sinking pelleted commercial diet (50% crude protein and 15% crude lipid, 2% fiber, 12% moisture, 8% ash) (in induced volitional spawning, the fish spawn willingly or without humans physically stripping the egg and sperm).

Broodstock Reproduction

For the past thirty years, pinfish eggs have been induced to mature using various types of hormones. In the 1970s, human chorionic gonadotropin (HCG) and a pituitary luteinizing hormone (PLH) of mammalian origin consisting of an estradiol benzoate, testosterone propionate and progesterone mixture was used to induce maturation (Cardeilhac 1976). In this study, pinfish were administered a single injection of 1000 international units (IU) of HCG and 0.7 mg steroid mixture in the muscle mass located just below the dorsal fin to induce maturation. A second injection of 5 mg of PLH was given 24 hours later if oocyte maturation had not been completed. In another study, female pinfish were administered a single 200-IU intraperitoneal dosage injection of HCG followed by an additional dosage of 400 IU every second day until mature ova (measuring 0.90–0.93 mm) could be collected (intraperitoneal injections, also called intracoelomic injections, are administered into the body cavity that contains the abdominal organs) (Schimmel 1977). In both studies, artificial fertilization, also known as strip spawning, was accomplished by mixing the mature eggs with freshly collected milt in seawater at 18°C.

At IRREC, pinfish have recently been successfully induced to volitionally spawn (release eggs and sperm into water) under experimental

conditions using Ovaprim[®] (Western Chemical, Inc.), an injectable salmon gonadotropin releasing hormone analogue (GnRHa) and domperidone solution.

Ovaprim[®] is not currently legal in the United States for commercial use in baitfish production. Males and females undergoing final gamete maturation, whose oocytes were larger than 0.5 mm (Cardeilhac 1976), were administered a single intraperitoneal injection of Ovaprim[®] at a dosage amount of 0.25 mL/kg and 0.50 mL/kg for males and females, respectively. Male pinfish ranged in weight from 77.7–290.0 g and ranged in length from 19.5–23.0 cm total length (TL) while females ranged in weight from 94.3–240.0 g and ranged in length from 20.5–21.5 cm TL. Volitional spawning occurred 48 hours after injection at a brood sex ratio of 1:1 (DiMaggio *et al.* 2010). Similarly, Cardeilhac (1976) and Schimmel (1977) both reported hatching within 48 hours after artificial fertilization at 18°C. DiMaggio *et al.* (2010) reported fecundities of 2,565 eggs/female which was below the range of fecundities (7,700–90,000 eggs/female) reported by Caldwell (1957) and Hansen (1970), potentially indicating a partial spawn.

Hatchery

Fertilized pinfish eggs are buoyant in seawater and are usually comprised of a single transparent oil globule and a spherical yolk. The diameter of fertilized pinfish eggs from induced spawning studies ranged from 0.90–0.93 mm (Schimmel 1977), 0.99–1.05 mm (Cardeilhac 1976) and 0.95–1.03 mm (DiMaggio *et al.* 2010) using HCG, a HCG/PLH combination, and Ovaprim[®], respectively. On the day of spawning, fertilized eggs were removed from the tank with an egg collector using surface skimming and the eggs were incubated in a static 350 L cylindrical tank filled with seawater from the broodstock system. Gentle aeration was provided with a submerged air stone placed in the center bottom of the tank. Development of the embryo was rapid with hatching occurring 24 hours after incubation at approximately 25°C (77°F).

Upon hatching, pinfish larvae use nutrients in their yolk sac for development. During this time period, larvae are fragile and morphological changes including eye pigmentation, swim bladder inflation,

and jaw formation occur. Once the yolk sac is absorbed, approximately three days post-hatch (DPH) at 25°C (77°F), larvae must find food in the environment in order to survive. At this time, pinfish larvae should be fed live zooplankton such as rotifers and/or copepods. Although copepods are the optimal food source for wild larval pinfish, protocols involving mass culture and proper feeding concentrations for larvae need to be developed. Successful larval rearing has been achieved by using industry standard protocols involving rotifers and *Artemia* spp. nauplii (DiMaggio *et al.* 2010).

At IRREC, pinfish larvae were fed rotifers, *Branchionus* sp., at first feeding (day three post-hatch) because they were small enough to be consumed and were readily digested. Rotifers were fed to larvae at a density range of 5–15 rotifers/mL from 1–21 DPH to accommodate the relatively slow swim speeds and low capture success of larval fish at the onset of feeding. As assimilation and digestion efficiency of rotifers by larvae have been shown to decrease sharply at higher rotifer concentrations, it is recommended that feeding densities do not exceed 15/mL in the larval rearing systems (Lubzens 1989). At IRREC, rotifer cultures were fed live microalgae (Tahitian strain *Isochrysis galbana*) and supplemented with culture Selco[®] (INVE Aquaculture Inc., Salt Lake City, Utah, USA) twice daily to enhance the nutritional composition. Furthermore, rotifers were also supplemented with ORI-GREEN, (Skretting Canada Inc., Bayside, New Brunswick, Canada) enrichment prior to feeding to ensure adequate essential nutrients, particularly n-3 HUFAs, were provided to the larvae. Enriched rotifers were stored in a refrigerator at ~9°C (48°F) to slow down the passage of the enrichment product through their gut tract. Depending on the size and density of larvae, rotifers may need to be fed to the larvae multiple times per day to maintain desired densities.

As fish larvae grow, food particle size and consumption rate increase accordingly. Therefore, larger *Artemia* or adult copepods should be fed to pinfish larvae as their growth progresses. At IRREC, unenriched instar I (newly hatched naupliar stage) *Artemia* were introduced to pinfish larvae on 13 DPH and a density up to 1.3 *Artemia*/mL was maintained

until 38 DPH. All larvae were completely weaned onto a microbound microparticulate diet (250 μm –450 μm , 46.1% crude protein, 37.4% crude lipid, 5.6% ash, and 10.9% nitrogen free extract) by 38 DPH, and as fish size increased a finfish starter #1 crumble (50–55% protein, 15% fat, 2% fiber, 12% moisture, 8% ash) (Kovalenko *et al.* 2002) was gradually introduced. Weaning to an artificial diet should begin about 30 DPH and after the feeding of *Artemia*, but the dietary shift must be gradual to ensure a successful transition. Feeding an artificial diet allows for an easier and less expensive way to provide proper nutrients to larval fish while reducing the high variable costs (i.e. labor, infrastructure, etc.) that are associated with live food production. All uneaten feed that accumulates at the bottom of tanks should be removed to prevent increases in ammonia and nitrite concentrations which may harm larvae.

Nursery

Specimens are considered early juveniles when fin formation is complete, at a size range from 12.0–13.9 mm SL (Zieske 1989). In the wild, daily growth rates are also rapid: juvenile pinfish can reach marketable size (50 to 125 mm) midway through their first year. Young juveniles ranging from 11–18 mm have also been found to survive in a wide range of water temperatures and salinities (Hansen 1970). Such tolerance provides great flexibility for growers to favorably establish ways to culture the fish in captivity. Growth performances and survival in captivity will depend on system design, environmental conditions (temperatures, salinity, dissolved oxygen), and diet (feed composition and ration).

Growout

Trials at IRREC have shown that captive juvenile pinfish respond well to formulated commercial diets consisting of 50–55% protein, 15% fat, 2% fiber, 12% moisture, 8% ash. Moreover, juveniles exhibited rapid growth rates and high survival within recirculating aquaculture systems (Ohs *et al.* 2010). Growout of juvenile pinfish to marketable bait size was accomplished in recirculating systems at high densities and reduced salinity. Two experiments were conducted. In the

density experiment, juvenile pinfish were randomly stocked into one of four densities (0.05/L, 0.2/L, 0.4/L and 0.6 fish/L) with three replicates per treatment at a salinity of 27 g/L. Daily growth of pinfish ranged 0.35 to 0.39 g/day as mean survival ranged from 94.3–99.18% over 82 days. Mean feed conversion ratios (FCR) ranged from 1.7–1.89. In the salinity experiment, two size classes of pinfish were stocked separately into salinities of 9 or 27 g/L and cultured for 65 days. Mean percent weight gain from this study ranged from 234–284% with no significant differences among salinities. Feed conversion ratios ranged from 2.5–3.1 with no statistically significant differences among salinities although the smaller size class converted feed more efficiently than the larger class. Survival was not different among treatments and ranged from 98.2–99.9% (Ohs *et al.* 2010). Results are presented in Ohs *et al.* (2010) and include graphs of growth for each treatment salinity and density. These graphs will help producers estimate time required for culture to market size. Further studies in recirculating aquaculture systems and land-based ponds are needed to develop the most appropriate culture techniques and protocols.

Disease

Outbreaks of *Streptococcus* sp. bacteria have been reported to cause heavy pinfish mortalities along the gulf coast of Florida and Alabama (Plumb *et al.* 1974). Moribund fish presented with erratic swimming behavior, distended abdomens and hemorrhagic lesions on the skin, especially around the mouth and at the base of the fins. Although *Streptococcus* outbreaks have not been reported in cultured pinfish, control of this disease in other finfish species by use of appropriate antibiotics has been documented. However, in the United States, no antibiotics are currently approved by the FDA for use in pinfish, and any treatment will require veterinary oversight. Erythromycin has been found to be effective against *Streptococcus* at an oral dosage rate of 1.5 grams per pound of food, fed for 10 to 14 days (Yanong and Francis-Floyd 2002). In addition, amoxicillin has been shown to treat infected *Tilapia* sp. at an oral dosage rate of 80 mg/kg body weight (=3.6 grams per pound of food) fed for 8 to 12 days (Darwish and Hobbs 2005). The isopod *Lironeca*

ovalis and the haematozoan *Haemogreyarina bigemina* have been reported as important parasites of pinfish (Muncy 1984). Parasitic infestations were observed to be the most common abnormalities found in pinfish along the Gulf Coast, whereas ulcerative lesions were most common in Atlantic Coast pinfish (FWRI 2006). Other than the aforementioned reports, knowledge and treatment of pathogens and parasites specific to pinfish are unknown.

Market

Pinfish are highly sought after for use as live bait by recreational and commercial anglers and are commonly sold in wholesale and retail markets within coastal states along the Atlantic Coast and Gulf of Mexico. Different size classes of pinfish are demanded depending on the species targeted by the angler. Pinfish from 3.75–15 cm (1.5–6 inches) are commonly used by anglers to target inshore and offshore species. In 2007, commercial landings of bait fish species in Florida totaled 2,022,492 pounds (FWRI 2006). In an older survey of the live bait market in Florida, wholesale prices of pinfish were \$0.30 to \$ 0.66 per fish with retail prices ranging from \$0.45 to \$1.50 per fish (Adams *et al.* 1998). Wholesale and retail prices fluctuate throughout the year and are dependent on fish size preferences and seasonal availability. Currently, there is no state law prohibiting or limiting the production of pinfish within the state of Florida because they are native to the region. Further market research on cultured pinfish for use as a potential baitfish is needed.

Conclusion

Pinfish show great potential as a new aquaculture species with the purpose of being sold as marine baitfish. Pinfish are resilient, easy to maintain, fast-growing fish that tolerate a wide range of environmental conditions. In addition, there already exists strong consumer demand and well-established wholesale and retail markets for pinfish as live bait. These characteristics strongly justify further research with pinfish aquaculture and make pinfish an attractive alternative aquaculture species for producers in Florida and other coastal states.

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