SOUTHERN REGIONAL
AQUACULTURE CENTER

SRAC Publication No. 7209
October 2011

Species Profile:
Pigfish, *Orthopristis chrysoptera*

Cortney L. Ohs,[1] Matthew A. DiMaggio,[1] Scott W. Grabe[1]

Figure 1. Adult pigfish, *Orthopristis chrysoptera.*

The pigfish, *Orthopristis chrysoptera* (Fig. 1), is a member of the grunt family, Haemulidae. Haemulids comprise 17 genera and as many as 150 species. Haemulids are distributed throughout the Atlantic, Indian, and Pacific Oceans and are mostly marine, although some brackish and freshwater species exist. Haemulids are called grunts because they can make a grunting or chattering noise by rubbing their pharyngeal teeth together.

Pigfish are distinguished from other grunt species throughout their range by several key morphological differences. The dorsal fin of pigfish usually has 12 to 13 spines followed by 15 to 16 soft rays, while the anal fin has three spines with 12 to 13 soft rays. Both the dorsal and anal fin spines are covered by a deep, scaly sheath, unlike the soft rays. There are 53 to 58 pored, lateral-line scales in ten longitudinal rows above the lateral line and 15 to 19 rows below. The chin has a median groove. The ovate-elliptical body is considerably compressed, resulting in a body depth that is 30 to 38 percent of their standard length (SL). Body color is typically a light blue-grey that shades gradually into silver ventrally. Scales have a blue center and bronze spots on the edges, which extend along the body to form stripes (horizontal below the lateral line and trailing slightly upward above). The head is covered with bronze spots, and fins are yellowish bronze with dusky margins.

Pigfish have many attributes that make them a good candidate for aquaculture. They are hardy, withstand handling, are euryhaline, tolerate high densities, reproduce in tanks, grow rapidly, have established markets with high demand, and are marketed as a baitfish.

Geographic distribution and habitat

Pigfish occur in the Gulf of Mexico from Florida to the Yucatan peninsula and along the Atlantic coast of the United States from New York to the northern Bahamas and Bermuda; they are less common north of Virginia. Pigfish are prey for larger fish such as snappers, groupers, sharks, and spotted seatrout. Juvenile pigfish typically inhabit shallow waters near shore and are often found near vegetation. Adults occur more frequently on deeper flats over soft bottom habitats such as channel edges, sandy and sparsely vegetated areas, and midshelf reefs.

Pigfish are found in the wild at water temperatures from 56.7 to 96.8 °F (13.7 to 36.0 °C) but prefer 75.0 to 80.0 °F (23.9 to 26.7 °C). They are found in salinities from

[1]University of Florida

0 to 44.1 g/L (ppt) but will avoid waters less saline than 15 g/L. Adults have a maximum recorded total length (TL) of 14.9 inches (380 mm) but rarely exceed 9.1 inches (230 mm). Pigfish consume a variety of prey throughout their lives. Larvae and juveniles are planktivorous, feeding primarily on copepods, shrimp larvae, and mysid shrimp. A gradual shift to a carnivorous diet begins at 1.2 inches (30 mm) TL, when pigfish will consume various benthic animals such as polychaetes, amphipods, fish larvae, shrimp, and crabs.

Culture techniques

Broodstock

Bait-sized pigfish are commonly collected along the Atlantic and Gulf of Mexico states by commercial and recreational anglers using cast nets, traps, and seines. Adult brood-sized pigfish are collected by cast nets, seines, and hook and line. Wild caught pigfish to be used in aquaculture should be quarantined in tanks in water of a similar salinity and temperature as their original environment. They should be assessed for pathogens and treated, if necessary, before they are introduced into established systems. A prophylactic 250 mg/L (ppm) formalin bath (Paracide-F, Argent Chemical Laboratories, Redmond, Washington, USA) will help reduce external parasite loads. Formalin baths should last 1 hour and occur on alternate days for a total of five treatments. During this time fish should be fed a commercial pelleted feed (2 mm sinking or slow sinking, 45 to 50 percent protein, 12 to 15 percent lipid) and will readily consume the feed within a few days.

Pigfish reach sexual maturity by the end of the second year and live approximately 4 years. The smallest mature specimens recorded had a TL of 7.9 inches (200 mm). Natural spawning occurs from late winter to early spring in protected coastal waters or in offshore waters before inshore migration. Females spawn multiple times within a single spawning season. Spawning takes place at dusk in offshore areas or in calm waters such as harbors and inlets near shore. Generally, the larger fish will spawn earlier in the season, followed by the smaller fish later in the season. Developing an optimal broodstock diet is essential to successful larval rearing, as nutrients are passed from adult to eggs and nutritional deficiencies may cause poor egg and larval quality. Brood diets have not been evaluated with pigfish, so general recommendations include feeding a 0.08-inch (2.0-mm), slow-sinking, pelleted commercial diet (containing 50 percent crude protein and 15 percent crude lipid) supplemented 1 to 2 months before spawning with frozen squid and krill. An examination of the nutritional content of wild pigfish larvae could divulge the proper nutrients needed for a broodstock diet and subsequent optimal larval development.

Brood pigfish need to be sampled to assess gamete development. Before handling, brood pigfish should be anaesthetized by immersion in a bucket of culture tank water containing 100 mg/L MS-222 (tricaine methanesulfonate). Males are distinguished from females by palpating the abdomen anterior to the urogenital opening to check for the presence of flowing milt. Ovarian maturity of females is assessed by intraovarian biopsy: Insert a teflon catheter tube (0.97 mm inside diameter, 1.27 mm outside diameter) into the urogenital opening of females and remove a sample by oral suction. Each sample must be viewed under a compound microscope outfitted with an optical micrometer to determine oocyte maturation stage and size. Females targeted for injection should have a vitellogenic oocyte diameter of 350 to 450μm.

A sex ratio of 1:1 (male:female, M:F) has resulted in successful spawning in experimental trials. Decisions regarding spawning aggregations should be dictated by the availability of brood pigfish and by production goals. Increasing the sex ratio to 2:1 M:F will ensure adequate fertilization if a single male experiences reproductive difficulties. Conversely, a single male may fertilize the spawns of many females and the ratio of males to females can be reduced if adequate numbers of male broodstock are not available. Aggregation size has also been postulated to affect spawning success in captivity. While there is little empirical ecological data on natural spawning behavior, pigfish most likely spawn in large aggregations. Maintaining large aggregations in a captive setting may not be practical, however, and researchers have successfully induced spawning in aggregations as small as two fish (1M:1F).

Captive pigfish have repeatedly produced natural volitional spawns using a 12:12 light cycle year round, which suggests that spawning is not triggered by photoperiod. Spawning may be triggered by the passage of a cold front and the associated decrease in water temperature. Spawns have been collected at temperatures from 68 to 77 °F (20 to 25 °C).

Within the culture system, temperature, salinity, and light cycle may be manipulated to simulate natural seasonal changes and condition broodstock to spawn. Hormones may be used to induce spawning also. Pigfish have been successfully induced to spawn in experimental trials using Ovaprim® (Western Chemical, Inc.), an injectable sGnRHa solution. However, this product is permitted for use only in ornamental and aquarium fish. Before injection, fish should be anesthetized with a 50 mg/L dose of MS-222 to reduce the chance of injury. Ovaprim® doses of 0.50 mL/kg female body weight and 0.25 mL/kg male body weight should be administered following the manufacturer's instructions. At 71.6 to 75.2 °F (22 to 24 °C) and

35 g/L salinity spawning occurs within 48 hours of injection. Fertilized eggs are buoyant in seawater and can be collected by skimming water from the surface and sieving through a mesh-screened collection tank or other egg-concentrating device. Many different designs will work; the most common design is to collect eggs in an external collection tank equipped with a screen (≤ 0.7-mm mesh diameter) to concentrate the eggs. Water leaving the culture tank through an open standpipe on the surface of the water will contain floating, viable eggs. Sinking, non-viable eggs can be collected through a pipe near the bottom of the culture tank.

To date, Chorulon® (Intervet Schering-Plough Animal Health, Inc.), an injectable product containing human chorionic gonadotropin (HCG) that is labeled for finfish, has not been successful in experimental spawning induction trials. Further research is needed to determine why.

Eggs and larvae

Fertilized eggs (Fig. 2) should be incubated in water conditions similar to the spawning tank—71.6 to 75.2 °F (22 to 24 °C) and 35.0 g/L salinity—in static, cylindrical, cone-bottom tanks with gentle aeration. Hatching begins within 30 hours of spawning. Larvae will initially subsist on yolk sac reserves (Fig. 3). By the end of day 2 or 3 post hatch (DPH) the yolk sac is depleted and exogenous feeding must occur (Fig. 4).

Future research is needed to define optimal larval culture conditions for pigfish. Based on preliminary studies and on culture methods of other marine finfish, some general recommendations can be made. Newly hatched larvae should be volumetrically stocked at a density of approximately 50 larvae per L. For the first 2 DPH, the water flow rate should be a 300 percent daily water exchange, gentle aeration should be provided, and daytime surface light levels should be kept below 150 lux.

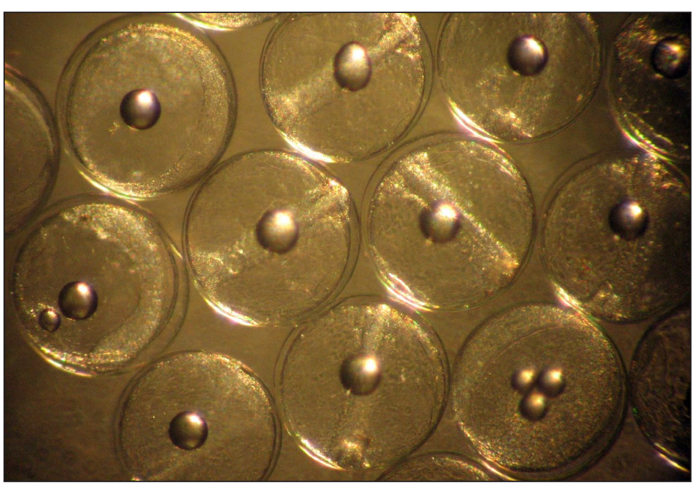

Figure 2. Pigfish early embryos (0.74 to 0.86 mm).

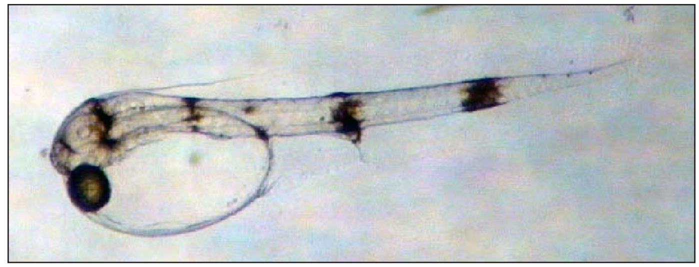

Figure 3. Pigfish larvae 0 DPH (2.4 to 2.9 mm).

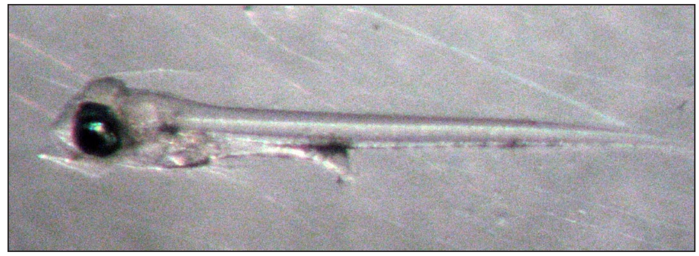

Figure 4. Pigfish larvae 3 DPH (2.4 to 3.1 mm).

Beginning on 2 DPH, tanks should be inoculated daily with live microalgae or algal paste (density of 200,000 cells per mL) to darken the water. This will provide a feeding background for fish larvae and help meet the nutritional requirements of the live feed organisms and possibly the fish larvae. Daily sampling of algal and live feed densities in the larval tank will ensure that proper densities are maintained as larvae grow. Once feeding begins, water flow can be increased to 400 percent daily water exchange, aeration can increase slightly, and daytime surface light levels can increase to a maximum of 1,000 to 1,550 lux. As larvae grow and feeding rates increase, daily water exchange should continue to increase to maintain ideal water quality. A consistent photoperiod of 12 hours light and 12 hours dark appears sufficient.

Copepod nauplii are an optimal first food source for pigfish larvae; they provide the proper nutrition, are of adequate size, and are the primary food source for wild larval pigfish. Rotifers can be used as a primary or supplemental live feed for the larvae. When copepod nauplii are fed, an internal standpipe with a 50-µm nylon mesh screen should be used to retain copepods; when rotifers are fed, an internal standpipe with a 240-µm nylon mesh screen should be used to flush uneaten rotifers.

Pigfish larvae can be fed rotifers, *Branchionus* sp., at first feeding (2 DPH) if they are small enough to be consumed. Rotifers that pass through a 70-µm screen appear to be of ideal size for pigfish from 2 to 5 DPH. Rotifers should be fed to larvae at a density of 5 to 15 rotifers per mL from 1 to approximately 20 DPH. Rotifer cultures can be fed live microalgae or algal paste and supplemented with culture Super Selco® (INVE Aquaculture Inc., Salt

Lake City, Utah, USA) twice daily to enhance their nutritional composition. Rotifers must also be given a commercial enrichment supplement so they will contain adequate concentrations of highly unsaturated fatty acid (HUFA) to meet the nutritional requirements of larvae. After enrichment, rotifers should be fed immediately or stored in a refrigerator at 48 °F (9° C) to slow the passage of the enrichment product through their gut. Depending on the size and density of larvae, fresh enriched rotifers should be fed to the larvae several times per day, and uneaten rotifers should be flushed through the screen.

Fish larvae consume more and larger food particles as they grow. Therefore, larger *Artemia* or adult copepods should be fed to pigfish larvae as they grow. Unenriched instar I *Artemia* should be introduced to larvae approximately 15 DPH and at a density of 0.5 to 1.3 *Artemia* per mL. The instar I stage of *Artemia* is a non-feeding stage that cannot be enriched. As larval pigfish grow they can consume more advanced stages of *Artemia,* and you may choose to enrich them. A feeding density of 1.0 to 1.3 *Artemia* per mL should be maintained until approximately 50 DPH. Weaning to an artificial diet should begin about 35 DPH and after the feeding of *Artemia*, but the dietary shift must be gradual to ensure a successful transition. Larvae should be completely weaned onto a microparticulate diet by approximately 55 DPH, and as fish size increases further a finfish starter #1 crumble (50 to 55 percent protein, 15 percent lipid) should be gradually introduced. Conversion to an artificial diet allows the nutrient intake of fish to be manipulated, eliminates live feed protocols, and reduces the labor associated with maintaining live feeds. All uneaten feed that accumulates at the bottoms of tanks should be removed daily to prevent water quality problems.

Juveniles

By 1 inch (25.4 mm) TL, pigfish have scales, all spines and fins are well-developed, and the overall appearance is that of an adult. However, the deep body and characteristic pigmentation do not develop until the fish is fully formed at about 2.76 inches (70 mm) TL. The developmental period in between is considered the juvenile phase. Once the larvae have been successfully transitioned to an artificial diet, they should be transferred from the larval tank to a new system. During the first year of life, the growth of wild juvenile pigfish ranges from 0.28 to 0.37 inches (7.0 to 9.3 mm) SL per month from June through October to 0.12 inch (3.1 mm) SL per month from October to April. Juveniles survive in a wide range of water temperatures and salinities. This should give producers the flexibility to use various culture systems and conditions. Culture success will depend on growth, survival, system design, environmental conditions (temperatures, salinity, dissolved oxygen), and diet (feed composition and ration). Further research is needed to define optimal diet, stocking density, lighting, salinity, and temperature.

Growout

The average size of pigfish sold as bait is 3 to 6 inches (76.2 to 152.4 mm). In one study, wild juveniles (67.0 mm and 5.40 g) were cultured in a recirculating aquaculture system consisting of 85-L aquaria for 65 days at three stocking densities—0.1 fish per L, 0.3 fish per L, and 0.5 fish per L. Ambient water temperature and light cycle were maintained in a greenhouse and salinity was constant at 26.0 g/L. Pigfish were fed 3 to 7 percent of their biomass daily over two feedings with a 2.0-mm, slow-sinking, pelleted commercial diet (50 percent crude protein and 15 percent crude lipid). During that study, juveniles grew 0.92 to 0.97 mm per day and gained 0.48 to 0.53 g per day. At this rate a 1-inch (25.4-mm) juvenile would take approximately 4 months to reach market size. Survival increased with an increase in stocking density (22 to 58 percent), but was quite variable. Feed conversion ratio was also variable, ranging from 2.04 to 5.33, with a higher stocking density converting feed more efficiently. Similar experiments conducted in larger recirculating systems again yielded the highest survival (42 percent) at the highest stocking density (0.4 fish per L). These studies suggest that densities at or above 0.5 fish per L may help to decrease aggression and result in increased growth and survival. Further research may help to identify optimal densities.

Markets

Recreational and commercial saltwater anglers prefer pigfish as live bait and buy them in different sizes depending on the species targeted by the angler. Pigfish from 1.5 to 6 inches (3.75 to 15 cm) are commonly used by anglers to catch inshore and offshore species. Wholesale prices of pigfish are $0.30 to $0.66 per fish, with retail prices ranging from $0.45 to $1.50 per fish. Wholesale and retail prices fluctuate throughout the year depending on the fish size demanded and their availability. The availability of pigfish varies by season and from one location to another; the size of fish available from the wild is not always what is in demand. Thus, there is potential in culturing this species.

Conclusion

Pigfish show strong potential as a species to culture and market as marine baitfish. Pigfish are resilient, easy to maintain, and grow fast; and, there is considerable market demand for them. There are well-established wholesale and retail markets for pigfish as live bait. These characteristics strongly justify further research to improve the hatchery stage of culture, to identify optimal juvenile growout conditions, to establish optimal nutrition, and to analyze the economics of each stage of culture.

Suggested readings

Darcy, G.H. 1983. Synopsis of biological data on the pigfish, *Orthopristis chrysoptera* (Pisces: Haemulidae). FAO Fisheries Synopsis No. 134.

Howe, J.C. 2001. Diet composition of juvenile pigfish, *Orthopristis chrysoptera* (Perciformes: Haemulidae), from the northern Gulf of Mexico. *Gulf of Mexico Science* 19(1):55-60.

Oesterling, M.J., C.M. Adams, and A.M. Lazur. 2004. Marine baitfish culture: workshop report on candidate species and considerations for commercial culture in the southeast U.S. Virginia Sea Grant Program, Marine Resource Advisory No. 77.

Sutter, F.C. and T.D. McIlwain. 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico) – pigfish. *U.S. Fish and Wildlife Service Biological Report* 82(11.71). U.S. Army Corps of Engineers, TR EL-82-4.

Watson, W. 1983. Redescription of larvae of the pigfish, *Orthopristis chrysoptera* Linnaeus (Pisces, Haemulidae). *U.S. Fish and Wildlife Service Fishery Bulletin* 81:847-854.

United States Department of Agriculture

National Institute of Food and Agriculture

The work reported in this publication was supported in part by the Southern Regional Aquaculture Center through Grant No. 2008-38500-19251 from the United States Department of Agriculture, National Institute of Food and Agriculture.