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When I began to stray from keeping tropical fish to natives in the 1970s, I was at first only interested in predator species and gar were at the top of my list. However, I never had any luck collecting them until I tagged along with another native fish fancier dip netting young-of-the-year Longnose Gar (*Lepisosteus osseus*) in back channels of the St. Croix River on the Minnesota-Wisconsin border (Figure 1). Polarized sunglasses increased our odds, but the catch rate was very low for the distance we covered. When we'd find our quarry, it was always a single four- to five-inch gar hovering motionless over or beside submerged brush and perfectly camouflaged as a twig.

Beginning in 1990, I no longer had to do it yourself (DIY) when a partnership began between two fish farmers. Dave Mueller owned the River of Life Hatchery in Minnesota. He cultured Paddlefish (Polyodon spathula), Lake Sturgeon (Acipenser fulvescens), and Shovelnose Sturgeon (Scaphirhynchus platorynchus) for the aquarium trade. There was a huge demand for these species as pets not in the U.S. but in China and Japan. Dave had mastered breeding the three species with a consistent survival rate greater than 90% to saleable sizes of three to four inches. The Asian fish brokers were equally interested in ordering gar, but Dave had not been able to "crack the code" for any species in this family. In the 1970s, Gary Richmond owned an aptly named pet store called Finny Critters in St. Paul, Minnesota. He carried some unique species for the time including pygmy sunfish (Elasoma spp.), Blackbanded Sunfish (Enneacanthus chaetodon), Flagfish (Jordanella floridae), and Sailfin Molly (Poecilia latipinna). After selling the store, he moved on to commercially harvesting glassworms (aka phantom midge larvae) as a live and frozen food for tropical fish, and later on, to boarding horses on his farm in Wisconsin. When the horse appeal began to fade, he planned a return to tropical fish as a wholesale distributor and began converting vacant stalls to indoor water pools. The Kinnickinnic River meandered through his property and he named his hatchery after the local name of the stream: Kinni River Fish Farm. Even though he had sold some native species in his retail store, he never felt any North American natives would be profit-

Photos by the author unless otherwise indicated.

able to rear for wholesale markets. That is until he met Dave, and as partners what an odd couple they made! Dave was Pentecostal born-again and Gary an avowed atheist. Dave never viewed Gary as an adversary because of his beliefs, but sincerely felt his "mission" in the partnership was to convert this lost soul. Gary on the other hand also knew both the Bible and history of Christianity very well. He found it very entertaining to engage Dave in lively, no-holds-barred debates. Despite these striking differences the partnership survived and flourished for over a decade, selling hundreds of thousands of gar to the Asian aquarium trade.



Young-of-the-year Longnose Gar cultured at Kinni River Fish Farm.



Figure 1. DIY: Eric Lindberg dip netting Longnose Gar in the St. Croix River (Washington County, MN).

Fall 2015



Figure 2. Longnose Gar broodstock from the Mississippi River near Prairie du Chien, WI.

Getting the gar farm off the ground presented some serious challenges and the first was money. Neither Dave nor Gary had much for startup funding so they built the rest of the hatchery on the cheap. Space was not problem since Gary had a no-longer-used horse arena where he and Dave plumbed wood racks lined with rows of Coke and Pepsi syrup barrels as hatching pools and a five-foot-deep, 25-feet-across swimming pool for rearing the young. A second hurdle was applying for a Wisconsin Department of Natural Resources (DNR) hatchery permit. The area fish manager opposed the permit being issued because the Kinnickinnic was a designated trout stream and his concern was either gar or wastewater effluent would escape from the hatchery, even though it was designed as a closed-circulation indoor facility well away from the stream and on high ground that never flooded. After many and sometimes heated discussions, Gary informed the DNR to either issue the permit or a citation when his broodstock arrived the following week. The permit was issued and renewed thereafter without question.

They targeted both species occurring in Minnesota and Wisconsin: Longnose and Shortnose Gar (*L. platostomus*). They tried collecting broodstock themselves in the spring before both species spawn, but had very little success. They soon turned to commercial fishing operators who knew where both species massed during the winter months (Figure 2). The fishermen were extremely pleased to have a market for an underutilized species and fetch an incredible price of \$10 a fish instead of a nickel a pound (that is if they could sell any gar at all). Gary and Dave regularly found hybrids between Longnose and Shortnose Gar in their broodstock, but they could be easily distinguished from the "Purebreds." Dr. John Lyons (Wisconsin DNR) agrees that hybrids do occur in this area (pers. comm.). He has



Figure 3. Top: Longnose Gar hatching on nylon screens. Bottom: silted eggs on bottom of rolling jar while newly hatched fry float up and out into rearing pool.

sampled fish extensively in the same general vicinity of the gar-farm broodstock and estimates gar hybrids comprise about three to five percent of the total gar catch. In the lower Chippewa River (Mississippi River tributary forming Lake Pepin), there's been only a single verified report of a hybrid. Conversely, hybrids comprise more than half of the total gar in the Wolf-Fox River system near Green Bay (Figure 4). At first some believed these hybrids were Spotted Gar (*L. oculatus*), which does not occur in Wisconsin, and the resemblance in appearance of some hybrids to Spotted Gar is striking. However, Dr. Justin Sipiorski (University of Wisconsin – Stevens Point) confirmed that the Wolf-Fox specimens were hybrids as part of his genetic and morphological Ph.D. thesis research (Sipiorski, 2011). John also noted that the Shortnose Gar head image (from this system) in *Fishes of Wisconsin* (Becker 1983) is actually a hybrid.

Once in the hatchery, the broodstock were kept cold and remained dormant on the bottom of the holding pool. At water temperatures below 50°F gar would not move an inch in weeks. About three weeks before spawning, the temperature and photoperiod were gradually increased. Gar were then injected with a hormone and within a few days scattered eggs would appear on the bottom of the pool. Gar may have a body shape like pike, but they are very different internally. Gravid females cannot be effec-



Hybrid gar (Lake Butte des Morts, Winnebago County, WI)



Longnose Gar (Wisconsin River, Richland County, WI)



Shortnose Gar (Wisconsin River, Crawford County, WI)

Figure 4. Gar comparisons. (Photos by John Lyons)

tively hand-stripped like pike because ovaries are enveloped within a sack of multiple tubes where eggs move individually to the oviduct as spawning begins. Pike, on the other hand, pass eggs through a single common duct. Unfortunately for gar, their physiology required the adults to be sacrificed to harvest the eggs. One formidable Alligator Gar (Atractosteus spatula) over seven feet induced enough fear of broken human bones and internal injuries that it had to be shot with a rifle before harvesting the eggs. To further complicate matters male gar more often than not produced non-motile sperm which only "buzzed" under the microscope. Almost always a few females would have tens of thousands of ripe eggs ready to be fertilized while male after male would have useless milt with no swimmers. Gary and Dave soon discovered adding testosterone to the initial hormone injection turned the lethargic sperm into dancing rockets. Another sticky situation arose when the eggs (especially Shortnose) were exposed to humid air that made them incredibly adhesive. They stuck like super glue to any surface (e.g., fingers, clothing, eye glasses, counter tops, and mixing bowls). The first attempt to incubate fertilized eggs used nylon mesh screens clipped to clothes line stretched across pools. The eggs were poured over the screen, but they never stuck evenly across the matrix. Single eggs would often hatch, but fungus would almost always spread through thickly clumped eggs, killing the embryos. Gary and Dave soon found that Pam[®] cooking spray prevented the eggs from sticking to mixing bowls, where they were silted with bentonite clay and then rolled in jars. This process eliminated both clumping and fungus (Figure 3). Their earliest spawning of Shortnose Gar was in December and January for Longnose Gar.

Before leaving the topic of gar eggs, one myth needs to be dispelled. Literature citations report the egg color as green for both Longnose and Shortnose Gar (Potter, 1926; Haase, 1969). Gary and Dave eventually cultured all five species found in North America. They did not "open" all that many Spotted or Florida Gar (L. platyrhincus) because the availability of broodstock was very intermittent. However, they did harvest eggs from hundreds of Longnose and Shortnose Gar and scores of Alligator Gar. There never, ever was one green egg. Shortnose eggs ranged from white to indigo blue, Longnose from white to charcoal gray, and Alligator white to gray (Figure 5). It is plausible the earlier accounts didn't examine fresh eggs and fixing in formalin or decomposition caused a discoloration. There is another literature report that gar eggs are toxic to wildlife, but not fish (Netsch and Witt, 1962). Being the skeptic, I repeated the original lab experiment purchasing two feeder mice from a pet store. Eggs from the gar farm were frozen and later mixed with pellets fed to the mice.



Figure 5. Examples of gar egg color. Top: Shortnose. Bottom: Longnose.



Figure 6. Top left: Shortnose Gar at two days. Bottom left: Shortnose at five days with a glassworm. Top right: Shortnose fry, black and thinly spaced. Bottom right: Longnose fry, white and tightly clustered.

One died within a day and the other was in a lethargic stupor for several days before fully recovering. Later, I heard an account from a local commercial fisherman about a rival who tried a caviar recipe using gar eggs. After dining on the delicacy he became violently ill, but lived following an emergency room visit.

The hatching success for all gar species was consistently higher than 90% and fry would hatch in about three days at 80°F. Growth was rapid in all species, but there were some stark differences in Shortnose and Longnose Gar during their early development. Immediately after hatching, Longnose fry are white while Shortnose are black. While they absorb their yolk sacs, temporary sucker-like structures on their noses allow gar fry to attach to a surface and remain in a fixed position. Longnose tightly cluster in large clumps while Shortnose prefer some "elbow room" (Figure 6). Of the three species, Shortnose young were the most cannibalistic on their siblings. Believe it or not, Alligator young were the least cannibalistic.

Immediately following yolk-sac absorption, the young basked in a continuous and dense cloud of live glassworms, which greatly reduced cannibalism. However, this live food is seasonal, ending in April or May when the adult midge flies hatch. The first year was extremely hectic with all the hungry mouths to feed, which required running to ponds daily to harvest whatever plankton species were blooming. Fortunately, Dave had had a similar problem rearing his sturgeon and Paddlefish until he found a commercial pellet feed that floated. Gar likewise easily switched and eagerly accepted the new item on the menu. Growth was very rapid, reaching a saleable size of three inches in six weeks (Figure 7). At this time, the heat was turned off and well water was pumped into the rearing pools to chill the water temperature. The cold water slowed their metabolism, stalled growth to almost nothing, and significantly reduced feeding costs (Figure 8).

Hybrid crosses were deliberately tried, at first out of necessity. Whenever Longnose Gar eggs were "waiting" for fertilization in the mixing bowls, the only fertile sperm available were those of Shortnose Gar and vice versa. However, there never was a great demand for crosses from either the Chinese or Japanese, who preferred "purebred" species. Spotted-Longnose crosses were the most striking, exhibiting the darkest markings and large fins. The Alli-



Figure 7: Gar at size ready for sale. Left: Shortnose Gar - Right: Longnose Gar.

gator-Shortnose cross was dark olive. Alligators also occasionally produced a morph which Gary and Dave labeled the platinum phase (Figure 9).

During the rearing period, not everything was smooth sailing. Small annoyances were almost humorous, such as Gary's dog, Josh, eating gar out of the counting bowls whenever Gary turned his back to pack orders, or his freeroaming Muscovy ducks sneaking into the hatchery and perching on the pool ledges to pick off gar one by one. Water quality posed a greater threat to young gar. Bacterial diseases afflicting the young were treated with antibiotics, however, some shocked the biological filter worse than others and ammonia levels would skyrocket. If the spike wasn't caught immediately, gar spines became permanently bent, turning fish into twisted pretzels. The worst plague by far (literally) was a virus that came in with the broodstock. There was very little mortality in adults, but it would ravage young gar. Samples were taken to the fish pa-



Figure 8. Gar "ball" chilling out in rearing pool.

thology lab at the Minnesota DNR for analysis but could not be identified and appeared to be a new virus never before found in the state. The only remedy was to destroy all the fish, bleach the system, and hope the commercial fishermen could still acquire more gravid broodstock to salvage the season.

Initially, both Shortnose and Longnose fetched a wholesale price of \$2.50 each. However, after the initial enthusiasm ebbed, the price leveled off to \$1.50. Orders ranged from 1,000–15,000 fish. The first time Alligator Gar were available they got an incredible \$50.00 a copy! However, it didn't last



Figure 9. Young of the year. Top: Longnose x Shortnose Gar hybrid. Bottom: Alligator Gar (back). Platinum phase (front).





Gar farmers Dave Mueller and Gary Richmond checking milt motility.

long. The same year a competitor was selling wild-caught Alligators, but he was apparently not aware of or didn't have cold well water on hand to slow the insane growth. Running out of holding space and increasing cannibalism drove him to flood the market at clearance prices. Gary said he felt like a De Beers diamond broker trying to stabilize the price, which eventually fell to \$8.00 and never recovered. The best year in operation, gar sales grossed over \$200,000. However, the good times would not last. Competition arose from Chinese fish breeders who, skilled in their own right, realized the business potential of culturing gar and began growing young for future broodstock. The death knell for Gary and Dave's Alligator Gar source came in 2005 when Hurricane Katrina hit New Orleans. Saltwater invaded Lake Pontchartrain from the storm surge, which destroyed vital barrier wetlands and made the swamps along the north shore of the lake too brackish for gar to spawn.

EPILOGUE

We in North America are all too aware of the never-ending flood of non-indigenous species that now occur here. However, I find it an irony we rarely hear much about our native species becoming established in other countries. A very brief surfing of sport-fishing forums found reports of adult Alligator Gar in ponds, lakes, and rivers of China, Indonesia, Myamar (Burma), and Thailand. I believe it is a safe bet to assume the other four species also occur in many Asian countries where the aquarium hobby is popular. I was also shocked to recently find gar species available in some local pet stores where one carried Florida Gar for \$35.00 and Alligator for \$249.00. Perhaps it is still worth it to farm gar?

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