The Bluefin Killifish, *Lucania goodei*: A Summary Review

Charles A. Nunziata
6530 Burning Tree Dr., Largo, FL 33777
epiplaty@tampabay.rr.com

Lucania goodei Jordan 1880, the Bluefin Killifish, has been known as Blue Dace, Bluefin Dace and *Chriopeops goodei*. Not a dace at all, the genus *Lucania* was erected in 1859 by Girard. For a time, the valid subgenus designation *Chriopeops* was incorrectly used as the genus name. The *Lucania* type locality is the Arlington River, a tributary of the St. Johns River, which flows through a vast region of northeastern Florida. The species *goodei* is the type for the genus. Other members of the genus include the euryhaline Rainwater Killifish, *L. parva* (Baird & Girard 1855), which occupies coastal regions within the same range as *L. goodei*, and the rarely seen Cuatro Cienegas Killifish, *L. interioris* Hubbs & Miller 1965, from México.

Lucania goodei, one of the most beautiful and adaptable native American killifishes, has been extensively written about in this and other journals. However, a review of this body of literature reveals some startling variations in the descriptions and experiences of the various authors. Accounts of fin color, breeding habits, natural conditions and rearing requirements differ widely. It turns out, however, that virtually all of these accounts are true, with the differences between them attributed to the vast distribution of the fish across myriad biotypes, and its ability to adapt successfully to extremes. Like the parable of the blind man describing an elephant through touch, each author related personal experiences and the current information available. However, these accounts tended to treat specific populations or locations with which each author was familiar, and not other populations that exhibited different color and behavior characteristics.

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For example, the extensive range of *L. goodei*, as well as the ability of this little jewel to adapt to an enormous variety of physical conditions, have led at least one author to state that it must be kept in cool conditions, and that breeding and feeding cease above 80°F (even while this author and others have collected *L. goodei* in natural and manmade water bodies at temperatures well into the 80s). Likewise, we are advised by some that only live foods are taken, while others report that a variety of dry foods are eagerly eaten.

While the dorsal fin is blue in many populations, *L. goodei* has been variously described as a fish with an anal fin that is primarily clear, yellow, yellow-green, pink, blue, orange, or red, and sometimes in various combinations of these colors. Once again, all these descriptions are true and accurate. We can now surmise that since the common name of the fish is Bluefin Killifish, that the author of that name examined a population that exhibited both a blue anal and dorsal fin. We now know that the predominant color of the anal fin, and to a lesser extent the dorsal and caudal fin, is highly variable, and with some notable exceptions correlates roughly to geography.

Range

Lucania goodei is found across a vast range (Fig. 1), stretching from the Florida Peninsula up to the Panhandle as far west as the Choctawhatchee River drainage. It is also found in discontinuous ranges along the Atlantic Coast as far north as central South Carolina, where it is thought to have been introduced.[9] *L. goodei* continues north from the Florida Panhandle into the extreme southeastern corner of Alabama and the Chipola River drainage. There are also reports of

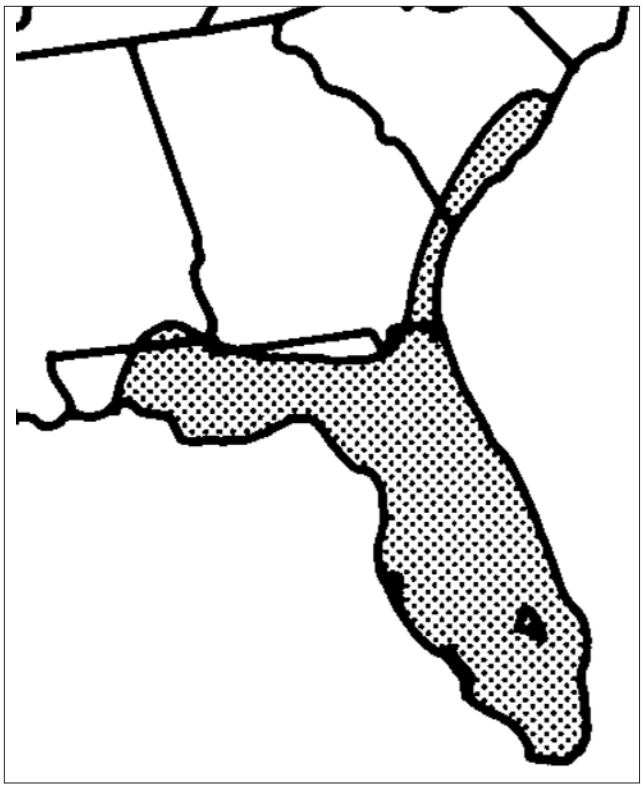

Fig. 1.
Range of Bluefin Killifish, *Lucania goodei*.

introductions in Texas and California.[1] *Lucania goodei* is common throughout its natural range and appears to be very well equipped to not only survive, but thrive, in a number of different habitats.

Description

Reaching two inches in length, the body of the male *L. goodei* is fairly slender and compressed, with a small, upturned mouth. There is a characteristic and rather wide zigzag-patterned stripe that is black to cocoa in color, depending on conditions and location. This stripe extends from the tip of snout through the center of the eye, widening on the flanks and narrowing again as it approaches the peduncle, where it terminates to a black spot on the caudal fin base. The scales are dark-edged. The overall body color of the fish is light brown, lighter above the line going to an olive or dusky gray back. The area above the line sometimes exhibits a cast, giving the appearance of a hazel coloration.[2] Below the zigzag pattern is darker brown going to a cream underside. There are 29-32 lateral scales.[9]

The dorsal fin has 9-12 rays and is positioned in front of the anal fin insertion.[9] The fin coloration is where we see surprising variations, roughly related to the geographic position of the population. In general terms, *L. goodei* from the area south of Sarasota at Port Charlotte exhibit anal fins that are red-orange to red with little blue.[2,4] In the central Florida range from Gainesville through Tampa Bay and south to Sarasota, we see dorsal and anal fins of bright iridescent blue with a black band on the base and a thin black edge. This area is considered a transition zone, however, because we also see isolated populations exhibiting orange or smaller amounts of red color in the anal fin, replacing the blue. In areas north of Gainesville, we find greenish-yellow anal fins,[10] tending to lemon yellow in the Florida Panhandle and points north.[2,4]

However, there are significant variations even within these regions. For example, at a site in Hillsboro County east of the city of Tampa, we find individual *L. goodei* males with blue anal and dorsal fins, together with males that exhibit a great deal of orange/red in both fins.[10] Obviously, the genes for both color forms exist within that same population and, at this site at least, both forms are expressed. Likewise, in Citrus County, at the northern range of this region, isolated populations exhibiting a greenish-yellow anal are found. At Hunter's Spring on the Crystal River just south of the Florida Panhandle, *L. goodei* is reported with clear fins.[6] Yet north of there in the vicinity of Tallahassee, pink anal fins are reported, very far from the orange and red forms found at Port Charlotte.[8]

The caudal fin is generally red-orange, but is not as intensely colored as the other unpaired fins.[3] There is a small region of pale blue at the base, followed by a region of red or red-orange varying in intensity and the amount of red coloration. The caudal fin terminates with a translucent region at the margins. In those populations that exhibit a pink anal, there is also a bright pink to red region at the caudal base.[8]

Females are slightly smaller than males, getting to 1-3/4". The body of the female is light brown with a hint of the zigzag pattern, below which the brown gives way to a sometimes brilliant silver underside. Otherwise, she lacks the complex body patterns and colors of the male. All fins are clear or yellowish.[1,3]

Natural Conditions

It is no surprise that such a highly variable fish would be found in a number of different natural settings. *Lucania goodei* is found in virtually every habitat available throughout its range. It has been reported in cool and deep springs with extremely clear water and much aquatic competition.[6]

Interestingly, this is also the locale of the "clear fin" variety. Other habitats include rivers, lakes, small pools and manmade retention ponds. While some have observed that *L. goodei* remains well below the surface,[1,9] others, including this author, often find them at the surface and in shallow water where they appear to prefer the protection of plants. Even in a river habitat where there is some current, *L. goodei* can be found under plants floating at the surface.[2]

The temperature variation among these habitats is quite large due to seasonal factors, the source of the water, and its depth. Harry Specht reports that *L. goodei* is tolerant of very warm water. "I have collected them in shallow ditches in direct sunlight when the water was so hot it was uncomfortable for me to stand still and fish!"[7] To be sure, many collections of *L. goodei* have been made by members of the Suncoast Killifish Society during warm summer months where standing water easily gets into the high 80s. Low temperatures are equally tolerated as well. Harry maintains *L. goodei* in tanks outside on his patio where they receive partial sunlight, limiting temperature spikes regardless of the season. During the winter he reports that these tanks go as low as the upper 40s with no appreciable losses among *L. goodei*.[7]

Natural water characteristics are equally varied, especially between coastal and inland regions. In addition, heavy rains drastically change water conditions over short periods of time. Inland, the water is acid (<6.5 pH) and soft with low conductivity, while the water in coastal regions is quite hard with high conductivities and pH values often in excess of 7.8. The composition of natural springs tends to be much more stable because of the constant replenishment by a consistent supply. Therefore, these habitats are not as much affected by rainfall. They tend to be somewhat acid yet moderately hard. Since *L. goodei* thrives in all these environments, it is obviously quite tolerant of water chemistry and temperature extremes, demonstrating yet again its ruggedness and ability to adapt to a highly variable environment. It should be noted that some older literature implies that salt or brackish water is tolerated or even recommended. I believe that these references confused the requirements of the closely related *L. parva* and inadvertently applied them to *L. goodei*. Yes, *L. goodei* may be able to withstand such water conditions for a time, but their natural habitat is fresh, not brackish, water.

Collecting

Henri DeBruyn's excellent two-part *JAKA* article provides a practical tutorial on collecting Florida natives. Because of its common distribution and its propensity to take shelter under overhanging or floating plants, *L. goodei* is one of the easier killies to collect. A dipnet, quickly thrust under the plants and into the shore, will produce a few *L. goodei* with every try. Generally, the sexes are quite even and pairs will inevitably be caught. Although *L. goodei* will shoal, it is not truly a schooling fish. Once a group is scattered, fewer individuals are picked up with each pass. The group will not reassemble until the interlopers have left and the water is once again calm.

One of my favorite local sites is a retention pond in the midst of a subdivision. Once a much smaller natural pond, it was greatly expanded when the subdivision was built. With small dipnets, we take from this site a brilliant blue form in about a foot of water where they congregate under overhanging plants. This pond is no more than 200 feet from the home of AKA/SKS/NANFA member Bill Shields. So the routine is to have a beer at Bill's, pad down to the pond, collect *L. goodei* (and tons of pleco catfish, if you want them), and back to Bill's before the beer gets warm. Now that is a collecting site!

Aquarium Maintenance

Lucania goodei is often skittish and nervous in bare aquariums set up for breeding purposes. Floating or overhanging plants and spawning mops puts them more at ease (but also, unfortunately, shields them from view). To observe any kind of natural behavior, and to appreciate their wonderfully subtle colors, a heavily planted tank with plenty of overhanging cover is required. In this breeding set up, *L. goodei* will hide in and under the spawning mops whenever there is activity in the fishroom. They have large appetites (as do all the Florida killies) and will dash from their hiding places to feed before quickly retreating. They feed at leisure only when I cease activity and quietly observe.

Poor aquarium management is not tolerated without a corresponding decline in vitality and coloration and, in a crowded aquarium, most color will be lost. Because this killie is highly tolerant of water variations, it is reported to do well under widely differing pH, hardness and conductivity characteristics, from tap water with a pH 7.8 and a hardness of 478 ppm,[7] to RO/tap water blends with a pH of 7.2 and 80 ppm. Since many natural conditions show pH values as low as 6.5, it is certain that reasonably acid conditions would be tolerated as well. This is a tough little fish and not prone to disease, so if they appear uncomfortable, water quality should be examined immediately.

There is a difference of opinion regarding the impact of large water changes. To be sure, *L. goodei* is subject to rapid and extreme changes in water conditions in its natural habitat, where large rainfalls inundate and cleanse watercourses in a matter of hours. Nonetheless, some authors have indicated that large water changes will require a recovery period before *L. goodei* resume normal activity,[1] while others hold that frequent water changes induce spawning.[5] I normally change 30% of the water every week without noticeable changes in behavior. However, the new water is quite close chemically to the old water, minimizing any shock potential. As in all things, moderation is recommended. If the new water matches the water it is replacing, then large water changes should not be a problem. At a minimum, moderate weekly water changes are highly recommended.

As in nature, temperature extremes in aquaria are well tolerated. My fishroom is an air-conditioned and insulated—but unheated—garage. The *L. goodei* tank is on a lower shelf that remains in the high 70s throughout the summer and in the mid to low 60 during the coldest part of the winter. I've not observed any change in behavior or seasonality under these conditions except that spawning ceases under 68°F. When it comes to the health and captive propagation of *L. goodei*, fish age and nutrition seem to be more important.

As stated above, *L. goodei* are heavy feeders that can consume surprising amounts of food given their size. Some earlier articles indicated that only live foods are taken, but this is simply not so. All manner of food is taken quite eagerly. Of course, live foods are relished, as are most freeze-dried and frozen foods. Dry food is also reported to be taken without problems.[4]

Keeping native fishes in outdoor ponds and aquariums is not uncommon in the southern states. *Lucani goodei* do quite well outdoors if the temperature stays between the upper 40s to the low 80s. Harry Specht is most successful with outdoor aquariums that have an abundance of green water and are planted with *Elodea*, hornwort, and Java moss clumped on the bottom.[7] Feeding is necessary because it is unlikely that enough insect food sources in the typical urban area will find their way into a backyard pond or aquarium.

Breeding

Lucania goodei is a plant spawner that will deposit eggs in nylon spawning mops, plants, peat fiber and Java moss. Large mops seem better suited because they provide more cover. Mops that are long enough to spill over the bottom are recommended.[2] Very early reports that eggs are suspended by threads from the female and then brushed off as she swims through the plants are based, I believe, on faulty observations of a suspect photograph that seemed to show an egg dangling from a female. The direct observations of several authors do not in any way support this observation. Rather, in a courtship routine typical of top-spawning killifishes, the male approaches from below, behind or aside the female. When she pauses at the spawning media, they assume the expected "S" shape, followed by rapid gyrations and the simultaneous release and fertilization of the egg.

Egg size is neither overly small (about 1 mm) nor particularly delicate to handle. Although some authors report that many eggs are laid by well-conditioned females, others indicate that eggs are sparingly laid each day. I have not seen an extraordinary number of eggs at one time. Generally, I pick less than 15 eggs after a few days. However, this may be due to the recorded propensity for *L. goodei* adults to eat their eggs, a practice sure to hold down apparent egg production, especially when eggs are not religiously picked each day. Some believe that the best spawning temperature is in the mid 70s and that spawning will cease below 70°F. Although there is no hard evidence either way, the non-scientific consensus seems to confirm these observations. This consensus also agrees with the fact that although fry are sexable at the early age of three months, it takes 9-12 months before they produce viable eggs. For example, my f3 generation spawned at about 10 months of age at a water temperature of 78°F.

Lucania goodei eggs are exceptionally clear. Embryo development is easy to observe with even a modest microscope. As shown in Fig. 2, egg development is correlated to—and almost linear with—storage temperature. There is no evidence of any resting stages or periods within the maturation cycle in which the rate of development varies. At least one author observed that eggs incubated at higher temperatures resulted in weaker fry than those incubated at lower temperatures.[1]

Fry Care

Authors agree that the fry, or at least most of them, are not able to take newly hatched brine shrimp, requiring instead microscopic foods such as infusoria. Microworms and newly hatched brine shrimp should be added after a few days while infusoria (or a like food) is continued so that fry of all sizes have an abundant supply of food.[2] Under these conditions, maximum fry growth can be expected.

Some authors have warned that large or frequent water

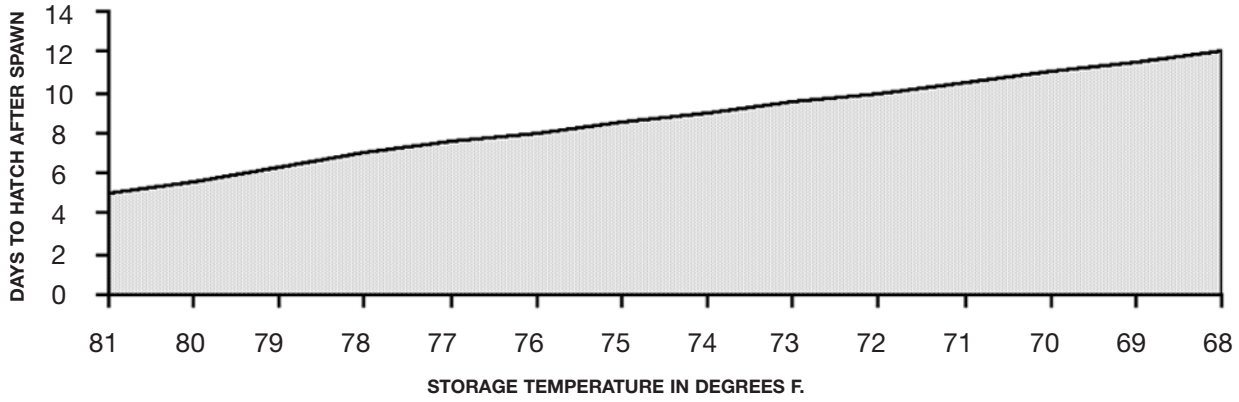

Fig. 2.
Correlation of egg development to storage temperature in Bluefin Killifish, *Lucania goodei*.

changes can lead to fry mortality.[1] To be sure, a deterioration of water quality will almost certainly kill the fry, so water changes must be made. Indeed, most authors agree that the most difficult part of propagating *L. goodei* is keeping the fry alive the first few days after they hatch. Once they survive these first days, the fry are easy to raise with few if any losses. I've found that losses from water changes can be eliminated if the fry tank water and the new water are chemically similar. I dip out a half-cup of water from the fry tank and add a half-cup of water from a clean adult tank, repeating this process about once an hour until 30% of the water is changed. I change fry tank water in this manner at least two or three times a week for the first month after hatching. A very small amount of rock salt, the equivalent of 1/2 teaspoon/gallon, is added to the fry tank after the water change is complete.

If you allow the eggs to hatch in the breeding tank, the parents will consume the fry.[4] I've never found fry in my breeding setup presumably because the spawning mop provides inadequate cover for the fry. But fry do survive in heavily planted tanks and in outside ponds that provide good cover.[4] If you're serious about propagating this fish, you will have to pick the eggs often. Alternatively, you may want to set up a heavily planted aquarium to both better observe these beautiful fish and provide an environment in which the fry will survive.

I've been keeping and raising killifish since the mid-1960s, but it was not until I moved to Florida in 1993 that I become familiar with this wonderful little fish. There are many native killies well worth keeping, and I hope this article will in some small way help to invigorate interest in our national killifish resources. Try a pair or two of *Lucania goodei*, and if you do, you will treasure them as I have. Once they are in your fishroom, they are there to stay for a very long time.

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