Care and Spawning of the Endangered Mohave Tui Chub in Captivity

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Captive spawning of endangered species can be an important part in the recovery of a species. Working in a controlled setting allows accurate observations of early life-history traits, and captive-produced offspring can reduce collection of wild fish for experimental studies and translocations (Buyanak and Mohr, 1981; Rakes et al., 1999). Many endangered fishes, including endangered cyprinids such as Colorado pikeminnow, bonytail, humpback chub, and roundtail chub, have been spawned in the laboratory (Hamman, 1982a, 1982b). Species in the genus *Gila* seem to be particularly easy to spawn in captivity, three additional species have been spawned in captivity at the University of Arizona, including Gila chub (*Gila intermedia*), Yaqui chub (*Gila purpurea*), and Mohave tui chub (*Gila bicolor mohavensis*; Archdeacon and Bonar, 2009; Kline and Bonar, 2009; Schultz and Bonar, 2009). However, most species in the genus *Gila* are impossible for hobbyists to possess legally. As researchers, we had the unique opportunity to collect and study these fishes in captivity. Here, we examine the Mohave tui chub in captivity (Fig. 1), and examine some methods that resulted in natural spawning in captivity.

Fig. 1.
Mohave tui chubs. Photo by Steve Parmenter.

Mohave tui chub are the only native fish in the Mojave River basin, and are probably not closely related to other Gila chubs, often placed in their own genus, *Siphateles*. There are no less than 13 described subspecies of tui chub in the United States, ranging from Oregon, to the southernmost population in the Mojave basin. Populations of Mohave tui chub declined in the Mojave River after the 1930s, when competition occurred with arroyo chubs *G. orcutti* (Hubbs and Miller, 1943), which were believed to have been introduced into the headwaters by anglers. Mohave tui chubs were eliminated from the Mojave River system by the late 1960s, and existed only at one isolated pool in Mojave National Preserve at Zzyzx Mineral Springs, California (Miller 1968). Recovery efforts involved transplantations of fish to establish new populations, and despite many attempts, the U.S Fish and Wildlife Service recognizes only three populations in springs in southern California (Hoover and St. Amant, 1983; Hughson and Woo, 2004).

Fish Collection and Husbandry

We used minnow traps to collect 25 adult Mohave tui chub from Lake Tuendae, a spring located at Zzyzx, California (Mojave National Preserve, Fig. 2), in August 2005. Lake Tuendae is approximately 400m from the only naturally-occurring population in MC Spring (Fig. 3), and covers about one acre, and contains an estimated 1,500-3,000 Mohave tui chubs, and two introduced species, mosquitofish (*Gambusia affinis*) and Saratoga Springs pupfish (*Cyprinodon nevadensis nevadensis*). Lake Tuendae (Fig. 4) was formerly a

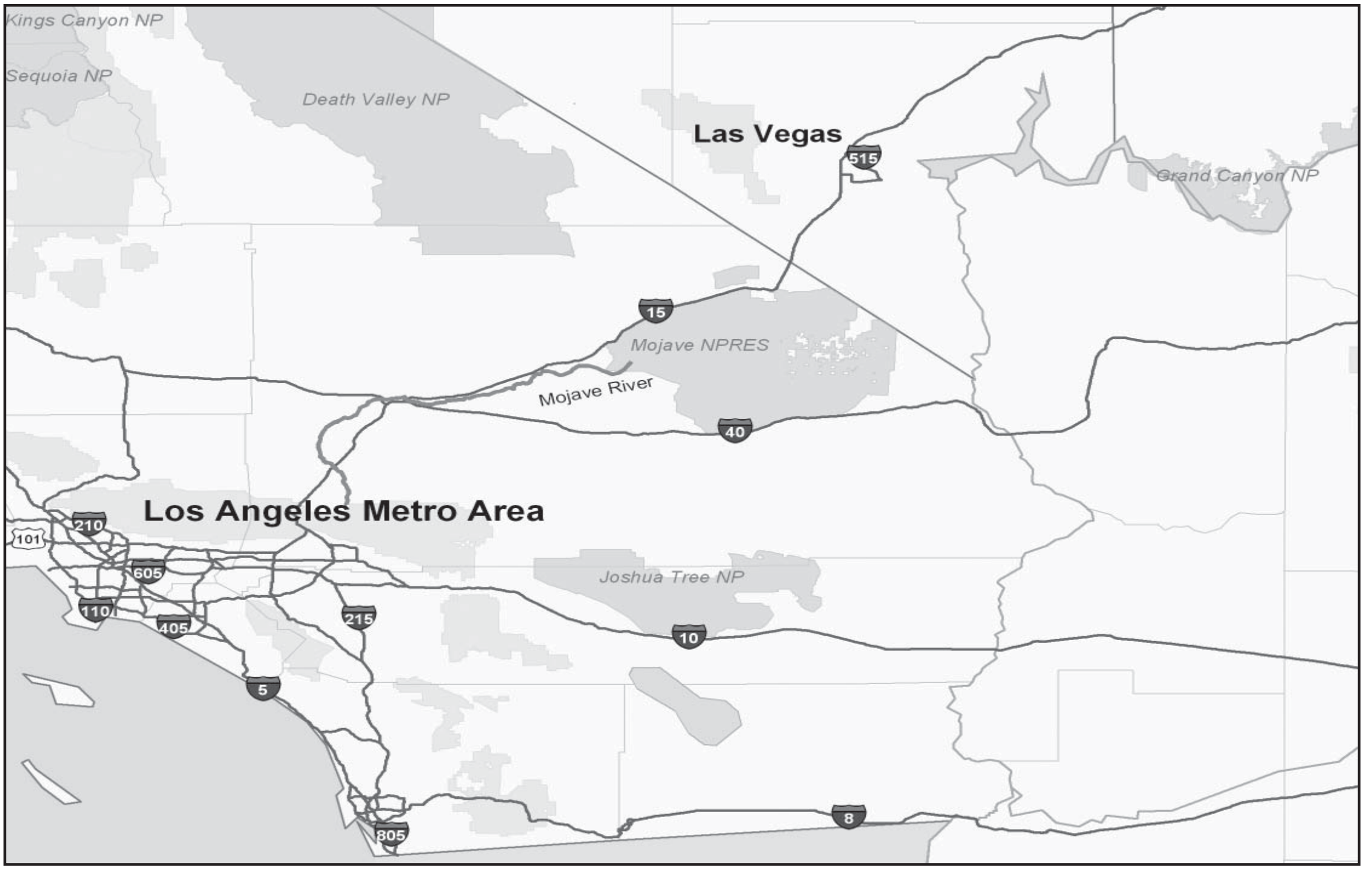

Fig. 2. Map of Mojave National Preserve.

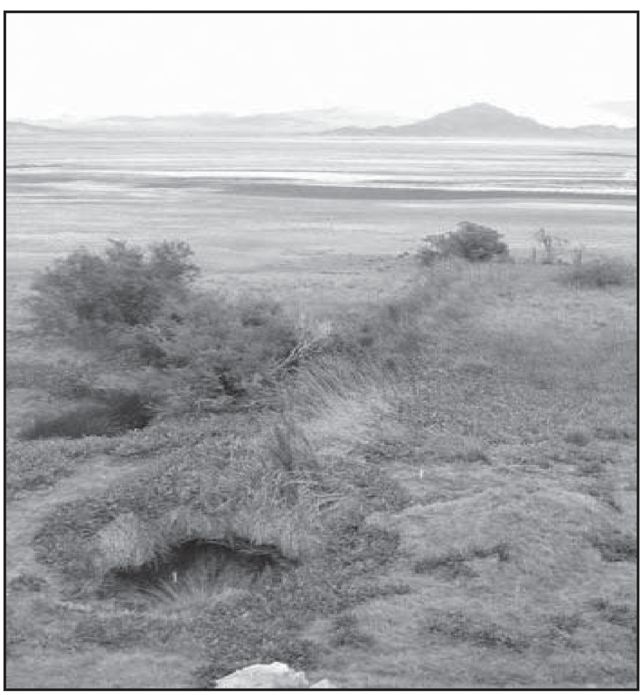

Fig. 3.
"MC Spring," containing the only natural population of Mohave tui chubs. Photo by Scott Bonar.

Fig. 4.
Lake Tuendae, the man-made pond containing Mohave tui chub, mosquitofish, and Saratoga Spring pupfish, where we collected broodstock for captive spawning of Mohave tui chub. Photo by Thomas Archdeacon.

resort, and is now a research station part of the California State University system. We collected fish (Fig. 5) ranging in size from about 4.5 to 9 inches total length. We treated the fish in a salt bath to remove external parasites and used a praziquantel bath (Mitchell 1989) to remove Asian tapeworm *Bothriocephalus acheilognathi*, which is known to occur at Lake Tuendae. Praziquantel is available through commercial pond supply catalogs. After transporting them to Tucson, Arizona, we housed 15 fish in a 125-gallon acrylic tank fitted with a custom-built recirculating biofilter and filled with well water (pH = 8.5-9.0), filled about 80% full. We used two 40-watt fluorescent lights (placed 30 cm above water level) on electronic timers to control the light cycle. We covered the outside bottom, back, and sides with 5-mm foam insulation, and placed pea-sized gravel substrate on the bottom of half the tank (the other half was left bare), and used pottery shards for fish cover. We fed bloodworms and pellet food once each per day, ad libitum, siphoned waste as needed, and performed routine water changes as needed to maintain ammonia and nitrate levels at 0 ppm. At least once per month, we replaced 10% of the tank water with clean well water.

Spawning substrate Tui chubs spawn over vegetation, and Kimsey (1954) observed that the eggs of the intergrade Eagle Lake tui chub (*Gila bicolor*: *obesus* x *pectinifer*) that fall into the substrate do not develop. We attached two artificial plants (Fancy Plants Giants® asparagus fern) to a plastic grate and placed them in the tank, held down with a large rock. These plants most resembled the aquatic vegetation found in Lake Tuendae. The plants provided a substrate for egg attachment—as well as additional cover—and could easily be removed from the tank. For the second and third spawns, we placed unglazed ceramic tiles under the grate to capture eggs that did not adhere to the plants (Schultz and Bonar, 2009).

Temperature and photoperiod manipulations To induce spawning, we lowered the water temperature in the tank by 1°C per day to about 9°C to simulate natural conditions in Lake Tuendae. Mohave tui chub are inactive during the coldest months (Vicker, 1973), and the average minimum water temperature during January is about 8°C. In Lake Tuendae, Mohave tui chub spawn as early as February, and peak spawning occurs when water warms to 18°C in mid-March (Vicker, 1973). During the temperature manipulation, we used a photoperiod of 10 h light: 14 h dark. After the water temperature was less than 10°C, we held it constant for 30 days. After 30 days, we allowed the tank to warm up 1°C per day to reach ambient air temperature (20-22°C) and we adjusted the photoperiod to 14 h light: 10 h dark when the tank reached 15°C.

Spawning As water was warmed to 15°C, we noticed increased activity among fish. Many fish developed a reddish tinge on the bases of the paired fins, and fish were often seen "milling" about the artificial plants. These observations are in agreement with previous studies of tui chub spawning in the wild (Kimsey, 1954; Vicker, 1973). On 6 February 2006, one month after the tanks reached ambient temperature (20-23°C), we noticed eggs in the tank. Unfortunately, we were not able to see the actual spawning process, we suspect spawning occurs at night, because we checked tanks daily and never witnessed spawning; eggs were always first noticed in the morning. We found three spawns occurred within 2 weeks, but the total number of eggs was difficult to estimate because they were difficult to see in the artificial plants. The first spawn yielded 166 larval fish, and the latter two spawns yielded over 800 larval fish each. At 20-23°C it took about 4 days for eggs to hatch, and less than 24 hours to reach swim-up after hatching. After eggs were discovered in the tanks, it was a simple matter to move the artificial plants and tiles containing eggs to 76-L rearing tanks. Eggs were incubated at ambient temperature (20-23°C). Larval fish were fed appropriately-sized commercial larval fish food. We also noticed much higher survival rates and lower susceptibility to fungal infections in Mohave tui chub larvae and fry, than in Yaqui and Gila chub. Mohave tui chub will also become cannibalistic in aquaria when given the opportunity.

Conclusions

Fish were very nervous when first brought into captivity. Adding substrate and artificial plants calmed the fish. While

Fig. 5.
Mohave tui chub. Photo by Steve Parmenter.

we did not perform an experiment, temperature cycling, photoperiod, and plants may all be important cues for spawning. Ten fish kept under similar conditions with access to spawning plants but not subjected to temperature cycling or photoperiod manipulation did not spawn after one year of captivity. We also noted that no new eggs appeared in the tanks after the artificial plants were removed. Whether the plants served as a cue for spawning or simply provided cover to prevent the eggs from immediately being eaten is unknown. Overall, Mohave tui chub adapted quite readily to captivity, required very little care, and spawned readily. Only two of the original 25 fish collected as brood stock died between transport in August 2005 and termination of the project in May 2007.

About 400 of the fish produced were used in subsequent growth and survival experiments with Asian tapeworm infections. The remaining propagated fish that were not used were returned to Mojave National Preserve in March 2007 and placed in a holding pond at Camp Cady, near Barstow, California.

Acknowledgements

We thank the USGS-BRD for funding. Steve Parmenter of California Fish and Game, Debra Hughson from the National Park Service, and Doug Threloff from the U.S. Fish and Wildlife Service helping obtain the necessary permits, and Rob Fulton of the Desert Research Center for field assistance, hospitality, and access to water and weather data at Lake Tuendae. I also thank S. Jason Kline, Andrea Francis, and Alison Iles from The University of Arizona for both field and laboratory assistance. The views in this article are the authors' and do not necessarily reflect the views of the Arizona Cooperative Fish and Wildlife Research Unit.

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