AN OUTLINE OF THE GENUS CYPRINODON

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The desert is not generally associated with fishes, yet in the desolate regions of the south-western Untied States and northern Mexico there are springs and intermittent streams fed by underground waters which provide year-round sources of water for flora and fauna of the desert. Some of these springs well up along fault lines from deep below the ground, warmed by molten rock. Other springs and streams are very salty and alkaline, where evaporation has concentrated the mineral content of the water. Yet, wherever the conditions are not so extreme as to preclude life altogether, those plants and animals hardy enough to survive have managed to adapt and thrive. Perhaps the most successful piscine inhabitant of these desert oases is the pupfish. Belonging to the genus Cyprinodon, these remarkable fishes live under many types of chemical and physical conditions in isolated pools and streams of the desert, each species separated in a unique environment.

The history of the Cyprinodon genus is an important example of the development of divergent forms through isolation. During the periods of glaciation, generally referred to as the Pluvial period in Earth's history, the southwestern portion of North America was much wetter and cooler than it is now. There were large drainage basins whose lakes and rivers were the home of the pupfishes' ancestors. As the glaciers retreated, this area became hot and dry. The lakes and rivers shrank, until only those springs and intermittent rivers supplied constantly by underground water sources were left.

Pupfish trapped in these disconnected environments were not able to interbreed with other populations and each group evolved in a different way. Some habitats remained connected longer than others. Those pupfish which have the most divergent forms are thought to have been separated the longest time, while those populations which are classed as subspecies were isolated more recently.

Other factors have contributed to the remarkably rapid speciation of the genus Cyprinodon. The number of generations of pupfish born each year is high, especially in those which inhabit warm springs. Also, the small population size of pupfish species contributes to rapid change. In a small population the accidental survival of a particular trait is greatly increased, whether this is a factor which enhances the fishes survival or not. This phenomenon is termed the Sewall Wright effect, after its originator, or drift. A new gene or gene combination has a much greater chance of being eventually transmitted throughout a small isolated population than in a large widespread popu-

lation where selection may prevent the survival of nonadaptive traits. Thus, with the tiny number of pupfish found in each spring or marsh, sometimes as few as fifty members, the chances of a new coloration or other change becoming a standard part of the entire group was much more likely than in a large river system where the inhabitants are not so isolated.

The various chemical and physical conditions in which each species lives is also thought to have an influence on the divergent development of pupfish species. Differences in salinity and temperature have been shown to have a direct effect on the meristic characters of fishes. Due to these variables nearly every pupfish habitat contains a unique form of Cyprinodon. The conditions under which those pupfish that live in salt marshes and creeks must survive change greatly in salinity and temperature with the season. Other pupfish live in springs whose temperature and salinity is constant throughout the year. Surprisingly, experimentation has shown that the temperature tolerances of pupfish from a constant environment are as great as those of pupfish whose habitats have a widely fluctuating temperature.

Besides the Desert Pupfish, there are also Cyprinodon species which inhabit brackish water. Cyprinodon variegatus is a well known native killie which is found along the Atlantic and Gulf coasts. This fish has been kept in aquariums often. Several related species which may be subspecies of C. variegatus have been described, most of which occur in brackish water: C. dearborni, from the Dutch West Indies; C. baconi, from Andros Island, Bahamas; C. bondi, from Etang Saumatre, Haiti; C. variegatus artifrons, from Yucatan; C. hubbsi, from Lake Eustis, Florida (a fresh-water form); C. jamaicensis, from Jamaica; and C. laciniatus, from the Bahamas.

The Chihuahuan Desert of southwestern Texas and northern Mexico has a desert spring system where pupfishes have evolved. In the Cuatrocienegas basin, Coahuila, Mexico, C. atrorus and C. bifaciatus are located. C. atrorus is now available to AKA members, as Dr. Richard Haas brought some back with him from a research trip to the area. The springs of this area are being adversely affected by the pumping of water for irrigation, so these species may become extinct in the near future.

South of Cuatrocienegas, near Parras, Mexico, C. latifaciatus made its home, but this fish is now thought to be extinct. pollution from factories in the area has killed most of the fish found there.

Moving northward, C. eximius is abundant in the Chonchos drainage of the Chihuahua area.

Near Fort Stockton, Texas, is found the Leon Springs pupfish, C. bovinus. This was considered extinct until 1966 when a remnant population was found in Willbank Spring. At present, C. bovinus is said to occur only in a marshy section of Leon Creek and a few semi-isolated springs.

The Comanche Springs pupfish, C. elegans, is also extinct in its original location, however a population considered to be C. elegans has survived near Balmorhea, Texas. These pupfish are unique, as they have adapted to live in the running water in irrigation ditches flowing out of Phantom Lake Spring. The release of C. variegatus into Lake Balmorhea, which connects with the present habitat of C. elegans, holds a threat for the rarer fish. C. variegatus is able to outcompete C. elegans in calm water. As long as C. elegans has running water in which to live, this will make a protective barrier to keep out the imported fish, but if the flow of water slows, C. variegatus will invade the irrigation ditches and replace the C. elegans. The Texas Parks and Wildlife Department is considering building a refugium for the Comanche Springs Pupfish at Balmorhea State Park.

A comparatively widespread species is C. macularius. The range of this fish was described originally as the basin of the lower Colorado and Gila Rivers and the Salton Sea, from southern Arizona to southeastern California and eastern Lower California and the Sonoyta River of northern Sonora, Mexico. However, it is no longer found throughout much of this range. C. macularius occurs at two protected locations; in Quitobaquito Springs at Organ Pipe Cactus National Monument, Arizona, and a wildlife refuge at Anza-Borrengo State Park on the western side of the Salton Sea.

C. rubrofluviatilis comes from the Red River which flows between Oklahoma and Texas.

The pupfishes of the Death Valley region show great variation, yet all these species have a similar pattern of scale structure different from that of other Cyprinodon species. This supports the geological evidence that these species descended from a common ancestor which lived in the once continuous waters of the Death Valley System.

C. salinus is found in Salt Creek, which empties into the Cottonball Marsh where a newly described species, C. milleri, resides. Both these habitats fluctuate greatly, the temperature varies from freezing to 100°F., and salt concentrations become as high as that of sea water.

C. nevadensis, found in Saratoga Springs and adjoining lakes, has many subspecies, several of which have become extinct or are the endangered species list. C. n. armagose, formerly found in the Armagose River, is now found only at Tecopa Bore, Tecopa Hot Springs, California, which ,strangely enough, is a man-made artesian well. It was dug in 1967 and pupfish from a nearby marsh colonized it. C. n. calidae, the Tecopa pupfish, is feared extinct. Though rediscovery of two additional populations gave hope for the survival of this subspecies, the introduction of mosquito fish into their waters has probably wiped out this fish permanently. C. n. mionectes is found in

several springs of Ash Meadow, Nevada. Introduced fish are feared to have endangered this subspecies. C. n. pectoralis is protected in a refuge at School Spring in Ash Meadow. This subspecies is on the endangered species list. C. n. shoshone is now extinct because of mosquito fish and green sunfish, although accidental pesticide poisoning may have contributed to its destruction.

Cyprinodon diabolis is the most distinctive of the Death Valley pupfish. It is only one half the size of the other species, and they have no cross bars on their sides, and no pelvic fins. Found only in Devil's Hole, Nevada, this fish was gravely threatened by lowering of the water table due to the pumping of water for irrigation and other purposes. For the moment, this species is safe, however their survival is still somewhat precarious. A refugium at Hoover Dam was built in order to create as closely as possible the conditions at Devil's Hole. Unfortunately, it seems that the fish established there are developing differently from the way they were in their natural environment. Efforts to raise C. diabolis in the aquarium have not succeeded.

Cyprinodon radiosus, the Owens Pupfish, from Owens Valley, California was thought to have become extinct, but a population was rediscovered in 1964. This fish was almost lost again when the marsh in which the remnant group lived dried up. Luckily the fish were rescued and have been established in a protected home in the Fish Slough, near Bishop, California. They have also been introduced into several other springs in the area.

The habitats where pupfish live are very fragile ecologically. The pumping of water threatens to lower the water table, and dry the waters where the pupfish live. The introduction of game fish, Gambusia and other competitors have already caused the extinction of several pupfishes and are threatening others. much work has already been done to save pupfishes, but their existance is still precarious. If you would like to find out more about these fishes, be sure to read the material listed in the bibliography of this article. Most university libraries will have the sources listed.

We "killie keepers" and "native keepers" can help save some species by raising them in our tanks, but one word of caution... some of these fish are protected by state or federal laws, and a permit is needed to keep them. Information about federal regulations may be obtained from:

Department of the Interior
Fish and Wildlife Department
Washington, D.C. 20240

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