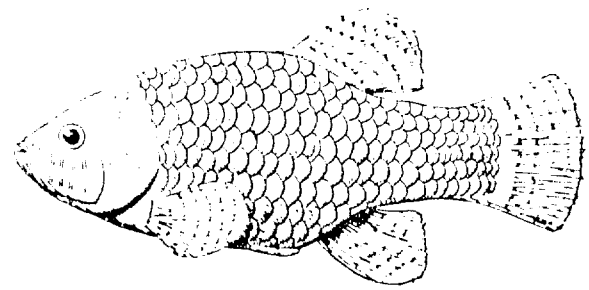
Desert Fishes Council



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THERMAL TOLERANCES FOR RELICT POPULATIONS OF DESERT PUPFISH, *Cyprinodon macularius*

by

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Abstract. Thermal tolerances of Desert Pupfish, *Cyprinodon macularius*, are legendary. Published data for critical thermal maxima and minima indicate a range of extremes from 7°C to 44.6°C (Lowe and Heath 1969, Deacon and Minckley 1974, Schoenherr, 1988). Furthermore, based on experiments with various species of pupfish the following generalizations may be made:

1. Thermal tolerances vary with acclimation temperature and season (Lowe and Heath 1969; Feldmeth, Stone, and Brown 1974).

2. Species from constant temperature habitats have narrower ranges of thermal tolerances, and those tolerances are inherited (Hirshfield and Feldmeth 1980).

We asked the question, "How long do pupfish populations have to be isolated in order to change their inherited thermal tolerances?" Preliminary data for pupfish populations from Chihuahua, Mexico showed the most significant differences in critical thermal maxima for populations that have been separated about a million years (Soltz and Feldmeth personal communication). Working with *Cyprinodon nevadensis* from Ash

meadows and the Amargosa River, Hirshfield and Feldmeth (1980) showed significant differences for populations that were separated from each other for several thousand years.

In the case of the Desert Pupfish, the population of *Cyprinodon macularius eremus*, from Quitobaquito Spring in Organ Pipe Cactus National Monument has been separated from the Colorado River and Salton Sea populations of *C. m. macularius* for a minimum of 100,000 years (Miller and Fuiman 1987). The critical thermal maximum of 44.6°C reported by Lowe and Heath (1969) for *C. m. eremus* is significantly higher than the 42.7°C our experiments showed for *C. m. macularius* for Salton Sea populations (Table 1). While we found no significant differences in critical thermal maxima for 3 populations of Salton Sea fish, we did find significant differences in critical thermal minima. We tested fish from Oasis Spring that lived at a constant 28°C for 13 generations and compared them to fish from Salt Creek where the seasonal temperature varied from 10°C to 31°C. The critical thermal minimum of 4.4°C is the lowest recorded for the species. Furthermore, we found no significant differences in critical thermal maxima and minima between fish from Salt Creek and fish transferred from Salt Creek to Thousand Palms where they lived in a similar variable temperature environment for 4 generations. These data imply that genetic thermal tolerances, particularly critical thermal minima, are able to evolve rapidly. In order to avoid genetic bottlenecks, refugia should provide the greatest amount of environmental heterogeneity possible.

TABLE 1. A SUMMARY OF THERMAL TOLERANCES FOR PUPFISH FROM OASIS SPRING AND SALT CREEK, RIVERSIDE COUNTY, CALIFORNIA

	Oasis Spring	Oasis Spring	Thsnd Palms	Salt Creek
CTMax (°C)	42.7	42.6	42.4	41.9
CTMin (°C)	5.3	6.3	4.4	4.6
Thermal Scope	37.4	36.3	38.0	37.3

LITERATURE CITED

Deacon, J. E. and W. L. Minckley. 1974. Desert fishes. Pp. 385-488 *in* Desert Biology, Vol. II (G. W. Brown, Jr. ed.), Academic Press, New York.

Feldmeth, C. R., E. A. Stone, and J. H. Brown. 1974. An increased scope for thermal tolerance upon acclimating pupfish (*Cyprinodon*) to cycling temperatures. J. Comp. Physiol., 89:39-44.

Hirshfield, M. F. and C. R. Feldmeth. 1980. Genetic differences in physiological tolerances of Amargosa Pupfish (*Cyprinodon nevadensis*) populations. Science, 207: 999-1001.

Lowe, C. H. and W. G. Heath. 1969. Behavioral and physiological responses to temperature in the desert pupfish *Cyprinodon macularius*. Physiol. Zool., 42:53-59.

Miller, R. R. and L. A. Fuiman. 1987. Description and conservation status of *Cyprinodon macularius eremus*, a new subspecies of pupfish from Organ Pipe Cactus National Monument, Arizona. Copeia, 593-609.

Schoenherr, A. A. 1988. A review of the life history and status of the desert pupfish, *Cyprinodon macularius*. Bull. Southern Calif. Acad. Sci., 87:104-134.