

The Mvstery of the Golden Pupfish

by Bruce J. Turner, Blacksburg, VA

The paper we eventually wrote was appropriately dry, almost dusty:

The variants were initially detected during routine field work at Salt Creek, Death Valley National Monument, on 21 March, 1966. At least 20 xanthic specimens were sighted among about 5000 normal individuals at a point about 400 m N of the end of the visitors' access road (Turner & Liu, 1977).

It doesn't begin to convey the excitement I felt in October, 1966 when I drove to Death Valley with Bob Liu to look for golden pupfish. I had arrived in L.A. from Brooklyn (like in Brooklyn, New York...) the month before. It, and the entire southern California scene were blowing my mind at every turn--socially, economically, politically, historically, ethnically, you name it.

The California deserts, Death Valley especially, took my already blown mind and twisted it inside out. The sharp relief of the land, the rapid changes of altitude and plant life, the dry heat and the hot wind, the alluvial fans and canyons like ovens, and the emptiness. I don't remember for sure now, but the 21-year-old I was then, used to the seashore and the gentle terrain of the East, probably spent most of the trip with his mouth hanging open.

Bob Liu studied the behavior of pupfishes, mostly those of Death Valley and adjacent regions. Although he did most of his behavioral work in the lab, his frequent trips to the Death Valley region probably subjected those pupfishes (Cyprinodon nevadensis, C. salinus, C. diabolis, etc.) to more scrutiny than they had received since Robert R. Miller and Carl Hubbs did their pioneering work in the area 25 and more years before.

That scrutiny had paid off for Bob in an interesting way the previous March. He had camped at Salt Creek, very near the end of the tourist access road, with the intention of studying the behavior of the C. salinus there at first light. Dawn found him sitting at the edge of the creek, notebook, stopwatch, light meter, thermometer and camera at his side, waiting for the pupfish to begin their daily round of activity. He was interested in the relationship of that activity to light and temperature levels. At what light level do the fish first begin feeding? What is the light level and temperature when spawning first begins? The sun

came up like thunder, as it always does in desert country. The pupfish came "out" promptly, as they almost always do in desert country.

As soon as he could see fish, Bob began recording observations. But as the light level increased, this cool professional dropped his notebook and stood and looked out at the creek in utter amazement: THERE WERE GOLDEN PUPFISH OUT THERE!

No one had ever seen a golden pupfish before. At this part of Salt Creek at this time of day, the pupfish were separated into aggregates of 150 to 200 individuals. Golden specimens, about 20 in all, could be seen in many of these aggregates. All thoughts of data-gathering stopped as Liu ran back to camp, woke his startled companions and practically jammed a seine into their groggy hands. An hour later, five of the golden fish had been collected and were on their way back to the lab at UCLA, with their collectors excitedly (and probably a little incoherently) asking the obvious questions. No golden specimens had been evident the previous month. By what means had these golden pupfish suddenly appeared? Would they persist in the population? They were very conspicuous to humans; would bird predators (e.g. ravens) take them preferentially? Could goldens be maintained and bred in the lab? Did the golden trait have interesting genetics?

The golden C. salinus could be considered "xanthic" variants. In general (the term is not well defined and is often broadly used), xanthic individuals have reduced amounts of melanin-based (black, brown) pigments, but retain these pigments in certain areas like the retina and peritoneum. They lack the characteristic blood red eyes (due to retinal pigment reduction) of the true albino. In life, the golden pupfish were light yellowish pink in color, with clear fins. The dark bars characteristic of most pupfishes were absent altogether, as were all other body markings. It was hard to discern sex, except by behavior. The overall impression was similar to that of a blond guppy or the "golden" medakas one sometimes sees in aquarium shops (i.e. the "red" mutation of medaka geneticists).

In May of that year Bob again saw a few golden pupfish at Salt Creek, but didn't collect any. The ones already in the lab were doing fine and seemed to be spawning quite regularly. And there were, after all, other things to be done.

By September (when I had arrived on the scene), it was clear to both of us that Bob had been too optimistic. The five golden C. salinus in the lab were doing well and seemed to be spawning, but no progeny were appearing. At that time we were breeding pupfishes by placing the breeders in a 10 or 20 gallon aquarium with a sand substrate, feeding them

heavily for a week or two, transferring them out, and then waiting for the fry to appear. It worked beautifully with most species, including ordinary C. salinus. It didn't work at all with the goldens. Bob and I began to suspect that maybe at least one sex of the goldens was sterile, or perhaps that the fry were unusually weak. Maybe it would be better to breed goldens with ordinary C. salinus, hoping to recover more golden individuals in a subsequent generation?

We decided that the best thing to do would be to get more golden specimens. Perhaps we could collect enough to fix some, section their gonads, and see if they were really fertile. Perhaps fertility was variable and/or under the control of specific environmental cues, and golden specimens in the natural environment were more fertile than ours (which by this time had been in the lab for 6 months)?

This, then, would be my introduction to field work in Death Valley. A drive direct to Salt Creek, an arduous day of seining to get all the goldens we could catch, then a lightning drive back to the lab (and when I say "lightning" remember that this was well before the days of the 55 mph limit, and that the existing limits on these sparsely policed roads were not diligently enforced. Remember also that I was young and not very wise.)

We did this, or at least we started to. But when we got to Salt Creek, there was not a single golden pupfish to be seen. We hiked and seined and seined and hiked. Not for one day, but two. The saline water and the sun chapped our hands, legs and thighs until they were raw and permeated our swimsuits until they felt like they were made of sandpaper. (Mine was so painful and shrunken that afterwards I refused to pull it off in the usual way--instead I took out my field knife and cut it off and threw it away--but my jeans were no better. They quickly got so caked with salt and mud that they wouldn't bend at the knees, and I spent hours that night beating on them with rocks in a vain attempt to restore flexibility). I saw more ordinary C. salinus than I ever wanted to see. I also saw more of Salt Creek than I ever wanted to see ---ironically, later I realized that we must have come within a quarter-mile of McLean's Spring, a locality we did not know, but which was "discovered" by others two or three years later to be the source of Salt Creek and the habitat of a permanent population of C. salinus---the Salt Creek population itself is probably seasonally ephemeral (see Soltz & Naiman, 1978). But we never saw a single golden C. salinus.

To my knowledge, no one has seen one since. The specimens we had in the lab never did breed. We preserved four of these, and I believe they are now in the collection of the California Academy of Sciences. Those 4 specimens and our little note in Southwestern Naturalist (which does

contain a photo) are our own species' only record of the xanthic or golden *C. salinus*.

But what really happened? More specifically, what factors caused a particular and conspicuous variant to suddenly appear in a natural population and then disappear again? And why do I find this all so interesting?

The first question is pretty tough, for data are almost entirely lacking on the genetics and biology of the xanthic pupfish variant. In their absence, I will not indulge in the temptation to construct plausible scenarios. However, I will note that modern population genetics (see Hartl, 1988, a good introduction for those with some background in genetics) does provide several routes (involving natural selection and/or chance fluctuation) for an initially rare gene in a population to become sufficiently common for homozygotes (i.e., individuals with two copies of the gene, one from each parent) to be probable. And I do presume that the golden specimens that Liu caught were homozygotes for a usually rare recessive form of a gene involved in pigment and/or pattern production. But we will probably never really know for sure.

The second question is a bit easier to answer than the first. The novelty value alone is enormous. What pupfish enthusiast would not want to be involved with, own or at least see some golden pupfish? More important than this though, is the fact that variants such as the xanthic pupfish can give us a glimpse of the sometimes very ephemeral processes that occur in natural populations of organisms.

At its lowest level, evolution is a change in the genetic composition (gene or allele frequencies) of a natural population. We have long known that most natural populations (fish included) are rich in genetic variation, but most of this variation is not easily discernible without specialized (often biochemical or molecular) techniques; generally, little of it seems to affect some conspicuous property of organisms (color, size, etc.) in an obvious way. Events such as the golden pupfish are a major exception. It appeared as a sudden, discontinuous variant in a seemingly uniform population. Then, almost as suddenly, it was gone. But even as it disappeared it confirmed our feeling for the genetically dynamic nature of natural populations in a very satisfying way. For a brief moment, a part of the evolutionary process was exposed to view, like a breeze suddenly lifting a veil from the face of a beautiful woman. And though the lack of data frustrates me sometimes, that is how I like to think of the little golden pupfish from Salt Creek.

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Note: Reprints of the last reference are available by
request to the author at: Dept. of Biology, VPI & SU,
Blacksburg, VA 24061.