

CONSERVATION OF FISHES OF THE DEATH VALLEY
SYSTEM IN CALIFORNIA AND NEVADA 1/ 2/

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Abstract: The fishes inhabiting the Death Valley system of streams and springs, in eastern California and southwestern Nevada, were investigated recently to determine their current status -- especially to identify the endangered forms and to propose measures for their continued existence as part of our unique wildlife heritage. Of the nine species in three families that are treated, the killifishes receive special attention since five kinds are either threatened with extinction or are of such local distribution that they need prompt attention if they are to survive. An actual count of individuals is given for the Devils Hole Pupfish and the Pahrump Valley poolfish. Potential refugia are listed and recommendations are proposed for establishment of the most endangered forms in such sanctuaries. One sanctuary, in Owens Valley, is scheduled for completion during the summer of 1969.

INTRODUCTION

The fishes of the Death Valley System (Miller, 1948) -- the Pleistocene drainage that once united the now isolated waters of Owens Valley, Death

1/ Modified from a report submitted to the U.S. National Park Service in 1967.

2/ Editor's Note: Although this paper was not presented at the Annual Meeting, the Editorial Committee reviewed this report and deemed it a significant contribution to professional wildlife knowledge for the California-Nevada area.

Valley, and the Amargosa and Mohave river basins -- have suffered depletion and even extinction during the past two decades. A number of them are on the Endangered Species lists of the U. S. Department of the Interior's "Redbook" (1967) and of the I.U.C.N. Redbook (1969). These native forms, limited in numbers and restricted in distribution, must be carefully watched if a unique heritage is not to be lost forever. The objective of the present study was to determine their status and to attempt to identify suitable refuge areas where endangered populations might be established to safeguard the stocks.

Field work began on June 26 and terminated on July 10, 1967. I was accompanied and assisted by my family and by Carl L. Hubbs and Laura C. Hubbs throughout the work and, at various times, by the following: Edwin P. Pister and party (California Department of Fish and Game), James E. Deacon and party (Nevada Southern University), Don Wilkie (Scripps Institution of Oceanography), Don Johnson and Elena Arnold (graduate students from Arizona State University), and David W. Greenfield (California State College Fullerton). Full cooperation was received in Death Valley National Monument from John W. Stratton, Dwight Warren and Homer Leach. The National Park Service, the National Science Foundation (NSF GV-4854), and conservation funds donated to the American Society of Ichthyologists and Herpetologists by the Zoological Society of San Diego provided financial assistance for the field work.

Since the killifishes (Cyprinodontidae) are the fishes most threatened in the Death Valley System, they are treated first. Five or more species inhabit the region: Cyprinodon diabolis, C. nevadensis, C. salinus, C. radiosus, and Empetrichthys latos (E. merriami, also discussed, has not been taken since 1948 and may be extinct). An undescribed population of Cyprinodon is yet to be named (see under account of C. salinus).

CYPRINODONTIDAE

Cyprinodon diabolis Wales

Devils Hole pupfish

Devils Hole, the extraordinarily restricted habitat of this species, in Ash Meadows, Nevada was examined from June 30 to July 1 during the following hours: 1:30 A.M. (traps set by J. E. Deacon and Carol J. James); 9:15 - 11:15 A.M.; 9:30 - 11:30 P.M.; 2:25 - 4:00 A.M.; and 7:15 - 9:30 A.M. An attempt was made to get an actual count of the total population, using 8 1/16-inch wire mesh traps, a new 6-foot "common sense" cotton seine, and various sizes of dipnets. From 2 to 11 persons worked in the Hole during the period indicated.

The only previous attempt to count the number of fish by removal from the spring was on April 1, 1950 (Miller 1961:548), when approximately 160 were recorded. However, that operation was far less thorough than the present one and, in retrospect, the population present then probably exceeded 200 individuals. The 1967 count, including 31 specimens that were preserved, was 464 individuals. This is regarded as a minimum count and is higher than any previous estimate (variously given as from about 100 to 400) and included many young fish. The population of C. diabolis is clearly in a healthy condition (it may have numbered as high as 800 individuals, including many newborn young).

In comparison with my last visit (on January 1, 1966), the habitat and its protection were much improved (trash on the shallow platform of the pool was gone and a concertina-type fence had been added inside the higher fence). Our rough estimate of the population then was between 180 and 200 individuals.

The principal danger to the Devils Hole pupfish now is that some "crank" or irresponsible person might try to wipe it out. To avoid the possibility of such a catastrophe, the species should be established elsewhere and a proposed refuge site is discussed later in this report.

Cyprinodon nevadensis Eigenmann and Eigenmann

Amargosa pupfish

This species is represented in Death Valley by two subspecies, C. n. nevadensis at Saratoga Springs and C. n. amargosae in the terminal surface flow of the Amargosa River about 7 to 8 miles northwest of Saratoga Springs. Near Tecopa, Shoshone, and in Ash Meadows, 4 other subspecies are known. The Death Valley populations have not been adversely affected by man since 1942 (fish abundant in 1967 and 1969) but those near Tecopa (C. n. calidae) and Shoshone (C. n. shoshone), and to a lesser extent the subspecies in Ash Meadows, have undergone severe to moderate depletion, especially since about 1950.

In January, 1966, we found the population of C. nevadensis calidae from the outlet of Tecopa Hot Springs to be almost extinct, and could not find any individuals of C. n. shoshone. However, Robert Ornduff (Associate Professor of Botany at Berkeley) wrote me on May 15, 1967, that during a visit to Shoshone in 1966 he found a residual population near the terminus of the outlet ditch of Shoshone Spring, near its junction with Amargosa River. Our investigation of this area on July 4, 1967, revealed only an infestation of mosquitofish (Gambusia affinis affinis). Examination of the source region on April 23, 1969, however, revealed a male, 2 females, and a juvenile, photographed and returned to the stream (Leonard Fisk, Calif. Dept.

of Fish and Game, in letter of May 5, 1969), so a remnant stock still survives. Every effort should be made to assure its perpetuation.

The Tecopa pupfish formerly inhabited the outflows of both North and South Tecopa Hot Springs. A population discovered in 1968 from a reservoir and adjacent creek flowing from a dug well at Jeds Motel, Tecopa Hot Springs, differs from typical C. n. calidae in having somewhat smaller scales; whether a pure population of calidae still survives is uncertain.

Crystal Pool in Ash Meadows, Nevada, is the type locality of the widespread subspecies C. nevadensis mionectes and has been devoid of native fish since at least 1966. In January 1966, we found this beautiful spring to be inhabited by largemouth bass only. Pupfish are doing well in Big Spring but not so well in nearby Jack Rabbit Spring. They are also doing well in certain other springs and ditches in the northern part of Ash Meadows, especially Longstreet and Rogers Springs and their outflows. It is estimated that each of ten springs in Ash Meadows supports from 50 to 2,000 individuals. Competition with introduced crayfish, bullfrogs, black mollies, and the highly competitive mosquitofish and largemouth bass, along with ditching of spring outflows and marsh drainage, are responsible for declining numbers.

The very restricted subspecies, C. n. pectoralis, is faring satisfactorily at the moment at Schoolhouse Spring, but needs protection there to assure survival. A sample from nearby Scruggs Springs, taken to determine if it might represent this same subspecies rather than C. n. mionectes, agrees with pectoralis as having a preponderance of 17 pectoral rays.

The location of springs in Ash Meadows is shown on the map (Pl. I) in Denny and Drewes (1965).

To summarize, 2 of the 6 subspecies of Cyprinodon nevadensis are either extinct or almost gone (Tecopa, Shoshone) and 1 (C. n. pectoralis) badly needs protection. One or more springs (e.g., Jack Rabbit Spring) which support the Ash Meadows form (C. n. mionectes) should be set aside to assure perpetuation of that subspecies. No special protection is indicated for the other 2 subspecies at this time.

Cyprinodon salinus Miller

Salt Creek pupfish

This pupfish is known only from Salt Creek, on the floor of Death Valley east and south of Stovepipe Wells. The pupfish that inhabits Cottonball Marsh, across the valley from the Park Service headquarters, is being described as a closely related species by LaBounty and Deacon.

On June 29, 1967, I walked up the bed of Salt Creek, from the end of the Park Service road almost to the canyon head, a distance estimated to be about 2 miles. The lower end of surface water in the creek lay about 200-300 yards above the road terminus. Pools on the east side of the canyon were teeming with Cyprinodon salinus of all ages; air was 105°F., water 92°F.; here at 11:15 A.M. We found the population size to be of the same order of magnitude ("existing by the millions") as my father and I noted almost to the day 29 years earlier. The species prefers the rather narrow and relatively deeper channels in the spongy grass which allow for retreat into cooler water by the larger adults who cannot tolerate such high temperatures as can the juveniles and smaller adults. Pools that seemed destined to become dry during the summer (mostly those on the western side of the canyon) were devoid of fish.

This population is in excellent condition and certainly needs no special attention. I would suggest, however, adding another sign to the one now at the road's end lettered "TAKE NO FISH", and I further recommend that this species be introduced into the courtyard pool at the Visitor Center as an interesting and meaningful attraction for the public; the species lives well in water of low salinity.

Cyprinodon radiosus Miller

Owens Valley pupfish

This species, thought to have become extinct between 1939 and 1942, was relocated by myself and Carl L. Hubbs in July, 1964, following information provided by William Richardson of the California Department of Fish and Game regarding a small, remnant population.

It is one of the most endangered species in the Death Valley System but perhaps the one that will be the easiest to reestablish in its former habitat. The Owens Valley Native Fish Sanctuary, authorized in 1968 by the above agency, is expected to be completed during the summer of 1969.

At the present time the fish is known only from one small, open and shallow marshy area along the east side of Fish Slough north of Bishop, in Mono County, California. The population size is difficult to estimate since many mosquitofish infest the marsh but it seemed to me not to have changed significantly since 1964; it comprises perhaps no more than 200 individuals, if that many.

It is planned to rehabilitate the two springs and their outlets at the northwestern end of Fish Slough where this species formerly lived. For the past 30 years they have contained only carp, bass, and mosquitofish.

After the exotic species are eliminated, a barrier will be installed shortly below the confluence of the springs to raise the water level from 1 to 3 feet over the area. This will provide a better habitat than was originally available for this pupfish and will also support the 3 other native species of Owens River (a sucker and 2 minnows) -- all of which lived in the springs and the outflows prior to 1942. The work is to be a cooperative undertaking between the California Department of Fish and Game and the Los Angeles Department of Water and Power, with perhaps other state organizations participating. The barrier to be used is a simple but effective one already operating successfully to protect the White River springfish, Crenichthys baileyi, in eastern Nevada.

Empetrichthys latos Miller

Pahrump Valley poolfish

This species formerly occurred at three localities in Pahrump Valley, Nye County, Nevada (Miller 1948:102), but is today known only from Manse Ranch where its numbers have dwindled precariously in recent years. Between July 2 and 4, 1967, approximately 1,300 individuals of this relict genus were removed from the main spring pool by 14 traps, dipnets, and seines. During that period a large goldfish population was mostly eliminated from the spring and irrigation ditches. The native species was then returned to the spring pool. At one time as many as 17 people were involved in the goldfish removal operation. Although there is no evidence of direct predation between the two species, it was felt that competition for food and breeding sites rendered the habitat less favorable for the native fish, which represents the last known population of the genus Empetrichthys. Among the some 1,300 poolfish collected were an estimated 300 young, many of which were newborn. Population structure, behavior, and life history of this species are being investigated by Dr. Deacon (see also Minckley and Deacon 1968:5-6).

Empetrichthys merriami Gilbert

This species was described in 1893 from a spring (probably Point of Rocks Spring) in Ash Meadows, Nye County, Nevada. Only 31 specimens were collected between 1891 and 1942. Since 1942, the species has been taken only once - a single specimen from Big Spring (called Deep Spring in Miller 1948) collected on September 7, 1948. Although our party seined this spring on June 30, 1967, and I searched it carefully with a face mask, Empetrichthys was neither seen nor collected. It is from Big Spring that nearly half (15) of all the known specimens of this species have been taken.

Four other springs in Ash Meadows (Jack Rabbit, Scruggs, Longstreet and Rogers) were either checked by face mask and/or seined on June 30 and July 1, 1967, without obtaining any Empetrichthys. There is much water, especially in the northern half of Ash Meadows, that has not been thoroughly worked for this fish, but even so its survival is questionable. The species seems to have been scarce even 30 years ago and perhaps was dying out then. Nevertheless concerted efforts to locate it should continue to be made.

CYPRINIDAE

Minnows are represented in the Death Valley System by three species: Gila (Siphateles) mohavensis, Gila (Siphateles) n. sp., and Rhinichthys osculus.

Gila mohavensis (Snyder)

Mohave chub

This species once occurred widely in the Mohave River and its tributaries (Hubbs and Miller, 1943) and, in fact, is the only fish known to be native in that drainage. Since about 1938 it has steadily declined due to competition from and hybridization with the introduced coastal Californian minnow Gila orcutti and the effects of other exotics (mosquitofish, bass, etc.). Our recent survey of the basin (July 5 to July 9, 1967), however, revealed that the species is still persisting in the river and tributaries, though it is very scarce there. It is abundant only in the spring-fed lake at Zzyzx Resort on the west side of Soda (Dry) Lake south of Baker, California. That population is in excellent condition but its future status is uncertain. For this reason it would be wise to establish a stock at another locality and the Zzyzx population should receive formal protection (see below, under Refugia).

Gila n. sp.

Owens Valley chub

This undescribed species is confined to Owens Valley and has dwindled in numbers ever since water was diverted from the valley and introduced species such as largemouth bass became established.

No attempt was made to determine its current status but this chub is to be reestablished along with the three other native Owens Valley fishes, in the reserve for Cyprinodon radiosus (see p. 0).

Rhinichthys osculus (Girard)

Speckled dace

This ubiquitous western American species occurs in the Death Valley System only in the Owens River and Amargosa River basins. No attempt was made to check its present distribution other than a brief examination of the spring-fed creek at Little Lake, in the southern end of Owens Valley. No dace were located but a further search for them there should be made. Preliminary studies of preserved material indicate local differentiation within, as well as between, these two drainages.

One of the Owens Valley representatives should be reestablished at Fish Slough in the reserve mentioned above. Some of the populations of R. o. nevadensis in Ash Meadows also need protection.

CATOSTOMIDAE

Only one living sucker is known from the Death Valley System, an undescribed species inhabiting the Owens River basin. The descriptions of this fish and of the Owens Valley chub are in preparation.

Catostomus n. sp.

Owens Valley sucker

No attempt was made to determine the current status of populations of this species. As with the dace, chub, and pupfish, it should become reestablished in its native habitat in the reserve being established at the northwestern part of Fish Slough north of Bishop (see above under Cyprinodon radiosus).

CONCLUSIONS

Three fishes of the Death Valley System are seriously endangered at this time, Cyprinodon radiosus, C. nevadensis shoshone, and Empetrichthys latos. Two others are so restricted that they too are endangered, but their status is not so precarious; these are Cyprinodon diabolis and Gila (Siphateles) mohavensis.

Except for the Devils Hole pupfish, there is no reason to be alarmed about the condition of the native fishes of Death Valley National Monument. Healthy populations of Cyprinodon salinus and C. nevadensis permit research

on these fishes by qualified investigators without danger of depletion. Because of unusual ability to tolerate physical disturbance of its very restricted habitat, C. diabolis is amenable to long-range research programs that do not involve continuing permanent removal of numbers of individuals or prolonged habitat disturbance. I would suggest that permanent removal (i.e., preservation) of 15 adults per month for one year would be unwise, especially if the effective breeding population began to show a significant decrease after 2 or 3 months of such removal. Removal of 15 adults and as many juveniles, say two or three times a year, would not, as I now understand the species, constitute a dangerous procedure. In other words, any research program on this species should be carefully designed to assure frequent checks on the population structure. This becomes particularly critical in years of lowered reproduction or at periods of the year (if there are such) when recruitment is at a reduced level. Attempts to get an accurate population estimate by removing and counting all individuals should not be undertaken more than once a year, and not that often if trapping and visual observation indicate that the population is impaired in any way. Damage to eggs and young by walking over the shallow shelf must be minimized.

In order to guard against the possibility of a catastrophe in Devils Hole, this species needs to be established elsewhere in the wild, since it appears to be unsuitable for artificial propagation.

As a precaution against extermination of Cyprinodon nevadensis pectoralis from Schoolhouse Spring (equivalent to Lovell's Spring in Miller, 1948), immediate efforts should be made to preserve the habitat at this locality, which is on BLM land. Since this spring does not connect with other waters, a natural barrier to invasion by exotic species is already present.

The Mohave chub, Gila mohavensis, needs to be established in nature at some suitable locality in order to guard against loss of the only surviving population at Zzyzx Resort.

REFUGIA

Prior to departure for the 1967 survey a careful review was made of a comprehensive report on the Mohave Desert region (Thompson 1929) for the purpose of locating potential sites where endangered species might be established. Several springs described in that report were checked before and during the trip, and a few, described below, are proposed as potential refugia. One species, Cyprinodon nevadensis, is already established outside of Death Valley National Monument in the spring-fed lake at Zzyzx Resort near Baker. Protection of this population and the native Mohave chub (Gila mohavensis) is being extended by the present resort operator

(Curtis Howe Springer), but I have read recently that BLM is instigating eviction orders against this gentleman. If the land is owned by the Federal Government it is hoped that the two fishes will receive continuing protection. Both species are now thriving there.

Saline Valley

A very promising site for establishment of endangered species is on the east side of Saline Valley (due east of Independence), Inyo County, California, at (Lower) Warm Spring in T 13 S., R 38 E., elevation 1,478 feet (California-Nevada Ballarat Quadrangle, 1913 ed. reprinted 1933). Saline Valley lacks native fishes although mosquitofish (Gambusia affinis) are now established in the sloughs around the old salt lake on the west side of the valley. Our examination of Saline Valley was made on June 28, 1967. In order to test whether the water in the hot spring was tolerable to fish life, we carried live individuals of mosquitofish from the west side of Saline Valley. The lowermost of the hot springs, 7.9 miles by road northeast of the main road along the west side of the valley, are indicated (by a sign) to be a future recreation site of the BLM, maintained by Inyo County. Although the warm spring is too hot (about 110°F) for fish, water taken from the spring and cooled maintained mosquitofish during the period of our visit. Palm Spring, 1 mile north-northeast, is even hotter (117°-118°F) and comprises four spring pools near an introduced palm, but no other trees. Many trees occur along the outflow of (Lower) Warm Spring. Near the latter (perhaps 150 feet to NE) is a "cool" spring which registered 85°F at 5 P.M. when the air was 105°F. At this time of year, at least, the spring outflows (especially of the cooler spring) are short, though subsurface flow obviously continues for some distance to maintain the trees. We were unable to reach (Upper) Warm Spring, which I visited in 1937 and found to be too hot for fish life. It too should be considered as a possible refugium.

By constructing a series of ponds and connecting channels, the temperature of (Lower) Warm Spring could be reduced to the level found in Devils Hole, and the habitat could be so designed that C. diabolis could seek temperature it prefers. Since the land already seems to be under BLM jurisdiction, all that is needed is approval, funds for construction, and interest in carrying out the development of the refugium. After successful establishment, the actual area occupied by the Devils Hole pupfish probably should be fenced, as at Devils Hole.

To further test the tolerance to fish life of water from (Lower) Warm Spring, we carried two 5-gallon jugs of it to Manse Ranch, Pahrump Valley, where juvenile to adult Empetrichthys latos showed no signs of distress over a 6-hour period that they were held in the containers (at 76° to 80°F).

It might be possible to establish Empetrichthys in the outflow of the cooler spring in Saline Valley but more needs to be known regarding temperature adaptation of adults, young, and eggs before one can reasonably predict the outcome of such a transplant. Perhaps Dr. Deacon could interest a student to undertake experimental studies of temperature tolerance in this species.

In the event that Empetrichthys proves unsuitable, the cooler spring might be utilized for the establishment of a refugium for Cyprinodon radiosus, the Owens Valley pupfish. This species will tolerate a wide range of temperature, both seasonally and daily, from around freezing to at least 95°F. However, if two species of Cyprinodon are transplanted to Saline Valley they should be placed in widely separated localities.

Deep Springs Valley

This valley, devoid of native fishes, is an isolated basin in Inyo County, California, about 5,000 feet high, lying east of Bishop and north of Saline Valley. It contains an endemic toad (Bufo exsul), which we found to be abundant during our examination of the springs, irrigation ditches and ponds on June 27, 1967. Our visit was made to determine whether any Salt Creek pupfish (Cyprinodon salinus) had survived from introductions made in 1939 and 1940. None was found after a thorough search. The only fish we noted were carp (Cyprinus carpio), which have been in the valley at least since 1934 and are locally abundant. (In 1934, Carl L. Hubbs also collected brown bullheads.) The spring sources vary from about 60° to 70°F, perhaps as high as 75°F. If used for a refugium for endangered species the carp population should be reduced (eliminated, if possible) and only cold-tolerant species should be considered for transplantation. Since Cyprinodon salinus failed to become established here, it is questionable whether any species of this genus could persist in Deep Springs Valley. Rhinichthys (or related genera) would seem to be a better candidate for transplanting to this valley because of its known tolerance to cool water.

Resting Springs, Inyo County, California

These springs lie about 4 miles east of Tecopa and are owned by Dr. Harry C. Godshall (Suite 1009, 2010 Wilshire Blvd., Los Angeles, Calif.; tel., 213 HU 3-2158; local address Tecopa, Inyo Co., Calif.). Dr. Godshall was not at the Resting Springs Ranch at the time of our visit (July 4, 1967) but he should be contacted about the possibility of utilizing his head spring as a refuge for endangered species. The caretaker (Mr. Ishmael, son of George Ishmael at Manse Ranch) showed us

around. The source spring, 82°F at 4:45 P.M. (air about 105°F), lies in extensive tules (Scirpus) and cane (Phragmites), but is scheduled to be cleared. It could become an excellent refugium for pupfish (Cyprinodon) or poolfish (Empetrichthys) because there is a rapid descent from the source to the ranch house (about 300 feet) along which barriers to upward migration of exotic species could readily be installed. At present there are goldfish and gamefish (bass, etc.) in ponds below the house.

I visited these springs about 25 years ago and found them to be fishless.

Lake at Zzyzx Resort

As indicated previously in this report, the spring-fed lake (Lake Tuendae) at Zzyzx Resort, on the west side of Soda (Dry) Lake about 9 miles south of Baker, San Bernardino County, California, is already a refugium for the native Mohave chub (Gila mohavensis) and the Amargosa pupfish (Cyprinodon nevadensis). Both species are thriving. The pupfish became established there by 1955; the chub lived in the original spring and moved into the various man-made ponds as they were constructed. The present lake dates from about 1945.

The health resort is operated by "Dr." Curtis Howe Springer, who is currently under fire by the U.S. Government which claims he is trespassing on government property (Los Angeles Times, July 14, 1967). According to the article cited, the BLM is seeking to evict Springer from Zzyzx Mineral Springs and to collect some \$34,187 in damages and "back rent" for 23 years of unauthorized use of 12,000 acres. Dr. David Greenfield (who sent me the above clipping) wrote BLM (at Riverside, Calif.) on July 20, 1967, regarding our concern for the endangered species (Gila mohavensis) here. I have written Boyd Rasmussen (BLM Director in Washington, D.C.) on the same subject.

It is certainly most desirable that the fishes now at Zzyzx receive formal protection in the event of eviction of Springer or occupation of the resort by another person. "Dr." Springer has recognized the value of the endangered species and has insured their safety during his period of residence at Zzyzx.

Bitter Spring

This spring (or springs), in San Bernardino County, California, lies in the north-central part of T. 13 N., R. 5 E., near the head of a long wash that drains southeastward to West Cronese Dry Lake (southwest of Baker). It is in the hydrographic basin of the Mohave River. We were led to

investigate the spring after being told by Mrs. Larry Coke (Hilda Road, Yermo, California), who moved to the Yermo area in 1932, that she and her husband had seen fish in it about 6 or 7 years ago.

On July 6, 1967, we reached the spring in a 4-wheel drive pickup truck to find that a cloudburst had raced through the area the night before with evidence of flood waters up to 10 feet deep in the wash immediately below the springs. Any fish that might have been there were, of course, destroyed by the flash flood.

One spring source lies in tules (Scirpus) on the east side of the wash at the southern approach to the spring area; other(s) evidently are in extensive cane (Phragmites) near the north end of the area.

Although Thompson (1929:546) reported the water to be of poor quality (with high sulphate content), he indicated it could be used in an emergency and evidently some fish can live in it. Conceivably the springs could be pumped to lift the water above the wash, away from flooding, to fill a pond that could then serve as a refugium. The Mohave chub (Gila mohavensis) is a possible candidate for such a refugium. We found no sign that the spring is being used in any way at the present time. It lies along the southeastern edge of the Fort Irwin Military Reservation.

Cushenbury Springs

These springs, on land owned by Kaiser Permanente Cement, lie near the mouth of Cushenbury Grade on California State Highway 18, about 8 miles southeast of Lucerne Valley in southwestern San Bernardino County. The ranch has a caretaker but is essentially abandoned, Kaiser having bought Cushenbury out around 1955, when the big cement plant was constructed about a half mile above the ranch.

There are reported to be three springs on the property (temperature at one outlet ditch 65°F at 9:20 A.M. on July 6, 1967, the air about 80°F), but we could find only two. Neither formed an open spring hole. When I visited this locality on May 16, 1939, there was a fine stream of cold water with ample vegetation and intermittent ponds.

This is a possible refuge site for a cold-water fish, provided one could interest Kaiser in such a project.

Cottonwood Spring

This spring, recently vandalized, lies about 14 miles east-southeast of Lucerne Valley, San Bernardino County, California. It is adjacent to, and probably arises from the same aquifer as, Old Woman Spring (which we learned supports a variety of exotic fishes); it is therefore assumed that the water would be suitable for fish life.

Only by considerable development of the aquifer and protection of the habitat so created could Cottonwood Spring become an important refugium for endangered species. We did not determine who owns the spring and adjacent land but were told that it was a fine (though not large) spring until destroyed by vandals. It is a site that is worth investigating further. (Unfortunately the owner of Old Woman Spring, contacted in San Bernardino by Dr. Hubbs, was hostile to the idea of using any of his springs for endangered species.)

Sheep Creek Spring, near the southern border of Death Valley National Monument, had been suggested as a possible refuge site. It was visited on July 5, 1967, by Dr. Hubbs and me. The spring, 4.5 miles southwest of the road to Saratoga Springs (from State Highway 127), consists of seepages in a large expanse of cane (Phragmites). These converged to form a short, small trickle into a small pool near the end of the road. Unfortunately, the spring lies in a deep and narrow canyon that is subject to flash floods. Consequently, we regard it as unsuitable for consideration as a refugium. (It is noteworthy that no amphibians were observed here, either in 1967 or when I visited the same spring on June 4, 1939.)

RECOMMENDATIONS

As a result of the 1967 survey, tempered by my experience with the Southwestern fish fauna over the past 30 years, the following recommendations are made:

- (1) Refugia should be established at the earliest opportunity for Cyprinodon radiosus, C. diabolis, C. nevadensis shoshone, Empetrichthys latos, and Gila (Siphateles) mohavensis.
- (2) Cyprinodon diabolis and, perhaps, Empetrichthys latos could be transplanted to Saline Valley after appropriate habitats are created there in warm springs on the east side of the Valley. Possibly C. radiosus could also become established there, but not until the existing population has increased. If both species of Cyprinodon were to be transplanted, they should be placed in separate springs. If Empetrichthys is not transferred to Saline Valley a suitable refuge site for it might be developed at Resting Springs, if the owner is agreeable.

- (3) The original habitat in and below the two feeder springs at the northwestern end of Fish Slough should be rehabilitated for establishment of Cyprinodon radiosus. After exotics are removed, a barrier should be installed to prevent their upstream migration into the refugium.
- (4) The three other native fishes of Owens Valley (Gila n. sp., Rhinichthys osculus, and Catostomus n. sp.) should also be reestablished in the rejuvenated C. Radiosus habitat.
- (5) The Bitter Spring area should be examined as a possible site for establishment of Gila mohavensis -- especially as to whether there is sufficient water to maintain (by pumping) a pond above flood level. Other refuge sites should be sought for this species.
- (6) Lake Tuendae, at Zzyzx Mineral Springs Resort near Baker, should receive formal protection for the last known population of Gila mohavensis and for the established stock of Cyprinodon nevadensis.
- (7) Big Spring, Jack Rabbit Spring, and (if ownership permits) Schoolhouse Spring -- all in Ash Meadows -- should be withdrawn by BLM and fenced in order to protect native stocks of pupfish (2 subspecies of Cyprinodon nevadensis) and minnows (Rhinichthys osculus). Exotic species should then be removed from Big Spring and Jack Rabbit Spring and barriers installed to prevent their re-entry; structures similar to those used at Hot Creek, Nevada, should be suitable here as well as in Fish Slough and Saline Valley (Dr. Deacon is familiar with them).
- (8) Further search should be made for remnant stocks of both the Shoshone pupfish, Cyprinodon nevadensis shoshone, and the Tecopa pupfish, C. n. calidae. Vigorous and prompt action needs to be taken to assure survival of such populations, either by culturing, rehabilitation of habitat, or transfer to another suitable habitat (possibly at Resting Springs).
- (9) Ownership of Cottonwood Spring should be determined with a view to developing the area as a refugium, providing the aquifer will permit such development.

LITERATURE CITED

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