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RECORDS OF SOME NATIVE FRESHWATER FISHES TRANSPLANTED INTO VARIOUS WATERS OF CALIFORNIA, BAJA CALIFORNIA, AND NEVADA[1]

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Records of transplants of certain cyprinids, catostomids, and cyprinodontids made between 1939 and 1955 are described. All records are given whether or not they were successful. The purpose was to test the effects of changed environment on meristic and morphometric characters. The waters involved are located in southern California, southern Nevada, and northern Baja California. Successfully established at the present time as a result of this work are populations of *Rhinichthys osculus*, *Cyprinodon nevadensis amargosae*, and *Cyprinodon salinus*.

INTRODUCTION

Nearly 30 years ago I began some transplantation experiments with native freshwater fishes of California, mostly of the genus *Cyprinodon*, designed to test the effects of changed environment on meristic and and morphometric characters (Miller, 1948: 111–126). No record of these transplants has heretofore been published (although typed lists were distributed to a few ichthyologists) and, since some were successful, the data should be made available lest zoogeographers and others be led astray. All attempts to establish species are discussed, whether they failed or not. A summary of the transplants is given in Table 1.

RESULTS

Gila orcuttii (Eigenmann and Eigenmann)—arroyo chub

This species is native to coastal streams of southern California from Malibu Creek, in extreme southwestern Los Angeles County, southward to the basin of San Luis Rey River, Riverside County. Its occurrence in the Santa Clara-Ventura river systems and in the Santa Ynez River basin, north of Los Angeles and Santa Barbara, respectively, very probably represents introductions. To my knowledge the species was first collected in the Santa Clara in 1934 and in the other two drainages in 1940 (see also discussion of distribution of *Rhinichthys osculus* in Miller, 1946*b*: 207). It is also now abundant in Gaviota Creek, Santa Barbara County (D. W. Greenfield, pers. comm., 1967).

On April 3, 1950, 60 half-grown to large adult individuals were planted in excellent condition in the lower part of Sentenac Canyon, in San Felipe Creek, a western flood tributary of the Salton Sea about 12 miles east of Julian, San Diego County. These fish had been collected the same day in Temecula Creek (tributary to Santa Margarita River) at Oak Grove, north of Lake Henshaw, San Diego County.

[1] Submitted for publication October 1967.

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When the canyon was revisited on June 14, 1950, only *Gila mohavensis* was collected (see below). Subsequently, this area of the creek became dry and only dead fish (no *Gila orcuttii*) were found (observation of C. L. Hubbs, April 1959).

On May 6, 1955, 50 individuals of various sizes were stocked in Río Santo Tomás, Baja California del Norte, at the first crossing below the highway at the upper end of the canyon. This locality lies approximately 20 airline miles south of Ensenada, at about 31° 35′, 116° 32′. These fish had been collected from the San Luis Rey River just west of Warner Hot Springs, San Diego County, on May 3. During his frequent trips to Baja California del Norte, Carl L. Hubbs failed to find any evidence of establishment of this species or *Gila mohavensis* (see below) in Río Santo Tomás.

Gila (Siphateles) mohavensis (Snyder)—Mohave chub

The allocation of *Siphateles* as a subgenus of *Gila* stems in large part from research by Uyeno (unpublished doctoral thesis, 1960, University of Michigan). Species assigned to *Siphateles* commonly hybridize where they are sympatric with *Gila* (*sensu stricto*), the osteology of the two subgenera is remarkably alike, and *Siphateles bicolor obesus*, of the Lahontan basin, is so similar to *Gila atraria* that the two taxa can only be distinguished by removing the pharyngeal teeth (uniserial in *Siphateles*, biserial in *Gila*). It is obvious that the two groups are intimately related, that *Siphateles* is derived from *Gila*, and that genes of *Gila orcuttii* have infiltrated those of *Siphateles mohavensis* (and vice versa) in the Mohave River basin to the extent that resulting samples are now (1967) difficult to assign to species. This introgressive hybridization is currently under experimental study by David W. Greenfield (California State College, Fullerton); a paper summarizing the hybridization history in the Mohave River, based on morphology, is in preparation by Hubbs and Miller (see also Hubbs and Miller, 1943).

On May 23, 1939, 48 individuals were introduced into the deep pool of San Felipe Creek below the highway bridge in Sentenac Canyon, San Diego County. These fish had been collected on May 20, 1939, in the concrete, spring-fed pool on the west side of Soda (Dry) Lake, south of Baker, San Bernardino County (at what has been known as Zzyzx Mineral Springs Resort). On June 8, 1939, no chubs were noted. About 110 fish (3 to 4 inches long) from this same place were stocked in Sentenac Canyon on July 29, 1940, at which time many young of the previous year's transplant were seen, indicating successful reproduction. On June 29, 1941, the canyon was checked by Ralph G. Miller and the pool just above the bridge was teeming with fish of all age groups. On March 23, 1942, W. I. Follett saw many fish in the canyon. On July 25, 1945, R. G. Miller again visited the canyon and found changes in the pool below the original bridge, which resulted from impending widening and straightening of State Highway 78. Fish were common, however, above the old bridge and 77 were preserved. On May 2, 1948, 483 individuals were preserved for comparison with the original stock at Soda Lake. By this time the original bridge had been replaced and the "old bridge hole" was destroyed. On June 14, 1950, young were collected for the same purpose. On May 3, 1955, fish were

TABLE 1

Transplant Records of Some Californian Fishes, 1939–1955

Taxon	Date	Origin	Where transplanted	Results	Remarks
Gila orcuttii	IV:3:1950	Temecula Cr., San Diego Co.	San Felipe Cr., San Diego Co.	Negative	None found VI:14:1950
Gila orcuttii	V:6:1955	San Luis Rey R., San Diego Co.	Río Santo Tomas, Baja California	Negative	See text
Gila (Siphateles) mohavensis	V:23:1939	Soda L., San Bernardino Co.	San Felipe Cr., San Diego Co.	Positive; negative	Successful for 20 years, then gone; see text
Gila (Siphateles) mohavensis	VII:29:1940 V:6:1955	Soda L., San Bernardino Co.	Río Santo Tomas, Baja California	Negative	See text
Rhinichthys osculus	V:29:1939	Little L., Owens Valley, Inyo Co.	Willow Cr., Saline Valley, Inyo Co.	Negative	Inadequate habitat
Rhinichthys osculus	VIII:31:1940	San Gabriel R., Los Angeles Co.	River Sprs., Adobe Valley, Mono Co.	Positive	Common in 1965
Rhinichthys osculus	V:18:1940	Shoshone Spr., Inyo Co.	Old Borax Works, Death Valley	Negative	No water X:2:1940
Catostomus (Pantosteus) santaanae	VIII:31:1940	San Gabriel R., Los Angeles Co.	River Sprs., Adobe Valley, Mono Co.	Negative	None seen 1941; none seen or collected 1965
Cyprinodon macularius	V:24:1939	Carrizo Cr., Salton Sea basin, Imperial Co.	Dos Palmas, NE side, Salton Sea (accidental release), Riverside Co.	Negative, probably	See text
Cyprinodon macularius	VIII:2, 9:1940	Date Palm Beach, Salton Sea, Riverside Co.	Spr. at Little L., Owens Valley, Inyo Co.	Negative	See text
Cyprinodon nevadensis					
C. n. nevadensis	X:27:1939 IX:6:1940	Saratoga Sprs., Death Valley, San Bernardino Co.	Lucerne Valley reservoir, San Bernardino Co.	Negative	None seined in 1940 or 1941; fish lost when reservoir cleaned by rancher
C. n. amargosae	V:18:1939	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Spr. at Little L., Owens Valley, Inyo Co.	Negative	None seen 1940; none seen or seined 1942
C. n. amargosae	VIII:3:1940 V:24:1939 VII:29:1940	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Shoreline Spr., Salton Sea, Riverside Co.	Negative	No open water in spring 1941

TABLE 1—Continued

Transplant Records of Some Californian Fishes, 1939–1955

Taxon	Date	Origin	Where transplanted	Results	Remarks
Gila orcuttii	VI:8:1939	NW of Saratoga Sprs., Death	San Felipe Cr., San Diego Co.	Negative	See text

		Riverside Co.	Inyo Co.		
Cyprinodon nevadensis					
C. n. nevadensis	X:27:1939 IX:6:1940	Saratoga Sprs., Death Valley, San Bernardino Co.	Lucerne Valley reservoir, San Bernardino Co.	Negative	None seined in 1940 or 1941; fish lost when reservoir cleaned by rancher
C. n. amargosae	V:18:1939 VIII:3:1940	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Spr. at Little L., Owens Valley, Inyo Co.	Negative	None seen 1940; none seen or seined 1942
C. n. amargosae	V:24:1939 VII:29:1940	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Shoreline Spr., Salton Sea, Riverside Co.	Negative	No open water in spring 1941

TABLE 1—Continued

Transplant Records of Some Californian Fishes, 1939–1955

Taxon	Date	Origin	Where transplanted	Results	Remarks
C. n. amargosae	VI:8:1939	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	San Felipe Cr., San Diego Co.	Negative	See text
C. n. amargosae	VIII:4:1940	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Pahrump Ranch, Nye Co., Nev.	Negative	Gone by 1941
C. n. amargosae	VIII:30:1940	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	River Sprs., Adobe Valley, Mono Co.	Positive	Abundant in 1965
C. n. amargosae	VIII:30:1940, IX:1:1940	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Outlet, Little L., Owens Valley, Inyo Co.	Negative	None seen 1940; none seen or collected 1942
C. n. amargosae	VI:13:1941	NW of Saratoga Sprs., Death Valley, San Bernardino Co.	Lucerne Valley reservoir, San Bernardino Co.	Negative	Survived through 1942; see text
C. n. shoshone	V:18:1939	Shoshone Spr., Inyo Co.	Old Borax Works, Death Valley, Inyo Co.	Negative	No water X:2:1940
Cyprinodon salinus	I:11:1939 V:20:1939 VIII:4:1940	Salt Cr., Death Valley, Inyo Co.	Pool at Soda L., San Bernardino Co.	Positive	Abundant by 1955
Cyprinodon salinus	V:19:1939 VIII:3:1940 IX:1:1940	Salt Cr., Death Valley, Inyo Inyo Co.	Deep Sprs. Valley, Inyo Co.	Negative	Survived at least until IX:2: 1942; none found 1967
Cyprinodon salinus	VIII:3:1940	Salt Cr., Death Valley, Inyo Co.	Near Fish Sprs., Owens Valley, Inyo Co.	Negative	No fish seen 1941
Cyprinodon salinus	VIII:31:1940	Salt Cr., Death Valley, Inyo Co.	River Sprs., Adobe Valley, Mono Co.	Positive	Abundant in 1965

numerous. On April 3, 1959, R. R. Miller and R. J. Schultz saw no fish but good pools in the lower part of the canyon. Later in April 1959, as recounted above under *Gila orcuttii*, only dead fish were observed by C. L. Hubbs when the creek had become nearly dry. Remains of hundreds were found in one small remaining pool. Thus, after 20 years, the erstwhile successful introduction had failed.

On May 6, 1955, 27 individuals from Soda Lake were introduced in Río Santo Tomás, Baja California del Norte, as recounted above for *Gila orcuttii*. The objective of this experiment was to observe if a hybrid swarm would develop from these two species, as in the Mohave River. Unfortunately, neither became established.

Rhinichthys osculus (Girard)—speckled dace

In coastal streams of southern California, this otherwise ubiquitous fish seems to be native only to the Santa Ana River system (Culver and Hubbs, 1917), which includes all of the drainage of the Los Angeles Plain. Although it has been recorded from the Santa Clara River basin, just north of Los Angeles, and from tributaries of the Cuyama River in southern San Luis Obispo County (Miller, 1946*b*: 207), the populations there almost surely represent introductions. This idea is strengthened, for the Cuyama River record, by the occurrence at the same station of the Monterey western roach, *Hesperoleucus symmetricus subditus* (Miller, 1946*a*: 197), collected in 1940. North of the Santa Ana system, on the Pacific slope, *R. osculus* is evidently native to San Luis Obispo Creek (Jordan, 1894), San Luis Obispo County, and to other coastal streams northward from that point. Thus, there apparently was a real hiatus in its natural distribution between the Los Angeles Plain and San Luis Obispo Creek.

In the interior drainage of the Death Valley system (Miller, 1948), the speckled dace occurs only in the Owens and Amargosa river basins.

On May 29, 1939, 32 individuals were introduced into Willow Creek, near the northwestern end of Saline Valley, about 17 airline miles due east of Independence, Inyo County, California. These fish had been collected the previous day from the spring-fed outlet of Little Lake, just below the hotel at Little Lake, in southern Owens Valley. When Willow Creek was carefully checked on June 28, 1967, no fish were found. There was obvious evidence of the powerful scouring effects of flash floods along the creek, which thus render the habitat inhospitable to fish life.

On August 31, 1940, 143 individuals were introduced into River Springs, on the east side of Adobe Valley, T. 1 N., R. 30 E., sec. 24, Mono County, California. These fish had been collected on August 25 from the San Gabriel River near the Montebello Oil Fields just northwest of Whittier, Los Angeles County. On September 10, 1941, when the transplant was checked by R. G. Miller, no fish were seen. However, on August 16, 1967, speckled dace were common at River Springs.

The successful establishment of this distinctive stock is fortunate since no native fishes whatever now occur in the San Gabriel River or elsewhere on the Los Angeles Plain.

On May 18, 1940, about 10 individuals of this species were transferred from the outlet of Shoshone Spring at Shoshone, Inyo County, to the

old (Eagle) Borax Works on the west side of Death Valley. When revisited on October 2, 1940, the water had disappeared.

Catostomus (Pantosteus) santaanae (Snyder)—Santa Ana mountain-sucker

The relegation of *Pantosteus* as a subgenus of *Catostomus* is dealt with by Smith (1966: 42–46).

This species is known from the Santa Clara, Los Angeles, San Gabriel, and Santa Ana rivers of southern California, but it is probably not native to the Santa Clara. An old resident of that drainage testified that the only fish present originally in the Santa Clara system was a small species, about 2 to 3 inches long, that swam in a jerky fashion and curled its tail when at rest. This obviously refers to *Gasterosteus aculeatus* (Hubbs, pers. comm.).

On August 31, 1940, 2 individuals of this sucker were accidentally introduced into River Springs, Adobe Valley (see above, under *Rhinichthys osculus*; they had also been collected from the same locality as was that species). When the springs were examined on September 10, 1941, no suckers were seen, and none was collected during the thorough survey of Adobe Valley on August 16–17, 1965.

Cyprinodon macularius Baird and Girard—desert pupfish

The distribution of this species was treated by Miller (1943). It lives today only in the Salton Sea basin of southeastern California, in one or two localities in Arizona, and in the Sonoyta Creek drainage, along the Arizona-Sonora line.

On May 24, 1939, at least six individuals escaped from a trap into Dos Palmas Spring, which lies near the northeastern corner of the Salton Sea, less than a mile south of the Coachella Canal (built since 1939). These fish had been collected the same day near the southwestern end of the Salton Sea from Carrizo Creek near its junction with San Felipe Creek, Imperial County. When the spring was revisited by R. G. Miller on February 4, 1940, no fish were seen, but on July 29, 1940, one fish was observed. On March 12, 1950, Kenneth S. Norris collected three individuals (25 to 34 mm SL) in Dos Palmas Spring, along with nine adults of *Gambusia a. affinis*. Whether these pupfish represent the stock introduced from Carrizo Creek is not certain, especially in view of the appearance of mosquitofish in Dos Palmas Spring between 1940 and 1950. A large collection would need to be preserved for comparison with the Carrizo Creek population, but even then the identity of the stock might remain in doubt.

On August 2 and 9, 1940, 53 specimens of desert pupfish were introduced into the most southeasterly of the head springs feeding the ditches at Little Lake in southern Owens Valley. These fish were collected on July 29 in the Salton Sea at Date Palm Beach, at the northeastern corner of the Sea about 8 miles south of Mecca. A few minutes after introduction the fish swam about with their heads out of water breathing rapidly, perhaps due to high CO_2 tension. On August 30, 1940, not one fish was found.

Cyprinodon nevadensis Eigenmann and Eigenmann—Nevada pupfish

Three subspecies of this pupfish, as delimited by Miller (1948), were transplanted as follows:

C. n. nevadensis.—This subspecies is confined to Saratoga Springs (80 to 85 F) in the southeastern arm of Death Valley. On October 27, 1939, R. G. Miller introduced 90 individuals into the reservoir on a ranch (owned by Roy Kendall) in Lucerne Valley, San Bernardino County. Fish were seen there on December 16, 1939, and, despite the formation of a thin layer of ice during the winter, 30 young were recovered by the rancher when he drained the pond early in the spring of 1940. When the reservoir was seined on July 11, 1940, however, we were unable to find any pupfish. Therefore, on September 6, 1940, 96 more individuals were stocked. A sizable population of pumpkinseed sunfish (*Lepomis gibbosus*) was observed at this time. On April 27, 1941, R. G. Miller was unable to seine any pupfish. He learned that a tenant (the rancher died in September 1940) had drained the pool 3 weeks earlier but saw few fish. This transplant failed when the pond was drained.

C. n. amargosae.—This subspecies occurs in the Amargosa River in California (in Death Valley, and near and below Tecopa). Only the Death Valley race was used for transplants (see Miller, 1948: 29). On May 18, 1939, about 150 fish were placed in the head warm spring at Little Lake, Owens Valley. No fish were seen in the spring or ditches on August 2, 1940. On August 30, 1940, 50 more were introduced, and on September 3, 1942, a thorough seining yielded no specimens. The transplant evidently failed for the reason hypothesized under the account of *Cyprinodon macularius.*

On May 24, 1939, 110 fish were put into "Shoreline Spring," near the northeastern end of Salton Sea only 0.7 mile from Dos Palmas Spring, Riverside County. They had been collected in Death Valley on May 20. After a few hours nearly all the fish were observed at the surface. On February 4, 1940, no fish were seen in the spring by R. G. Miller. On July 29, 1940, 200 additional fish of all sizes were introduced, and on August 7, 1940, at least 25 or 30 fish could be seen at one time. On October 23, 1940, R. G. Miller could find no fish although the spring was very clear. Finally, on June 29, 1941, Shoreline Spring contained no surface water at all, and the former pool had become completely overgrown by dense stands of tules. No fish could be seen.

On June 8, 1939, 114 individuals (mostly young) were placed in San Felipe Creek, in Sentenac Canyon, directly under the old highway bridge. These had been collected on June 4. No pupfish were seen in the creek on July 29, 1940, or on subsequent visits.

On August 4, 1940, about 750 pupfish of all sizes which had been collected 4 hours earlier in Death Valley, were placed in the head spring at Pahrump Ranch, Pahrump Valley, Nye County, Nevada. A thorough check on June 12, 1941, by R. G. Miller, failed to reveal any individuals in the clear spring pool which, as in 1940, contained *Empetrichthys latos* and carp.

On August 30, 1940, approximately 350 fish of all sizes were planted in River Springs, Adobe Valley, Mono County (see account of

Rhinichthys osculus). Although none was seen by R. G. Miller on September 10, 1941, pupfish were common there on August 16, 1965.

Also on August 30, 1940, about 400 pupfish of all sizes (taken the same day in Death Valley) were placed in spring-fed ditches about 300 yards below the hotel at Little Lake, Owens Valley. Although they showed no distress, and hundreds were seen here on September 1, 1940 when 58 additional individuals were stocked), only 8 days later none was observed during 2 hours of searching. On September 3, 1942, the habitat was thoroughly seined and yielded no pupfish, and none was seen on subsequent visits. Possibly these fish were eaten by largemouth bass.

On June 13, 1941, about 100 individuals were carried from Death Valley to the reservoir in Lucerne Valley, San Bernardino County (see account of *C. n. nevadensis*), where they were stocked by R. G. Miller and observed for about 3 hours. They seemed perfectly at home. When again checked on August 15, 1941, they were in fine condition, with many newborn young. Again, on November 17, 1941, many young and adults were seen and on June 3, 1942, fish were abundant. On September 24, 1942, the pond was seined thoroughly and fish of varied sizes were found. No further checks were made, but the stock doubtless died out when the reservoir was drained or destroyed.

Cyprinodon n. shoshone.—This subspecies is known only from Shoshone Warm Spring and its outlet near Shoshone, Inyo County. On May 18, 1939, well over 100 individuals were placed in the Old (Eagle) Borax Works on the west side of Death Valley. By October 2, 1940, no water remained in this locality.

Cyprinodon salinus Miller—Salt Creek pupfish

This species occurs in Salt Creek, on the floor of Death Valley east of Stovepipe Wells, and in briny pools on the valley floor farther south in "Pupfish" (= Cottonball) Marsh—see Hunt et al. (1966: 35).

About 150 individuals, mostly young, were collected on January 10, 1939, and introduced the next day into the spring-fed pool at Soda Station, on the west side of Soda (Dry) Lake south of Baker, San Bernardino County, California. On April 8, 1939, about 6 individuals were observed. On May 20, 1939, an additional 140 were stocked after first seining from the pool 2 females of the previous transfer. On June 3, 1939, at least 60 individuals were observed in the pool, but on October 22, 1939, R. G. Miller could see no pupfish after a 45-minute search. Aquatic vegetation may have hidden them, however.

On July 28, 1940, a pair was observed after spending 1½ hours cleaning the pool of thick vegetation with a rake. On August 4, about 400 more pupfish were stocked and 1 female from former transfers was caught when seining the pool. On August 30, many young and adults (estimated by R. G. Miller to total at least 200) were seen.

On July 12, 1941, only 1 pupfish (a male) was seen by R. G. Miller in a half-hour search, but on May 1, 1955, the species was common and has been ever since (last checked on July 5, 1967), although during winter (as on January 3, 1966) it is difficult to observe individuals. This is one of only two transfers of *Cyprinodon* that have proved successful.

On May 19, 1939, over 120 Salt Creek pupfish were introduced into spring-fed ditches of Deep Springs Valley, east of Bishop in northern Inyo County. The fish had been collected the previous day and held overnight in a trap at Little Lake. The introduction was made just southwest of the old stone corral. The fish were in excellent condition and responded well to the new habitat. Returning on August 3, 1940, the ditches were thoroughly searched but no pupfish could be found. On this date, more than 400 additional fish (mostly young) were stocked and these, too, responded well. On August 15, 1940, 7 young to adult specimens were collected by D. D. McLean and H. M. Bourland and sent alive to George S. Myers. On September 1, 1940, only 3 fish were seen or captured after a long search, but heavy plant cover and the large number of ditches made seining difficult. An additional 26 pupfish, not in very good condition, were stocked. On September 2, 1942, 1 pupfish was seen. A very careful search of the ditches (including seining) by 10 persons on July 27, 1967, revealed only carp.

On August 3, 1940, over 300 Salt Creek pupfish (mostly young-of-the-year) were transplanted to one of the spring sources of the slough at Fish Springs, about 6 miles south of Big Pine in Owens Valley, Inyo County. The pool where they were introduced was about 40 feet in diameter, with much duckweed on the surface (over half of which was removed prior to stocking so that fish could be more easily observed). On September 1, 1940, no fish were seen (overcast day), and the spring was cleared of excess algae. On September 9, 1941, the spring was entirely covered with a crust of vegetation so thick it was difficult to penetrate with a stick. A surface hole 6 feet in diameter was excavated directly over the spring source where the water was 3 to 4 feet deep. Though the water was very clear, no fish could be seen.

On August 31, 1940, over 425 pupfish were put into the main spring pool at River Springs, Adobe Valley (see account of *Cyprinodon nevadensis amargosae*). On September 10, 1941, R. G. Miller was unable to see a single pupfish in the clear water of the spring or in any of the outlet ditches. However, on August 16, 1965, pupfish were abundant.

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