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ESTABLISHMENT OF RED SHINER, *NOTROPIS LUTRENSIS*, IN THE SAN JOAQUIN VALLEY, CALIFORNIA [1]

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Red shiner, *Notropis lutrensis*, recently introduced into the San Joaquin Valley, California are spreading throughout the Valley floor. Densities of shiner were highest in irrigation canals and drains, and other small, shallow, unstable aquatic habitats that were strongly influenced by agricultural and other human-related activities. These habitats were characterized by elevated turbidity, conductivity, total dissolved solids, total alkalinity, and total hardness. Fish species closely associated with red shiner were common carp, *Cyprinus carpio*, threadfin shad, *Dorosoma petenense*, mosquitofish, *Gambusia affinis*, inland silverside, *Menidia beryllina*, striped bass, *Morone saxatilis*, fathead minnow, *Pimephales promelas*, and Sacramento blackfish, *Orthodon microlepidotus*. All of these species are generally able to tolerate the harsh conditions present in many streams and rivers on the Valley floor. Limited observations on the life history of red shiner in the Valley showed them to be similar to endemic populations in the Mississippi River basin. Adults (mostly fish in their second growing season) were reproductively active from April to October. Major foods of these fish included filamentous algae and aquatic insect larvae. However, red shiner in irrigation drains and canals on the Valley floor also consumed terrestrial ants (Formicidae). The species is expected to eventually spread through the entire lower San Joaquin River system.

INTRODUCTION

Red shiner, *Notropis lutrensis*, are native to midwestern streams in the Mississippi River and Rio Grande drainages (Moyle 1976). In California, this fish has occurred in the Colorado River since at least 1953, presumably through bait minnow releases (Hubbs 1954). From the Colorado River, red shiner have moved into freshwater irrigation drains around the edge of the Salton Sea. In 1985, red shiner were also discovered in Big Tujunga Creek and in Coyote Creek at the upper end of Newport Bay within the Los Angeles basin of southern California (Los Angeles County Museum of Natural History; LACM 44507-2, 44508-1, 44509-1, 44510-1, 44522-2). However, attempts to establish the species elsewhere in the State as a source of live bait have generally been unsuccessful (Kimsey and Fisk 1964, Moyle 1976, McGinnis 1984).

Red shiner were first observed in the San Joaquin Valley when Wang (1986) collected an unspecified number of juvenile and adult fish in Millerton Lake, Fresno County, from 1980 to 1982. During July 1981, a single fish was collected from the San Joaquin River near Firebaugh, Fresno County (Saiki 1984). From May to July 1984, Ohlendorf et al. (1987) obtained three composite samples of red shiner from unspecified locations in the Grassland Water District (Grasslands), Merced County, about 30 km northwest of Firebaugh, for analysis of trace elements and pesticide residues. In September 1984 and again in September 1985, red shiner were collected in the Grasslands from Agatha Canal, Camp 13 Ditch, and Mud Slough at Gun Club Road (M.K. Saiki, unpubl. data). Additionally, unpublished field notes from the California Department of Fish and Game (CDFG) indicated that three adult red shiner were collected on 29 July 1985 from Los Banos Creek, about 2 km upstream from the Los Banos Detention Reservoir, Merced County (C. J. Brown, Jr., Associate Fishery Biologist, CDFG, pers. comm.). This locality is about 20 km west of the Grasslands.

Here we report the results of an extensive field survey conducted in 1986, with supplemental collections made in 1987, that document the distribution of red shiner in the San Joaquin River and selected tributaries on the Valley floor. We also present data on the morphometrics and ecology of this recently established population, including observations on reproductive characteristics, age, growth, and food.

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MATERIALS AND METHODS

A total of 27 sites were intensively sampled for red shiner in September–November 1986, and additional collections were made for morphometric analyses of specimens from eight of the sites in February–May 1987 (Figure 1). All fish were collected with bag seines (6.4-mm mesh wing and 3.2-mm mesh bag, bar measure) and backpack electrofishing gear. To compute catch-per-effort statistics for the 1986 collections, we made all seine hauls parallel to shore over a standard distance of about 15 m, and electrofishing was conducted for at least 10 min (the actual time spent in electrofishing was recorded).

During the 1986 collections, we measured the following environmental variables at each site: current, water temperature, pH, turbidity, dissolved oxygen, total alkalinity, conductivity, total dissolved solids, stream width, stream depth, and the particle size distribution of bottom sediments. Schoklitsch's sediment factor, *s*, was computed from the sediment data with a standard formula described by Bogardi (1974). We estimated the percentages of pools, riffles, and runs at each site by using the "ocular" method described by Pfankuch (1975). We also used this method to estimate the percentage of cover provided by emergent and submerged vegetation. Finally, we assigned each site a subjective rating of 1–5 (with 1 being the lowest) that characterized the extent of "human impact" (e.g., channelization, removal of riparian cover, and water flow diversions) as perceived by one of us (M.R.J.), an experienced field observer.

All captured fish were identified, counted, and except for representative samples preserved in 10% formalin, returned to the water. Preserved samples were kept for counts of fin rays and scales (Hubbs and Lagler 1958); and determinations of fecundity (Bagenal and Braum 1978), age and growth (Bagenal and Tesch 1978), and stomach contents (Windell and Bowen 1978).

Before conducting analysis-of-variance (ANOVA) tests, we logarithmically transformed all catch-per-effort values to best meet the assumptions (i.e., symmetry, equal variances among groups, linearity, and additive structure) of the statistical procedure. We accepted the level of significance as being $P \leq 0.05$ unless otherwise indicated. When F-statistics were significant, we conducted Tukey-Kramer "honestly significant difference" (hsd) tests to compare geometric means for statistical differences. We calculated Spearman's rank correlations (r_s) to identify significant statistical associations between the abundance of red shiner and various ecological characteristics (i.e., water quality and hydrological measurements, and the abundance of other fish species).

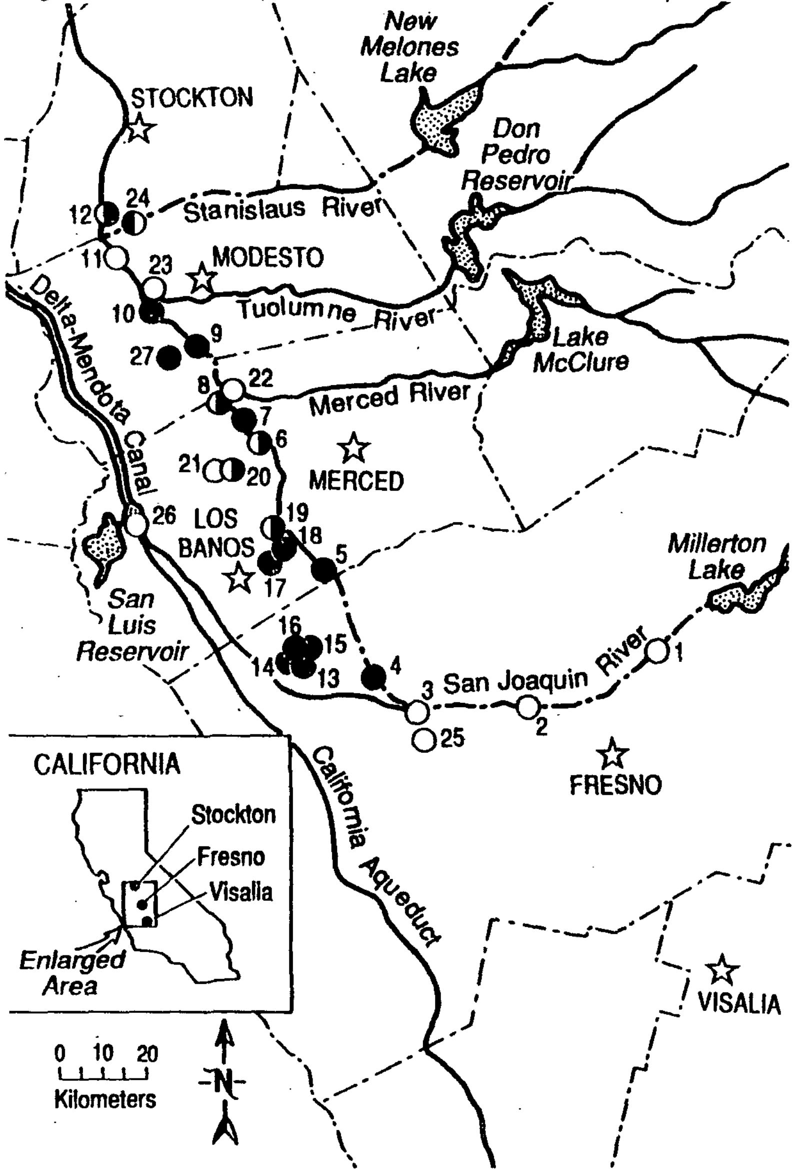

FIGURE 1. Locations of sampling sites in the study area, and abbreviations used in Table 1: (1) San Joaquin River near Fort Washington Road, (2) San Joaquin River at Hwy 145, (3) San Joaquin River at Mendota Pool, (4) San Joaquin River at Firebaugh, (5) San Joaquin River at Hwy 152, (6) San Joaquin River at Lander Avenue, (7) San Joaquin River at Fremont Ford State Recreational Area, (8) San Joaquin River at Hills Ferry Road, (9) San Joaquin River at Crows Landing Road, (10) San Joaquin River at Laird County Park, (11) San Joaquin River at Maze Road, (12) San Joaquin River at Durham Ferry State Recreation Area, (13) Helm Canal, (14) Main Canal, (15) Agatha Canal, (16) Camp 13 Ditch, (17) Mud Slough at the Los Banos Wildlife Area, (18) Salt Slough at Hereford Road, (19) Salt Slough at the San Luis National Wildlife Refuge, (20) Mud Slough at Gun Club Road, (21) Los Banos Creek at Gun Club Road, (22) Merced River at George J. Hatfield State Recreational Area, (23) Tuolumne River at Shiloh Road, (24) Stanislaus River at Caswell Memorial State Park, (25) Fresno Slough, (26) Delta-Mendota Canal at O'Neill Forebay, and (27) Crow Creek at Hwy 33. Localities where red shiner were collected in September–November 1986 are denoted by filled circles; in February–May 1987, by left-hand filled circles; in both 1986 and 1987, by right-half filled circles; and, where never collected, by unfilled circles.

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RESULTS AND DISCUSSION

We collected 1,341 red shiner at 17 of 27 sites on the San Joaquin Valley floor in September–November 1986 (Figure 1). An additional 800 specimens were collected at 6 of 8 sites in February–May 1987, with one of these sites representing a new occurrence of the species (Figure 1), thus bringing the total number of sites containing red shiner to 18.

Morphological examination of 125 specimens from 17 sites indicated that they most resembled *Notropis lutrensis lutrensis.* Adults >25 mm total length (TL) were relatively deep bodied and closely matched the descriptions by Hubbs and Ortenburger (1929). Average lateral line scale counts were 34.5 (range, 33–36), and anal fin rays 9 (range, 8–10) in over 80% of the fish examined. Our specimens differed from the Colorado River populations of *N. l. lutrensis* X *N. l. suavis* intergrades (described by Hubbs 1954) in having a "chunkier" body shape and higher lateral line scale counts. However, the possibility of hybrid populations of *N. lutrensis* in the San Joaquin Valley cannot be ruled out. Additional studies (e.g., Matthews 1987) on the geographical variation of native populations of *N. lutrensis* in the Midwest might assist in identifying the probable origin of the San Joaquin Valley population. Voucher specimens from all sites were deposited in collections at the Museum of Zoology, University of Michigan (UMMZ 213990–214006).

Abundance and Distribution

Red shiner were most abundant in irrigation canals and drains of the Grasslands (e.g., Agatha and Main canals, Camp 13 Ditch, and Mud and Salt sloughs), followed by sites on the San Joaquin River that were adjacent to the Grasslands or downstream from tributaries that drain the Grasslands (e.g., from Firebaugh to Durham Ferry State Recreation Area; see Table 1). We also collected about 20 specimens in September 1987 from Crow Creek, an intermittent stream that flows into the San Joaquin River about 15 km downstream from the Grasslands. Although we collected a single fish in March 1987 from the Stanislaus River, red shiner were seemingly lacking in tributaries that drain the east side of the San Joaquin Valley and from the southern end of the Valley floor (Table 1).

TABLE 1. Abundance of Red Shiner from 26 Sites on the San Joaquin Valley Floor as Determined by Electrofishing (Numbers of Fish per 10 Min of Fishing) and Bag Seining (Numbers of Fish per 15-m Haul) in Sept.–Nov. 1986. Within Regions, Sampling Sites are Tabulated in Approximate Longitudinal (Upstream–Downstream) Sequence; Refer to Figure 1 for Names and Locations of Sites. Values are expressed as Unweighted Geometric Means for Each Region and Site. Means in Each Column Followed by the Same Capital Letter are not Significantly Different ($P > 0.05$, Tukey-Kramer hsd Test). Values in Parentheses Indicate Number of Observations.

Region and site	*Electrofishing*	*Bag seining*
San Joaquin River:		
27	0.0	0.0
16	0.0	0.0
1	0.0	0.0
2	0.0	1.7
8	0.0	0.6
18	0.7	0.0
20	4.0	0.0
17	5.3	0.0
21	0.8	1.3
22	0.2	0.0
24	0.0	0.0
25	0.5	0.4
	0.7 B (n=33)	0.3 B (n=62)
Grassland Water District:		
7	5.5	0.5
4	0.3	0.0
5	4.1	5.5
6	25.6	0.0
13	0.0	0.0
9	4.2	0.2
10	—[a]	0.4
11	4.3	0.7
12	58.8	1.7
	3.9 A (n=23)	0.8 A (n=53)
Eastern tributaries:		
19	0.0	0.0
23	0.0	0.0
26	0.0	0.0[b]
	0.0 B (n=7)	0.0 B (n=15)
Other tributaries[c]:		
15	0.0	0.0
3	0.0	0.0
	0.0 B (n=6)	0.0 B (n=10)
F (df1,df2)[d]	6.77**	4.65**

[a] No data.
[b] One red shiner was collected from this site in February–May 1987.
[c] One site (14) was omitted because fishing effort was not quantified.
[d] For electrofishing, df1=4, df2=64; for bag seining, df1=4, df2=135. $^{**}P \leq 0.01$.

Relation to Water Quality and Hydrology

The ranges of geometric means of selected hydrological variables at 16 of the 18 sites where red shiner were collected are presented in Table 2. These measurements reveal the variable influence that irrigation return flows, which typically contain high concentrations of suspended sediments, agricultural fertilizers, other dissolved salts, and animal wastes (Sylvester and Seabloom 1963, Miller et al. 1978), had on the aquatic habitats that we sampled.

TABLE 2 Ranges of Geometric Means of Selected Hydrological Variables at 16 of the 18 Sites in the San Joaquin Valley Where Red Shiner were Collected.

Hydrological variable	*Range*
Stream width	4–80 m
Average water depth	0.3–4.3 m
Maximum water depth	0.3–5.7 m
Current velocity	<0.01–0.52 m/sec
Water temperature	12–22°C
Turbidity	2.3–26 NTU's
Conductivity	141–2,453 μmhos/cm @ 25°C
Total dissolved solids	80–1,600 mg/L
pH	6.9–8.0
Dissolved oxygen	7.5–9.6 mg/L
Total hardness	44–527 mg/L as $CaCO_3$
Total alkalinity	49–200 mg/L as $CaCO_3$

The abundance of red shiner was positively correlated with turbidity, pH, conductivity, total alkalinity, total hardness, total dissolved solids, percentage of runs, and degree of human impact, and negatively correlated with maximum stream depth and stream width (Table 3). Several investigators (e.g., Matthews and Hill 1977, 1979; Becker 1983; Matthews 1986) reported that many red shiner populations in the plains states of the Midwest seem to thrive under conditions of intermittent flow, high temperatures, high turbidity, and other harsh environmental conditions similar to those in the San Joaquin Valley.

TABLE 3. Spearman's Rank Correlations (r_s) Between Various Ecological Variables and the Abundance of Red Shiner as Determined by Electrofishing (Numbers of Fish per 10 Min of Fishing) and Bag Seining (Numbers of Fish per 15-m Haul)[a].

Ecological parameter	*Electrofishing*	*Bag seining*
Water quality		
Dissolved oxygen	−0.07	−0.10
pH	0.39*	0.29
Total alkalinity	0.62**	0.56**
Total hardness	0.74**	0.60**
Total dissolved solids	0.72**	0.60**
Conductivity	0.75**	0.59**
Temperature	0.13	−0.06
Turbidity	0.58**	0.23
Hydrology		
Current velocity	0.15	−0.07
Stream depth	−0.19	0.36
Maximum stream depth	−0.32	−0.48**
Stream width	−0.47*	−0.15
Sediment factor, *s*	−0.17	0.08
Pool (%)	−0.05	−0.14
Riffle (%)	−0.22	−0.03
Run (%)	0.50**	0.16
Other		
Emergent vegetation (%)	−0.04	−0.03
Submerged vegetation (%)	−0.03	−0.01
Human impact	0.40**	0.02

[a] Codes: $^{*}P \leq 0.05$; $^{**}P \leq 0.01$.

Relation to Other Fishes

The abundance of red shiner was correlated positively with the abundance of common carp, *Cyprinus carpio,* threadfin shad, *Dorosoma petenense,* mosquitofish, *Gambusia affinis,* inland silverside, *Menidia beryllina,* striped bass, *Morone saxatilis,* fathead minnow, *Pimephales promelas,* and Sacramento blackfish, *Orthodon microlepidotus,* and negatively with the abundance of redear sunfish, *Lepomis microlophus,* as shown in Table 4. However, we did not determine if these patterns were due to the environmental requirements and tolerances of the different species, dynamic ecological interactions (e.g., predator-prey relations, competition), or other factors. Red shiner are the fourth most abundant fish on the San Joaquin Valley floor after introduced threadfin shad, mosquitofish, and inland silverside (Jennings and Saiki, in prep.), and they are undoubtedly important prey for piscivorous fishes (Becker 1983). In some areas, red shiner have increased their range and, in the process, displaced other fishes with similar ecological requirements (Page and Smith 1970; Echelle et al. 1972; Minckley 1973; Cross 1978, 1985; Deacon 1988; Greger and Deacon 1988).

TABLE 4. Spearman's Rank Correlations (r_s) Between the Abundance of Various Fish Species and Red Shiner as Determined by Electrofishing (Numbers of Fish per 10 Min of Fishing) and Bag Seining (Numbers of Fish per 15-m Haul)[a].

Fish species	*Origin*[b]	*Electro-fishing*	*Bag seining*
→ Yellowfin goby, *Acanthogobius flavimanus*	I	0.28	—0.15
White sturgeon, *Acipenser transmontanus*	N	0.28	—[c]
American shad, *Alosa sapidissima*	I	0.34	—0.15
Goldfish, *Carassius auratus*	I	—0.02	0.37
Sacramento sucker, *Catostomus occidentalis*	N	0.36	—0.15
Prickly sculpin, *Cottus asper*	N	0.16	0.04
Common carp, *Cyprinus carpio*	I	0.39 *	0.17
Threadfin shad, *Dorosoma petenense*	I	0.63 **	0.09
Mosquitofish, *Gambusia affinis*	I	0.32	0.41 *
Tule perch, *Hysterocarpus traski*	N	0.34	—[c]
White catfish, *Ictalurus catus*	I	—0.23	0.32
Black bullhead, *I. melas*	I	0.07	—0.16
Brown bullhead, *I. nebulosus*	I	0.23	—[c]
Channel catfish, *I. punctatus*	I	0.09	0.24
Hitch, *Lavinia exilicauda*	N	0.32	0.18
Green sunfish, *Lepomis cyanellus*	I	0.14	0.24
Warmouth, *L. gulosus*	I	0.29	0.24
Bluegill, *L. macrochirus*	I	—0.37	—0.04
Redear sunfish, *L. microlophus*	I	—0.54 **	—0.06
Inland silverside, *Menidia beryllina*	I	0.40 *	0.23
Smallmouth bass, *Micropterus dolomieui*	I	—0.05	—0.22
Largemouth bass, *M. salmoides*	I	—0.16	—0.09
Striped bass, *Morone saxatilis*	I	0.50 **	0.25
Golden shiner, *Notemigonus crysoleucas*	I	0.07	0.06
Sacramento blackfish, *Orthodon microlepidotus*	N	0.34	0.46 *
Bigscale logperch, *Percina macrolepida*	I	—0.13	0.20
Fathead minnow, *Pimephales promelas*	I	0.63 **	0.47 *
Sacramento splittail, *Pogonichthys macrolepidotus*	N	0.28	—[c]
White crappie, *Pomoxis annularis*	I	0.26	—0.04
Black crappie, *P. nigromaculatus*	I	0.38	—0.11

[a] Codes: * $P \leq 0.05$; ** $P \leq 0.01$.
[b] Codes: I, introduced; N, native.
[c] No data

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intro 23

There were no significant negative correlations between the abundance of red shiner and native fishes such as Sacramento sucker, *Catostomus occidentalis,* prickly sculpin, *Cottus asper,* tule perch, *Hysterocarpus traski,* hitch, *Lavinia exilicauda,* Sacramento splittail, *Pogonichthys macrolepidotus,* and Sacramento blackfish (Table 4). These data suggest that red shiner have not yet strongly influenced the distribution and abundance of native fishes on the Valley floor. However, the relative scarcity of the natives (< 25% of the total species; see Table 4) might be partly responsible for our failure to detect

significant correlations. Nonetheless, because red shiner are newly established in the San Joaquin Valley, the magnitude of their effects on native fishes might still be forthcoming.

According to McGinnis (1984), the native California roach, *Hesperoleucus symmetricus,* shares many ecological requirements with red shiner, and may be vulnerable to displacement by this newcomer. Despite considerable sampling, we collected no California roach on the Valley floor (also see Saiki 1984), suggesting that it is either absent or rare in Valley floor watercourses. However, California roach are present upstream at higher elevation sites in east side (Sierra Nevada foothill) tributaries such as the Merced and Tuolumne rivers (Moyle and Nichols 1974; M. K. Saiki, unpubl. data). Red shiner are expected to move into these eastside habitats but, as of May 1987, they were not found in the Merced and Tuolumne rivers, and only one specimen was collected from the Stanislaus River. Therefore, any effects of red shiner on California roach remain unknown.

Life History Observations

Reproduction

Adult males in breeding coloration (orange-red caudal, pelvic, anal, and pectoral fins) were observed in the San Joaquin Valley during September–October 1986 and April–May 1987. Cross (1967) and Farringer *et al.* (1979) wrote that red shiner in Kansas, Texas, and Oklahoma spawn at water temperatures of 15.6–29.4°C from May to October, with most spawning probably occurring in June and July. Wang (1986) estimated that spawning occurred during June and July in Millerton Lake in the San Joaquin Valley.

We examined 11 gravid females ranging in total length from 42 to 55 mm, and counted 1,177 to 5,411 eggs per fish (geometric mean, 2,205 eggs). These counts were nearly fourfold higher than those reported for red shiner in central Iowa (Laser and Carlander 1971). We found no significant correlation between the number of eggs and female length (r_s = −0.27, df = 9), a result also reported by Laser and Carlander (1971). Because red shiner are "fractional" spawners (Gale 1986), females may release their eggs on several occasions between April and October in the San Joaquin Valley; this spawning pattern might obscure associations between the number of eggs and size of females.

Age and Growth

As judged from cursory scale examinations of 25 fish, the oldest red shiner in our collections had two complete annuli (i.e., the specimen was in its third growing season). We found three gravid young-of-the-year females, but the remaining gravid females were in their second growing season. Similar findings were reported by Carlander (1969), Laser and Carlander (1971), and Wang (1986).

The length-weight relation of 2,008 red shiner (TL 10–66 mm) from our study was best described (r^2 = 0.97) by the equation

$$\log_{10} W = 0.0000032 + 3.284678 \log_{10} L$$

where W is the mass of the fish (g) and L is the TL (mm).

Food

We examined the stomach contents of 100 red shiner from 17 sites and noted mostly filamentous algae and aquatic insect larvae (Table 5). Other researchers (e.g., Cross 1967, Hardwood 1972, Minckley 1973, Becker 1983, Wang 1986, Greger and Deacon 1988) have reported similar omnivorous diets for this fish. Although red shiner consume filamentous algae, the food value of algae is doubtful because of its apparently low digestibility (Becker 1983).

TABLE 5. Food Organisms in 79 of 100 Red Shiner Collected from 17 Localities in the San Joaquin Valley, California.

Taxa	*Occurrence* (%)	*Volume* (%)
Plants		
Chlorophyta		
Chlorophyceae		
Zygnematales		
Zygnemataceae	50.0	10.1
Mesotaeniaceae	15.0	3.0
Desmidiaceae	35.0	6.3
Euglenophyta		
Unknown	1.2	0.1
Chrysophyta		
Bacillariophyceae		
Pennales	36.0	7.8
Tracheophyta		
Spermopsida		
Angiospermae	5.8	1.7
Animals		
Rotatoria		
Monogonota		
Floscularicea	2.3	0.2
Annelida		
Oligochaeta		
Plesiopora	7.0	5.1
Arthropoda		
Crustacea		
Cladocera	2.3	1.8
Copepoda	2.3	0.8
Arachnida		
Araneae	2.3	1.4
Insecta		
Trichoptera		
Hydropsychidae	3.5	1.8
Hymenoptera		
Formicidae	15.1	10.4
Unknown	1.2	0.3
Coleoptera	1.2	1.3
Diptera		
Chironomidae	10.5	4.8
Unknown	14.0	10.1
Unknown	44.2	31.8
Chordata		
Osteichthyes		
Cypriniformes	1.2	1.2

Additionally, we observed that terrestrial ants (Formicidae) contributed >50% (by volume) of the total diet of red shiner collected from irrigation canals and drains in the Grasslands (for fish from all sites combined, however, ants contributed only 10.4% of the total diet; see Table 5). The importance of ants as forage for fish in the Grasslands was probably due to the profusion of overhanging grasses and other locally abundant ditchbank vegetation frequented by ants.

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We thank K. Dray, G.
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CONCLUSIONS

The rapid spread of red shiner in the San Joaquin Valley parallels the explosive population growth of this baitfish in other areas of California, Arizona, and Nevada where it has been introduced (Minckley 1973, Moyle 1976, Cross 1985, Greger and Deacon 1988). The previous omission of this species as a major component of the ichthyofauna from the San Joaquin Valley floor is probably due to its recent establishment in the Valley, and its superficial resemblance to juvenile golden shiner, *Notemigonus crysoleucas,* and fathead minnow. We suspect that red shiner were first stocked into Millerton Lake and Grasslands waters in the late 1970's to early 1980's from the bait buckets of fishermen. From the latter locality, this species is now rapidly invading the lower San Joaquin River system, a process that may be aided by the extensive network of irrigation canals (especially the Delta-Mendota Canal) and drains in the Valley, and the indiscriminant use of live "minnows" by some bait fishermen.

In 1979, the California Citizen's Nongame Advisory Committee recommended to the CDFG that red shiner be removed from the list of allowable freshwater live bait species. In 1982, a report prepared by the CDFG (Gleason 1982) recommended that the use of this species as live bait in inland waters be limited to the Colorado River and Salton Sea. However, red shiner can still be legally used as live bait in many areas of California, including the northern San Joaquin Valley (i.e., north of Interstate 580 and State Highway 132, California Department of Fish and Game 1989). Furthermore, at least five aquacultural facilities are registered by the State of California for rearing this species in counties lying beyond the Colorado River-Salton Sea drainage, including one in Merced County (California Department of Fish and Game 1986). The documented establishment of this highly fecund species on the San Joaquin Valley floor, and recent reports of new populations in other portions of central and southern California, suggest that this baitfish should be prohibited from all waters in California where it is not yet established. We also suggest that red shiner not be cultured in drainages where its use as a live bait species is prohibited.

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