

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

NOTROPIS XANTHICARA, A NEW CYPRINID FISH
FROM THE CUATRO CIÉNEGAS BASIN, NORTH-
CENTRAL MÉXICO

BY W. L. MINCKLEY AND GLADY L. LYTLE

Department of Zoology, Arizona State University, Tempe 85281

The *lutrensis-ornatus* group of the subgenus *Cyprinella* of *Notropis* (Gibbs, 1957) includes in the middle Río Grande and adjacent drainages a number of nominal and undescribed forms related to *Notropis proserpinus* (Girard). *Notropis proserpinus*, as understood by us, lives in clearer waters of the lower Pecos River system from southern New Mexico (Koster, 1957) south and east to the Devil's River and San Felipe Spring, Val Verde County, Texas. Koster's implication (p. 68) that this species is present in the lower Río Grande Valley, New Mexico, is unverified. *Notropis lepidus* (Girard) inhabits spring-fed waters of the Nueces, Frio, Medina, and Guadalupe River systems in Texas (Hubbs, 1954). *Notropis rutilus* (Girard) is in similar habitat in the ríos Salado and San Juan, northern México. And, two undescribed species, one from the basin of the Río Conchos, Chihuahua, México (Salvador Contreras B. and Minckley, unpublished), and the other from the semi-isolated Bolson of Cuatro Ciénegas, central Coahuila, northern México (Minckley, 1969), complete the assemblage. The present contribution describes the Cuatro Ciénegas form, and is one in a series of papers resulting from research supported by N.S.F. Grants GB-2461 and GB-6477X. Thanks are due the curators of various museums for aid in obtaining specimens, the personnel who assisted in collections, and persons who assisted in analyses. Permission to collect in various states, and in Mexico, readily granted, is gratefully acknowledged.

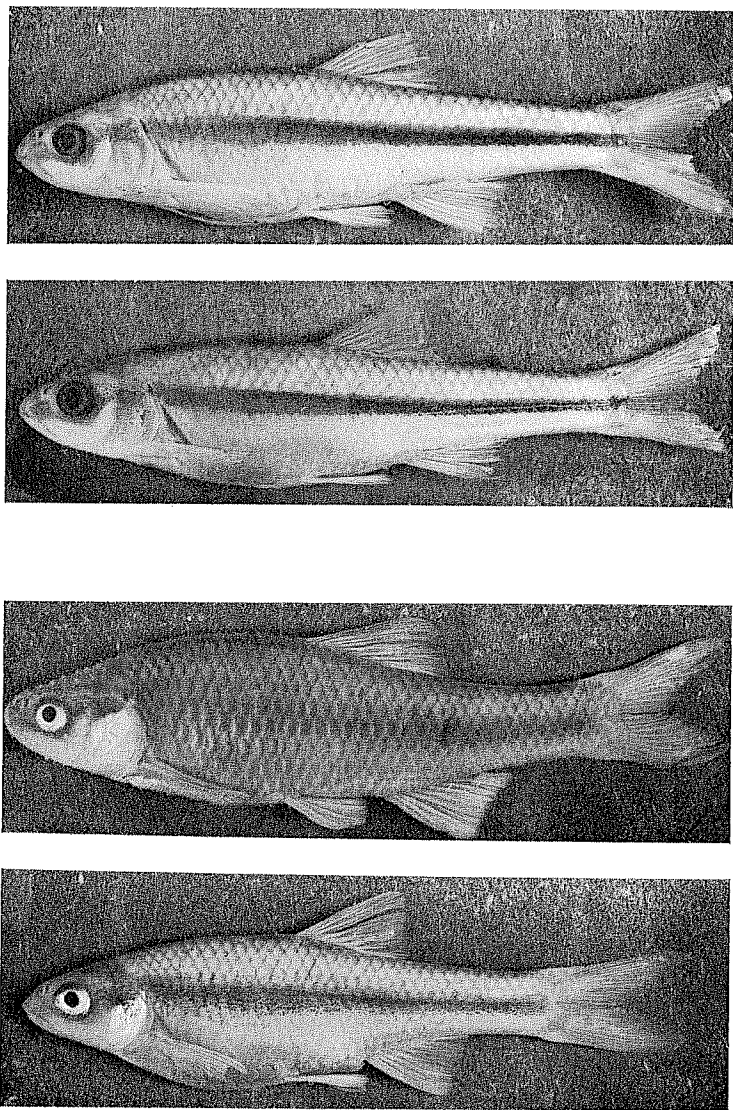


FIGURE 1. Male and female paratypes of *N. xanthicara* (KU 7404; upper) and a male and female of *N. rutilus* from the Río Salado de los Nadadores (KU 7347; lower).

Notropis xanthicara new species

(Notropis sp., Minckley, 1969)

Cuatro Ciénegas shiner (Fig. 1)

Diagnosis: *Notropis xanthicara* is a member of the subgenus *Cyprinella* of *Notropis*, as delimited by Gibbs (1957), and is most closely related to the nominal *N. rutilus*, from which it probably arose. The new species may be distinguished from the latter, and from other members of the subgenus, by the following combination of characters: body terete, not obviously slab-sided; lateral-line scales usually 34, often 33; anal fin-rays usually eight; pharyngeal teeth 4-4, slender and hooked, with serrated grinding edges; lower jaw included; lateral band black, discrete, about one scale-row wide, extending to, but not through, eye, appearing again as a pre-ocular streak on each side of snout; scale pockets weakly outlined on abdomen; belly immaculate, with black peritoneum showing through midline; predorsal streak broad and diffuse; postdorsal streak faint to absent; gular area variably darkened, interopercular area and anterior part of breast sometimes bearing melanophores; breeding male predominantly yellow, especially on head and fins; nuptial tubercles on snout of breeding males separated from those on dorsum of head by a distinct hiatus.

Material: About 1,000 specimens of *Notropis xanthicara* were examined, from throughout the Cuatro Ciénegas basin. Detailed locality data are provided only for the holotype and for paratypes. Information on non-type material of *N. xanthicara*, and on comparative material of *N. rutilus*, is by river system only. Detailed reports on range and variation of the entire species-group are in preparation. The abbreviations for depositories are as follows: ASU = Collection of Fishes, Arizona State University, Tempe; KU = Museum of Natural History, University of Kansas, Lawrence; UMMZ = University of Michigan Museum of Zoology, Ann Arbor; and UNL, Laboratorio de Vertebrados, Universidad de Nuevo León, Monterrey. Additional materials, loaned by Tulane University and the University of Texas, will be reported later. All localities in the Cuatro Ciénegas basin are given in kilometers (km) from the center of Cuatro Ciénegas. Field data has been revised to correspond to the detailed map published by Minckley (1969), and reproduced here in simplified form as Figure 2.

Notropis xanthicara: Holotype—UMMZ 188782, a mature, tuberculate male, 45 millimeters (mm) long, collected 6 April 1961 by R. R. Miller and family, C. L. Hubbs, D. R. Tindall, and W. L. Minckley, Río Puente Colorado, 8.5 km south and 0.7 km west of Cuatro Ciénegas, Coahuila, México. Paratypes—UMMZ 179834, 11 specimens, collected with the holotype; ASU 969, 8 specimens, collected at the type locality, 10 June 1964. ASU 2316, 185 specimens, collected 25 December 1965, Río Churince, 14.7 km south and 7.0 km west. UMMZ 179202, 46 specimens, collected 6 April 1961; UNL 703, 6 specimens, and UNL 709, 105 specimens, collected 26 and 27 August 1964, respectively, all from Posos de la Becerra, 11.4 km south and 6.7 km west. ASU 3728, 68 specimens,

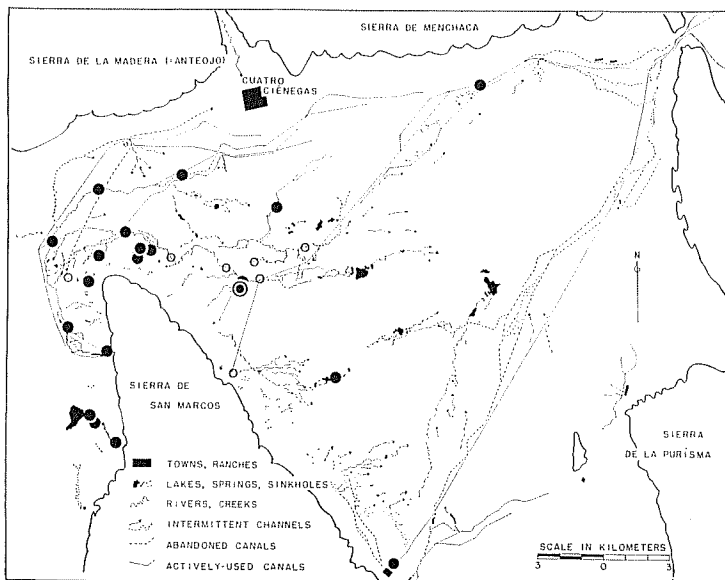


FIGURE 2. Distributional records for *N. xanthicara* in the Cuatro Ciénegas basin, Coahuila, México; dots = localities for specimens in museums, open circles = field observation of the species, and the circle dot = the type locality (map modified from Minckley, 1969).

collected 16 August 1968, Río Garabatal, 6.7 km south and 8.8 km west. KU 7404, 72 specimens, collected 17 April 1963, Canal de Julio, 3.4 km south and 1.2 km east. UMMZ 179860, 53 specimens, collected 9 April 1961, Río Mesquites, 8.2 km south and 0.8 km west. Additional material (non-types)—Río Churince system (see Minckley, 1969, for details on intra-basin drainages; numbers of specimens are in parentheses): ASU 1658, 1747, 2332; KU 7389; UMMZ 179878 (99 fish). Posos de la Becerra-Río Garabatal system: KU 7374, 7383; UMMZ 179827 (56). Lagunas de Juan Santos: UNL 714 (45). Río Mesquites system: ASU 2268; KU 7363, 7394 (151). Río Puente Chiquito system: UMMZ 179205 (125). Canal de Saca del Fuente: ASU 945 (2). Tío Candido system: UMMZ 179221 (1). Santa Tecla system: KU 7421 (5).

Notropis rutilus: E. G. Marsh collection (discussed later): UMMZ 130377, 130387. Río Salado system: ASU 913, 1723; KU 7347; UMMZ 130366, 130369, 130398, 179805, 179812; UNL 439, 688, 697. Río San Juan system: UMMZ 97420–7 (97421 = topotypes), 124425, 146980, 162131; UNL 29, 648.

Description and Comparisons: *Notropis xanthicara* is similar in most respects to *N. rutilus*, differing principally in features of pigmentation and

in its slender, more delicate structure (Fig. 1). Fin-rays of the new form are especially fragile. Anal rays, counted as the last two sharing a common base, number eight in 264 of 283 fish, ranging from seven (two fish) through nine (17 fish). A similarly strong mode of eight anal rays is present in 447 counts available for *N. rutilus* (six rays in one; seven in five; eight, 371; and nine, 70).

Length of the dorsal fin in *N. xanthicara* is usually equal to or greater than depth of body. In *rutilus* the length of the dorsal fin is most often less than greatest depth of body. Shape of the dorsal is similar in both species: the fin is square to slightly concave at its distal margin, and the anterior rays reach approximately to the tip of the last, when the fin is depressed. The anal fin of *xanthicara* tends to be slightly falcate, especially in larger adults, with the first rays extending past the tip of the last when depressed. In *rutilus*, the distal border of the anal fin is squared to slightly falcate, but the first ray usually falls short of the tip of the last (except in some breeding males). Caudal fins are large in both forms, but in *xanthicara* the upper lobe is slightly more expansive, and the lower more elongate and acutely tipped.

Standard lengths range from 30.2 to 56.0 mm in *N. xanthicara* (149 fish) and from 30.0 to 60.0 mm in our sample of *rutilus* (447 fish). Origin of the dorsal fin is slightly more posterior in *N. xanthicara*. Ranges which follow mean values represent, first, the over-all range obtained, and second, the range of means for 13 samples of *xanthicara* and for 23 populations of *rutilus*. Predorsal length averages 54.1 per cent of standard length (49.5–59.5; 53.1–55.6) in *xanthicara*, and is almost identical in *rutilus*, 53.3 per cent (50.0–58.0; 51.2–55.7). Dorsal-fin origin is behind the insertion of the pelvic fins in both species. Prepelvic lengths are more different than predorsal lengths, averaging 52.2 per cent of standard length for *xanthicara* (48.6–56.3; 50.3–53.7), and 50.2 per cent for *rutilus* (46.9–55.0; 48.8–51.7).

The paired fins are relatively small in *N. xanthicara*. The pectoral fins are acutely tipped, then gently rounded on their distal margins. They extend $2/3$ to $3/4$ of the distance to the pelvic-fin bases, and are slightly longer in males. Pectoral fins of *rutilus* from the Río Salado system are similar, as are those of non-breeding specimens from the Río San Juan basin. However, some samples of males of *rutilus* from San Juan have expansive, elongate pectoral fins. The pelvic fins of *xanthicara* are pointed, with an almost-straight distal margin. Pelvic fins of *rutilus* are more rounded and often longer.

Mean numbers of lateral-line scales differ slightly. About 66 per cent of the 149 *N. xanthicara* counted have 34 scales in the lateral series; 21 per cent has 33 (mean 33.9, range 33–36). In the sample of 447 *rutilus*, about 42 per cent has 34 scales, and 40 per cent has 33 (mean 33.6, range 32–36). The holotype of *xanthicara* has 35 lateral-line scales, and lacks a lateral canal on the three posterior scales on the left side; although some scales are regenerated, the canal appears normal on the

right side and such aberrations are rare in the series examined. The lateral line is gently decurved in *xanthicara*, and there is little pigmentation associated with it except where it passes through the discrete lateral band. *N. rutilus* has a strongly decurved lateral-line canal, and melanophores are often positioned as small spots or crescents along the canal at scale margins.

The head of the new form is attenuate, slender dorso-ventrally, and its length averages 26.6 per cent of standard length (23.1–29.1; 24.8–28.0). Head length in *rutilus* is similar, averaging 26.1 per cent (22.9–30.2; 24.7–28.8), but it is more blunt (Fig. 1). These slight differences reflect in part the longer snout of *xanthicara*, 8.0 per cent of standard length (6.2–9.5; 6.8–8.8), as opposed to an average of 7.1 per cent for *rutilus* (5.3–9.0; 6.6–8.2). Orbital lengths are very similar, 9.0 per cent (6.4–11.9; 8.1–10.6) and 8.4 per cent (6.4–11.3; 7.7–9.3), respectively. The mouths of both species are oblique, more so in young, and lower jaws are reduced and included within the upper; the angles from the mandibles to the lower side of the head are abrupt (Fig. 1).

Body depth and width of *N. xanthicara*, respectively, average 21.7 per cent (17.8–25.6; 19.1–23.3) and 12.4 per cent (10.0–14.9; 11.1–13.5) of standard length, as opposed to 23.1 per cent (18.9–28.1; 21.3–25.5) and 12.2 per cent (8.6–17.4; 10.5–14.3) for *rutilus*. Variation is high as a result of sexual, seasonal, and individual variations. The slenderer body of *xanthicara* is reflected, however, in the less variable measurement from the dorsal origin to the anal origin, which averages 25.3 per cent for the new form (21.2–27.8; 23.5–26.3) and 27.0 per cent for *rutilus* (23.2–32.8; 25.3–29.1). The discrete lateral band of *xanthicara* emphasizes its slightly slenderer body and gives the impression of an elongate fish (Fig. 1). Depth of caudal peduncle averages 10.3 per cent (8.9–13.2; 9.6–11.0) of standard length, and its length averages 23.1 per cent (18.8–26.1; 21.7–24.0) in *xanthicara*; *rutilus* has a thicker, slightly longer caudal peduncle, depth 11.1 per cent (9.3–15.3; 11.0–12.4) and length 24.1 per cent (20.3–28.2; 23.2–25.1).

Pigmentation of *N. xanthicara* is highly diagnostic. The external aspect is dominated by a discrete, blue-black lateral band that extends from the darkened two to five (usually four) rays of the middle caudal fin, through a diffusely-broadened caudal spot, to the back of the eye, becoming variably diffuse, downward, onto the opercle. The cornea is relatively unpigmented, but the band continues as a pre-ocular bar that terminates about 2/3 of the way along the snout. The lateral band of *rutilus* is much less discrete, and is highly variable in expression. Slight blackening of the central caudal fin-rays in *rutilus* is separated from the lateral band by a depigmented area just over the end of the hypural plate. The band usually broadens slightly below the dorsal-fin base, and it may almost disappear as it passes anteriorly, especially in breeding individuals. The lateral pigmentation is scarcely evident above the opercles of *rutilus*, and the preocular component usually is obscured by darker snout pigmentation.

The body of *N. xanthicara* is pallid except for the lateral band. Scale margins on the dorsum are diffusely pigmented, giving a cross-hatched appearance (intensive in breeding individuals), but melanophores are scarce and randomly distributed on the ventro-lateral surfaces. The belly is superficially immaculate, with the peritoneum showing through at the midline. Cross-hatching on the upper sides and back of *rutilus* is accompanied by pigmentation of the intervening spaces, giving a much darker aspect. Melanophores often extend below the lateral band, especially onto the abdomen. The belly of *rutilus* is white, and the usually-speckled peritoneum does not show through at the midline. The pigmentation of the peritoneum of *rutilus* ranges from dusky to speckled, but it is invariably black or dark brown in *xanthicara*.

The predorsal streak of *N. xanthicara* is broad and diffuse; a postdorsal streak often is lacking. The predorsal streak is interrupted by a narrow, relatively depigmented band at the nape, marking the passage of the supratemporal canal, then broadens to a heart-shaped or sub-hexagonal spot over the parietal and posterior part of the frontal bones. This spot is bounded anteriorly by another, transverse, elliptical, depigmented area. There is a second, heart-shaped area of large melanophores over the frontal bones, between the orbits, then fine melanophores dust the snout and (variably) the upper part of the upper lip. The arc of the lower part of the lower lip is similarly dusted with melanin, and this leads medially into a dusky gular streak. The streak may involve the extreme anterior part of the breast in some darker fish, but it is sometimes absent in lightened individuals. Except for a circumorbital scattering of melanophores, and an occasional larger one, the cheeks, lower parts of the branchiostegal rays, and the medial parts of the mandibles are silvery white.

Both a predorsal and a postdorsal streak are present in *N. rutilus*, the latter less distinct. Details of dorsal head pigmentation are typically masked by dark melanophores that may extend to the tip of the snout and to the tip of the upper jaw. There is strong circumorbital melanization. The gular streak is typically dark, and extends back to include the anterior part of the breast in some individuals.

There are deep-lying melanophores associated with the bases of both the anal and dorsal fins in both species. However, these are often masked by other pigment in *N. rutilus*. Pigmentation of the fins themselves in non-breeding individuals of *xanthicara* is mostly restricted to melanophores lining each delicate ray. The dorsal fin has a dark anterior margin, resulting from greater concentrations of pigment along the leading rays. In some fish elongate melanophores darken the interradials of the distal third of this fin. There is a tendency for concentration of pigment on the procurent caudal fin rays of *xanthicara*, which, along with the caudal extension of the lateral band, gives an impression of a distinct triad of caudal spots in individuals with more intense pigmentation. The anal fin is sparsely pigmented, except at its base. The pelvic fins have a darkened leading edge, but the remainder is clear. The pectoral fins are blackened anteriorly, with scattered melanophores posteriorly, and distally

darkened on rays and interradials in some individuals. Pigmentation of the fins of *rutilus* is exaggerated over that of *xanthicara*, especially in the dorsal fin which often appears sooty gray. The procurent and major unbranched caudal fin-rays are blackened, but no pattern is evident.

Breeding males of *N. xanthicara* are exceedingly colorful. The following notes, transcribed in edited form from field observations of the holotype and male paratopotypes, span most variations that we have seen: head brassy-gold over dorsum and onto snout, color interrupted on sides of snout and on opercles by dark melanophores, but continuing ventrally on opercle; yellow continuing on dorsum to caudal fin, overlying gray or brown ground color that is distinctly cross-hatched. Lateral band intensely prominent; sides below lateral band pinkish-orange; belly white, slightly suffused with yellow; pectoral fins lemon-yellow in center, color more intense anteriorly and with a dark black, leading edge; pelvic fins with a dark leading edge margined posteriorly by an iridescent, bluish line (milky-white in some), then the remainder of the fin yellow; anal fin transparent distally and proximally, yellow centrally; caudal fin intense yellow in belly of lobes, light yellow proximally, with procurent rays and central rays black; dorsal fin yellow-orange, opaque, with milky-white pigments proximally, edged with black; cornea yellow, reflecting blue dorsally; pupil jet black.

Breeding colors of male *N. rutilus* are to be detailed elsewhere. For purposes of comparison they consist of a greenish-yellow over-all aspect on the body, more intensely yellow below. The opercles and sides of the head are yellow and the dorsum of the head and snout are green or orange-green (the latter is rare). The fins are milky-yellow to bright yellow, except for the dorsal which sometimes is blackened. Very little black pigmentation is evident, except in the dorsal fin, and the lateral band is often totally masked.

Tuberculation of breeding males of both species consists of strong organs on the dorsum of the head, separated from smaller ones on the snout by a narrow, pre-narial hiatus. Tubercles often appear on the chin, and granulations are present on the cheeks and gular areas. *N. rutilus* usually develops small tubercles on the nape, while *xanthicara* does not. There is a strong band of densely concentrated tubercles above the anal base and along the lower sides of the caudal peduncle in both forms. This rarely extends more than half the length of the peduncle in *rutilus*, but may go to the procurent rays of the caudal fin in *xanthicara*. Tubercles develop on all fins, those on the pectorals usually as a double row on the second through fifth rays and as single rows on the sixth and (rarely) seventh rays. On other fins, tubercles vary in occurrence on the second through fourth or fifth rays; they are rarely present on the dorsal or caudal fins.

Etymology: The name "*xanthicara*" is a compound of the transliterated Greek words "*xanthos*" (yellow) and "*cara*" (or "*kara*"; top of head), that describes part of the breeding coloration of the new form. "*Kara*" is a neuter noun; its use in a compound name dictates retention of its end-

ing. We, however, follow general usage (Hubbs and Hubbs, 1958) in treating *Notropis* as masculine.

Discussion: *N. xanthicara* presently is allopatric to other species of *Notropis*. Intensive collecting in the Río Salado de los Nadadores, just east of the Cuatro Ciénegas basin, and elsewhere, has produced only *N. rutilus*. Conversely, samples from the canals on the north and northeast (outlet) sides of the basin have produced no specimens of either species, and *xanthicara* prevails (though rare) in parts of the basin where *rutilus* might be expected. E. G. Marsh, Jr. collected a *Notropis* at two places within the Cuatro Ciénegas basin in 1939, most likely from Canal de La Angostura (Minckley, 1969). These specimens (UMMZ 130377, 130387) correspond with *rutilus* in all critical characters of pigmentation, and in features of body proportions and meristics. In more than 50 seining collections in that canal since 1960, *Notropis* was taken only once, and they are *xanthicara* (KU 7374). As noted above, shiners are very rare on the north side of the basin. Perhaps more intensive manipulation of canals in that area now than in the past excludes these fishes.

Some specimens of *N. rutilus* from the Río Salado de los Nadadores have pigmentation approaching that of *xanthicara*. This is especially evident in non-breeding fish. We have been unable to define intermediacy of these samples on the basis of other characters, and presently consider this a response to the clarity of water in that stream. However, it is possible that hybridization influence, the selective introgression of pigment characters, has occurred between *xanthicara* and the downstream population of *rutilus*; the problem is under additional study.

Five specimens from Laguna de los Fresnos (Santa Tecla system; KU 7421) differ somewhat from other *N. xanthicara*. They tend to have long heads (27.2 per cent of standard length, range 25.4–28.6), with reduced snouts (7.4 per cent, 6.8–7.9) and large eyes (10.2 per cent, 9.4–11.7). Their body depths and the measurement from dorsal to anal-fin origin are high (22.6 per cent [21.1–25.1] and 27.0 per cent [25.5–28.7], respectively), tending toward *rutilus*. Pigmentation of these fish is darker than usual for *xanthicara*, and is much more similar to that species than to *rutilus*; their peritonea are black. The Santa Tecla system is largely disjunct at present, partially a result of canalization, and has been studied less than other parts of the Cuatro Ciénegas basin. Nevertheless, 17 collections have been made in the system, and only one included shiners. We consider the Los Fresnos specimens to be a form of *xanthicara*, deferring speculation on their status until additional material becomes available.

There seems little doubt that *N. xanthicara* is derived from *N. rutilus* or its progenitor, probably in isolation in the large springs and spring-fed streams of the basin it now inhabits. Isolation of the Cuatro Ciénegas basin has undoubtedly occurred sporadically for millenia; levels of differentiation of aquatic organisms living there range from endemic subfamilies and genera in molluscs (Taylor, 1966), through vertebrates and invertebrates that do not differ from animals living outside (Minckley, 1969).

N. xanthicara is intermediate to these extremes, and probably dates to later Pleistocene. The other five described endemic fishes range from *Cyprinodon bifasciatus* Miller (1968), which is considered an ancient, pre-Pleistocene, relict, through the distinct, but less highly differentiated *C. atrorus* Miller, *Lucania interioris* Hubbs and Miller (1965), *Gambusia longispinis* Minckley (1962), and *Xiphophorus gordonii* Miller and Minckley (1963). Three cichlids and a darter (Percidae) remain to be described, which will elevate the total endemic fish component of the basin to more than 50 per cent (10 of 18 known species). Other species, a catfish, cf. *Ictalurus lupus* (Girard), a largemouth bass, *Micropterus salmoides* (Lacépède), and a sunfish, *Lepomis megalotis* (Rafinesque), all are different from the forms outside the basin, though probably not more than subspecifically.

N. xanthicara occurs widely in the Cuatro Ciénegas basin (Fig. 2), but has never been taken in shallow marshes or in larger, terminal lakes. It is most abundant in the upper reaches of streams, just below their origins in limnocrenes, and often concentrates at the transition dividing lentic and lotic conditions. In streams and canals the fish lives in groups of three to 25 individuals in zones of shear between current and backwater, or moves near the bottom in current. In day time they are rarely on bottom, but forage at the surface and inspect almost all floating objects at any depth. At night, the fish rest on the bottom in eddies, in groups of four to more than 30 individuals, and are lethargic in the spotlight of a diver. Nothing has been observed on the breeding activities of this species.

N. rutilus tends to concentrate above and below riffles, with aggregations of nuptial males often occurring on the swiftest riffles and females remaining in associated eddies or pools.

The most common associates of *N. xanthicara* are the Mexican tetra, *Astyanax fasciatus mexicanus* (Filippi) and *Dionda episcopa* Girard, the roundnose minnow, both in the springs and in streams. Both other species tend to favor swifter waters, however, and are more active and aggressive. At one time or another, *N. xanthicara* has been caught in association with most other fishes in the basin (Minckley, 1969), except for those that characterize marshes or saline lakes (*C. atrorus*, *L. interioris*, and *G. longispinis*).

LITERATURE CITED

- GIBBS, R. H., JR. 1957. Cyprinid fishes of the subgenus *Cyprinella* of *Notropis*. I. Systematic status of the subgenus *Cyprinella*, with a key to the species exclusive of the *lutrensis-ornatus* complex. *Copeia* 1957: 185-195.
- HUBBS, C. L. AND C. HUBBS. 1958. *Notropis saladonis*, a new cyprinid fish endemic in the Río Salado of northeastern México. *ibid.* 1958: 297-307.
- and R. R. MILLER. 1965. Studies of cyprinodont fishes. XXII. Variation in *Lucania parva*, its establishment in western United States, and description of a new species from an

- interior basin in Coahuila, México. Misc. Publ. Mus. Zool., Univ. Michigan 127: 1-104, 3 pls.
- HUBBS, C. 1954. Corrected distributional records for Texas freshwater fishes. Texas Jour. Sci. 6: 277-291.
- KOSTER, W. J. 1957. Guide to the Fishes of New Mexico. Univ. New Mexico Press, vii + 116 pp.
- MILLER, R. R. 1968. Two new fishes of the genus *Cyprinodon* from the Cuatro Ciénegas basin, Coahuila, México. Occ. Pap. Mus. Zool., Univ. Michigan 659: 1-15.
- AND W. L. MINCKLEY. 1963. *Xiphophorus gordonii*, a new species of platyfish from Coahuila, México. Copeia 1963: 538-546.
- MINCKLEY, W. L. 1962. Two new species of fishes of the genus *Gambusia* (Poeciliidae) from northeastern México. *ibid.* 1962: 391-396.
- . 1969. Environments of the Bolsón of Cuatro Ciénegas, Coahuila, Mexico, with special reference to the aquatic biota. Publ. Univ. Texas El Paso, Sci. Ser. 2: in press.
- TAYLOR, D. W. 1966. A remarkable snail fauna from Coahuila, México. Veliger 9: 152-228, 11 pls.

