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The Red River Shiner, *Notropis bairdi*, in Kansas with Notes on Depletion of its Arkansas River Cognate, *Notropis girardi*

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ABSTRACT

Within the past 15 years, *Notropis bairdi* has become common throughout the Cimarron River in Oklahoma and Kansas, largely replacing its cognate species *N. girardi*. Apart from the Cimarron neither *N. girardi* nor *N. bairdi* has been found recently in the Arkansas River basin in western Kansas. Reduced flows, especially in summer when *N. girardi* needs high flows for reproduction, probably account for depletion of *N. girardi* in the upper Arkansas mainstream.

Notropis bairdi Hubbs and Ortenburger, formerly endemic to the Red River Basin in Oklahoma and Texas, now seems firmly established in the Cimarron River drainage of the Arkansas River basin. Following initial capture of the species in 1976 by Marshall (1978), in Logan County, Oklahoma, Felley and Cothran (1981) made collections at 11 sites along the Cimarron mainstream in Oklahoma in June and July 1979, finding *N. bairdi* at all of those localities. We became aware of the existence of the Red River Shiner in the Arkansas system when Haslouer brought Cross a specimen (KU 18016, 49 mm standard length) caught on 8 May 1979 by J. E. Fry and R. R. Bronaugh (Kansas Department of Health and Environment) in the Cimarron River in Sec. 8, T35S, R29W (adjacent to bridge on Kansas Highway 23) in Meade County, Kansas. Subsequently, we have obtained the following series of *N. bairdi* from the Cimarron drainage in Kansas: KU 18474 (45 specimens) and KU 18475 (8), 4 July and 7 August 1979, same locality as KU 18016; KU 18473 (167), Big Sandy Creek in Sec. 36, T34S, R23W, 9 mi. S Ashland, Clark County, 4 July 1979; and KU 19082 (4) Cimarron River in Sec. 19, T34S, R21W, 8 mi. S and 1 mi. E of Sitka, Clark County, 3 September 1981. All our collections include more than one age-group of *N. bairdi*, and adults in one series have pronounced reproductive development.

While *N. bairdi* has successfully colonized most of the Cimarron basin in

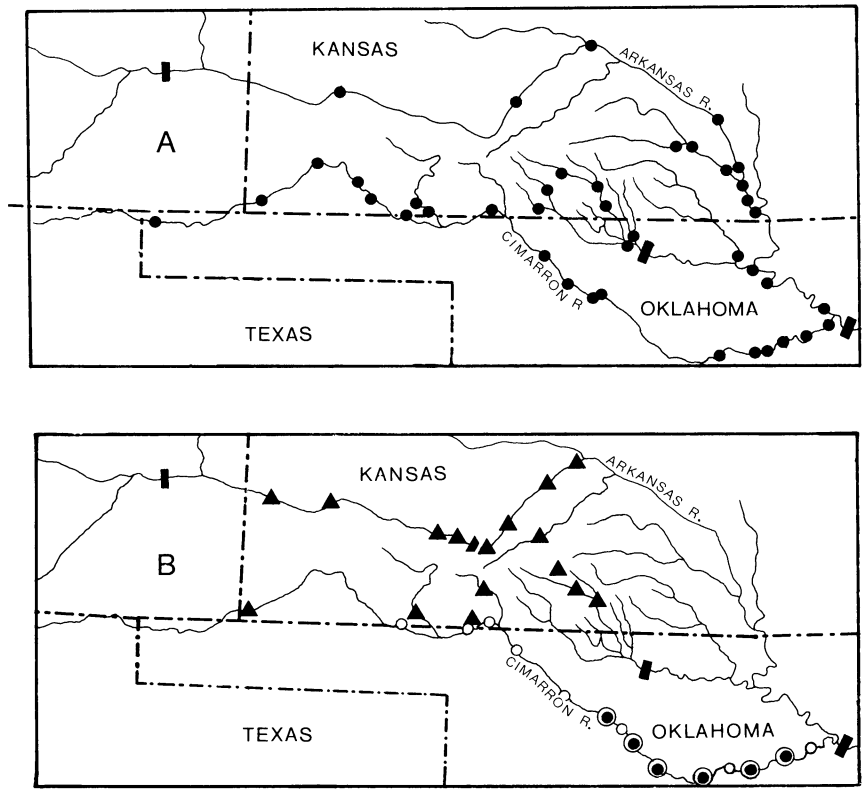

Fig. 1. A. Localities of record for *Notropis girardi* in the Arkansas and Cimarron rivers, above their confluence; most records prior to 1965. B. Localities sampled 1979–1981; solid dots = *N. girardi,* as in A; open circles = *N. bairdi*; triangles = neither species; rectangles = reservoir locations.

recent years, populations of its cognate species in the Arkansas River system, *Notropis girardi* Hubbs and Ortenburger, have been depleted. *N. girardi* was not found at any of 7 localities in the Cimarron, sampled in 1979 by Gorman and E. D. Wiseman, although it occurred commonly in the same region as recently as 1964 (Fig. 1, Table 1). Collections made in 1962 and 1964 are available from two sites where *N. bairdi* was obtained in 1979 and 1981. In Table 1, the numbers of specimens recorded for each species at locations "K-23" and "S Ashland" reflect numbers actually captured, but that is not the case for the two collections from "S Sitka"; the Sitka samples were selective, and probably not indicative of the relative abundance of the species secured. Disregarding species represented by single individuals in these samples, the most apparent faunal change from 1964 to 1979 involves the addition of *N. bairdi* and disappearance of *N. girardi.*

Felley and Cothran (1981) reported similar results in the Oklahoma seg-

Table 1. Species composition at sites in the Cimarron drainage in Kansas where *Notropis bairdi* has been found.

Species	K-23[a]		S Sitka[b]		S Ashland[c]
	1964[d]	1979[e]	1962[f]	1981[g]	1979[e]
Notropis lutrensis	80	39	35	?	72
Notropis stramineus	78	49	35	12	214
Notropis bairdi	—	45	—	4	167
Notropis girardi	174	—	20	—	—
Pimephales promelas	1	—	12	1	5
Hybognathus placitus	444	41	—	3	34
Carpiodes carpio	—	—	—	1	—
Ictalurus melas	—	—	—	1	—
Ictalurus punctatus	—	—	1	—	—
Fundulus zebrinus	39	52	6	3	6
Gambusia affinis	5	—	5	3	—
Micropterus salmoides	—	—	—	—	1
Lepomis cyanellus	—	—	1	—	—
Lepomis humilis	—	—	1	—	—

[a] Cimarron River, Meade Co., Kansas, at Highway 23, Sec. 8, T35S R29W.
[b] Cimarron River, Clark Co., Kansas, 8 mi. S Sitka, Sec. 19, T34S, R21W.
[c] Big Sandy Creek, Clark Co., Kansas, 9 mi. S Ashland, Sec. 36, T34S, R23W.
[d] D. Kilgore and J. Rising, 17 July 1964.
[e] O. T. Gorman and E. D. Wiseman, 4 July 1979.
[f] A. L. Metcalf, 3 April 1962.
[g] K. Herrin and K. Brunson, 3 September 1981.

ment of the Cimarron drainage. In 1979, they found *N. girardi* at the lowermost six of their 11 sampling sites, but listed no more than four individuals at any locality. Ten previous collections from the Cimarron, made prior to 1964 and deposited in the University of Oklahoma Museum of Zoology, contain an average of 245 specimens of *N. girardi* per collection (Felley and Cothran, 1981).

N. bairdi and *N. girardi* have many structural and ecological similarities (Hubbs and Ortenburger, 1929; Moore, 1944; Cross, 1953; Felley and Cothran, 1981). Some morphological differences useful in distinguishing the two species are given in Table 2. *N. bairdi* attains a larger size than *N. girardi* (standard length 62 vs. 49 mm), and is more robust in body form. Under natural conditions in their native ranges, each species inhabits the shallow, often turbid channels of major streams, principally in the High Plains sections of their respective drainages. Streambeds there are uniformly sandy, broad and unshaded, with widely fluctuating flows subject to high summer temperatures, high rates of evaporation, and high concentrations of dissolved solids. Gorman recorded a water temperature of 38°C where one series (KU 18474) of *N. bairdi* was captured. Other habitat notes for that series are: in main channel, mean depth 19.8 cm, current 0.5 m/sec, substrate sand. Field notes of D. Kilgore recorded when 174 *N. girardi* were taken at the same

Table 2. Characters distinguishing *Notropis bairdi* from *N. girardi* and *N. stramineus*, species native to the Arkansas River with which *N. bairdi* may be confused.

	N. girardi	*N. bairdi*	*N. stramineus*
Anal fin-rays	usually 8	7	7
Pectoral fin	falcate (1st ray longest)	falcate (1st ray longest)	rounded (2nd or 3rd ray longest)
Dorsal fin height (length of 1st ray)	equals length of pectoral fin; equal to or greater than head length	shorter than pectoral fin; shorter than head length	longer than pectoral fin; equal to or shorter than head length
Eye diameter	less than ¼ head length	less than ¼ head length	¼ head length
Nape, immediately behind occiput	scaled	naked, or with scales embedded	scaled

site in 1964, describe the habitat as having a depth range of 15–70 cm, "swift" current, and sandy substrates.

The reproductive mode is known for *N. girardi* (Moore, 1944). It spawns only during high flows in late spring or summer; its eggs drift pelagically in strong currents in midstream, hatching within approximately 48 hours of deposition. The reproductive mode of *N. bairdi* is not known, although several authors have speculated that it is similar to that of *N. girardi.* Table 3 compares fecundities of *N. bairdi* and *N. girardi,* based on KU 18474 (*bairdi*), and a series (KU 3959) of *girardi* obtained from the Cimarron River in Secs. 8 and 17, T32S, R33W, Seward County, Kansas, on 14 June 1958. Mature males of *N. girardi* vary in size from 37–44 mm SL, mature females from 37–49 mm; the average length in both sexes is 40 mm. Males of *N. bairdi* (KU 18474) average 42 mm in length (range 32–51 mm), females 48 mm (range 39–55 mm). These lengths and data in Table 3 were determined following prolonged retention of the specimens in 70% ethyl alcohol. The gonadosomatic indices in Table 3 are based on weight of intact ovaries divided by somatic weight of the specimens following removal of viscera. Fecundity of each specimen was determined by counting eggs in a fraction, usually at least 10% by weight, removed from anterior and posterior parts of each ovary.

Both species seemingly have high, but approximately equal, fecundity. Egg-complements recorded for 10 other species of *Notropis* in Carlander (1969) are all lower than for these two species, especially relative to size of adults. Ova are nearly uniform in size within gonads of both *N. bairdi* and *N. girardi.* We infer that both species spawn once annually, within brief intervals.

Food items recorded from stomachs of five females in *bairdi* series 18474 consisted mainly of terrestrial insects of the following groups: Orthoptera,

Table 3. Fecundities of *Notropis bairdi* and *N. girardi* in the Cimarron River, Kansas. GSI = ovary weight divided by body weight (eviscerated). Ova = estimated total number, all well developed. Egg diam. = average diameter of 10 eggs measured, each fish. Specimens in 70% ethanol.

N. bairdi from KU 18474				*N. girardi* from KU 3959			
Standard length (mm)	GSI	Ova	Egg diam. (mm)	Standard length (mm)	GSI	Ova	Egg diam. (mm)
42	0.449	1520	0.76	38	0.286	1012	0.70
45	0.313	1656	0.75	40	0.307	1654	0.68
51	0.469	3314	0.73	40	0.466	2490	0.68
53	0.318	1926	0.71	43	0.428	2886	0.68
54	0.374	2815	0.73	49	0.335	3246	0.68
49	0.385	2246	0.74	42	0.364	2258	0.68

Acrididae; Hemiptera, Tingidae; Coleoptera, Cicindelidae; Mecoptera; Diptera, Tipulidae; and Hymenoptera, Formicidae. Only one of 16 items was aquatic (Hemiptera, Corixidae).

In addition to collecting sites we have discussed in the Cimarron drainage, Gorman and Wiseman made collections at six locations on the Arkansas River in 1979, where *N. girardi* might be expected to occur. They found neither *N. girardi* nor *N. bairdi* at these localities. Clarke (1980) found neither species at eight sites along the Arkansas mainstream in western Kansas in the summer of 1980. The localities sampled in 1979 and 1980 are plotted in Figure 1. We have examined numerous additional collections from the western Arkansas River and its tributaries, obtained by personnel of the Kansas Fish and Game Commission in 1967–1974, none of which contained *N. girardi* or *N. bairdi*. The Arkansas River Shiner may have disappeared from a major part of its former range in Kansas, only a smaller part of which has been occupied by *N. bairdi*.

Reduced flows may account for depletion of *N. girardi* in the Arkansas River. Irrigation of croplands has diverted much surface water, and lowered ground-water tables, throughout southwestern Kansas. Watertables receded more than 10 feet, in some areas more than 100 feet, over much of that region in the period 1950–1975 (Western Kansas Groundwater, Public Information Packet Two, Governor's Task Force on Water Resources, Topeka, October 1977). The effect on stream flow has been more severe in the Arkansas than in the Cimarron River. Although discharge of both streams fluctuated widely under natural conditions, high flows are virtually nonexistent in the Arkansas mainstream at present. Flow-duration tables compiled by the U.S. Geological Survey (Jordan, 1978 and subsequent data) record these changes. At Syracuse, Hamilton County, Kansas, flows exceeding 1000 cubic feet per second have occurred on only 2 days since 1970 (1

day in 1972, 1 in 1975); the drainage area upstream of that site on the Arkansas River is 25,763 square miles. In 1977–1980, the discharge at Syracuse has been less than 3 c.f.s. more than half the time, and greater than 150 c.f.s. less than 10% of the time. Prior to 1943, flows exceeding 1000 c.f.s. occurred at Syracuse in 21 of 22 years of record, usually on several successive days. During June, the month when *N. girardi* normally would spawn most successfully, flows prior to 1943 exceeded 200 c.f.s. approximately 50% of the time, 1000 c.f.s. approximately 25% of the time, and 6000 c.f.s. nearly 5% of the time. The extreme drought that accounted for "dust bowl" conditions in the region falls within that period of record. From 1977 through 1980, June flows at Syracuse exceeded 200 c.f.s. about 25% of the time and exceeded 920 c.f.s. on only 1 day in this 4-year interval.

It seems unlikely that recent flows at Syracuse would allow reproduction by *N. girardi,* dependent as it is on abruptly increased discharge to trigger spawning, and on high flows sustained long enough to permit completion of the pelagic egg and larval stages of development.

Discharges in the Cimarron have declined less severely than those in the Arkansas mainstream. The only gauging station now operating on the Cimarron River in Kansas is beneath a bridge on Kansas Highway 23, one of the sites at which we know *N. girardi* occurred abundantly in 1964, and *N. bairdi* occurs now. Discharge records at K-23 extend from 1966 to date; the drainage area above the station is 8536 square miles. Farther upstream, discharges were recorded for 4 years at Liberal, Kansas (1939–1942) and at Satanta (1943–1946). Flows exceeded 1000 c.f.s. at these three locations in 15 of the 23 years of record, including 1977, 1978, and 1979. In 1980, however, discharge exceeded 110 c.f.s. on 1 day only.

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