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Title: Five Natural Hybrid Combinations in Minnows (Cyprinidae)

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Release Date: April 12, 2011 [EBook #35838]

Language: English

Credits: Produced by Chris Curnow, Erica Pfister-Altschul, Joseph Cooper and the Online Distributed Proofreading Team at <http://www.pgdp.net>

*** START OF THE PROJECT GUTENBERG EBOOK FIVE NATURAL HYBRID COMBINATIONS IN MINNOWS (CYPRINIDAE) ***

Transcriber's Note

The follow suspected error has been corrected in this text: On page 3, *C. erythogaster* changed to *C. erythrogaster*.

UNIVERSITY OF KANSAS PUBLICATIONS
MUSEUM OF NATURAL HISTORY

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Volume 13, No. 1, pp. 1-18
June 1, 1960

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UNIVERSITY OF KANSAS
LAWRENCE
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**Editors: E. Raymond Hall, Chairman, Henry S. Fitch,
Robert W. Wilson**

Volume 13, No. 1, pp. 1-18
Published June 1, 1960

UNIVERSITY OF KANSAS
Lawrence, Kansas



28-3424

Five Natural Hybrid Combinations in Minnows (Cyprinidae)

[Pg 3]

BY
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The hybrid fishes described herein are *Chrosomus erythrogaster* (Rafinesque) × *Notropis cornutus frontalis* (Agassiz), *C. erythrogaster* × *Semotilus atromaculatus* (Mitchill), *Campostoma anomalum plumbeum* (Girard) × *S. atromaculatus*, *Gila nigrescens* (Girard) × *Rhinichthys cataractae* (Valenciennes), and *Notropis venustus venustus* (Girard) × *Notropis whipplei* (Girard). Two of the combinations have been reported, without descriptions, in literature (citations below), and Hubbs (1955: Fig. 3) graphically indicated hybridization between the same genera with which this paper is concerned, but did not designate the species involved.

All specimens of *C. erythrogaster* × *N. c. frontalis*, *C. erythrogaster* × *S. atromaculatus*, *C. a. plumbeum* × *S. atromaculatus*, and *N. v. venustus* × *N. whipplei* were taken in a period of severe drought in Kansas and Arkansas. All were from small, spring-fed streams that support large populations of fishes. That the drought of 1953-1956 had pronounced effects on stream habitats in Kansas has been documented by Minckley and Cross (1959). Satisfactory sites for spawning may have been few, but an abundance of adult fishes persisted from earlier, wet years. Unusual crowding of spawning fishes would increase the opportunity for fertilization of the eggs of one species by sperm from another species. We think that the hybrids reported here (excepting *G. nigrescens* × *R. cataractae*) are explainable on the basis of crowding; we have no information about stream-conditions where the last-named hybrid was found. Generally, hybridization of fishes seems most common in areas that have been subject to radical climatic change in the past 20,000 or fewer years (Hubbs, 1955:18-19), and in streams that have been altered recently by the activities of man (Hubbs and Strawn, 1956:342, and others). Streams from which we report hybrids probably were affected by overgrazing of their watersheds; overgrazing was unusually severe in the drought.

Most of the hybrids were recognized as unusual at the time of capture, and were saved as part of numerically selective samples from the streams (rather than being discovered in the laboratory, in random samples).

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Our measurements were made by methods defined by Hubbs and Lagler (1958); values are expressed as thousandths of the larger dimension.

***Chrosomus erythrogaster* × *Notropis cornutus frontalis*:** KU 3872 (26.7 mm. in standard length) and KU 4170 (46.6 mm.) from Deep Creek, Riley Co., Kansas, Sec. 23, T. 11S, R. 7E, Dec. 14, 1957, and Apr. 26, 1958, respectively; and KU 4185 (39.3 mm.) from Bluff Creek, Pottawatomie Co., Kansas, Sec. 15, T. 6S, R. 8E, June 29, 1958. Compared in Table 1 with five specimens of *C. erythrogaster*, KU 3914 (39.3 to 47.3 mm., mean 43.0 mm.) from the same locality and of the same date as KU 3872 (above); and with five specimens of *N. c. frontalis*, KU 4184 (41.0 to 46.5 mm., mean 42.5 mm.) from the same locality and of the same date as KU 4185 (above). This cross has previously been recorded by Trautman (1957:326, 355) and by Minckley (1959:431).

The head-lengths of the hybrids are greater than in specimens of like size of *C. erythrogaster* or *N. c. frontalis* (Table 1). Hubbs and Miller (1943:373-374) reported that hybrids of *Gila orcutti* × *Siphateles mohavensis* have larger, more robust heads than either of the parental species, perhaps because of heterosis. The enlarged heads in hybrids of *C. erythrogaster* and *N. c. frontalis* result primarily from elongation of the postorbital region, with lesser elongation of the snout and orbit. The enlarged head affects measurements obtained for other structures that are parts of the head (and expressed as proportions of standard length or head-length), causing a tendency toward *N. c. frontalis* when the head-part is divided by standard length, and greater intermediacy or a tendency toward *C. erythrogaster* when the head-part is divided by head-length. In characters in which the parental species differ most (size of eye, length of upper jaw, and width of gape), the hybrids are intermediate between the parental species, regardless of whether the measurements are expressed as proportions of head-length or standard length; however, tendencies toward one or the other of the parental species (dependent on the divisor) can also be seen in these characters. Some experimentally propagated hybrids show highly variable, and sometimes extreme characters, rather than intermediacy of meristic and

TABLE 1. COMPARISONS OF THREE SPECIMENS OF *CHROSOMUS ERYTHROGASTER* × *NOTROPIS CORNUTUS FRONTALIS* [Pg 5]
 WITH SPECIMENS OF THE PARENTAL SPECIES (MEANS ARE ABOVE, RANGES IN PARENTHESES BELOW)

	<i>Chrosomus erythrogaster</i>	KU 4170 and 4185	KU 3872	<i>Notropis c. frontalis</i>
Standard lengths	43.0 (39.3-47.3)	43.0 (39.3-46.6)	26.7 ...	42.5 (41.0-46.5)
<u>Head-length</u> Standard length	253 (246-262)	282 (280-283)	307 ...	276 (273-283)
<u>Orbital length</u> Standard length	067 (063-071)	075 (071-079)	101 ...	083 (080-086)
<u>Orbital length</u> Head-length	263 (252-272)	266 (250-282)	329 ...	300 (291-310)
<u>Snout-length</u> Standard length	069 (068-071)	073 (071-075)	071 ...	068 (066-071)
<u>Snout-length</u> Head-length	272 (262-280)	260 (255-265)	232 ...	245 (233-260)
<u>Interorbital width</u> Standard length	069 (065-071)	074 (069-079)	079 ...	068 (067-069)
<u>Interorbital width</u> Head-length	272 (262-286)	263 (245-280)	256 ...	245 (241-250)
<u>Gape-width</u> Standard length	056 (051-059)	065 (059-071)	064 ...	065 (062-066)
<u>Gape-width</u> Head-length	222 (204-241)	230 (209-250)	207 ...	233 (224-239)
<u>Upper jaw-length</u> Standard length	057 (051-061)	082 (076-088)	112 ...	083 (080-086)
<u>Upper jaw-length</u> Head-length	223 (206-237)	292 (273-311)	268 ...	301 (284-315)
<u>Postorbital length</u> Standard length	113 (108-120)	130 (129-130)	124 ...	123 (121-125)
<u>Postorbital length</u> Head-length	444 (432-456)	460 (455-464)	402 ...	446 (431-457)
<u>Length of depressed dorsal fin</u> Standard length	224 (217-232)	250 (247-252)	255 ...	237 (233-243)
<u>Length of depressed dorsal fin</u> Head-length	885 (869-892)	886 (871-900)	829 ...	858 (836-890)
Number scales in lateral line	71.7 (68-76)	53.0 (53.0)	52(?) ...	38.8 (38-39)
Pharyngeal teeth	0,5-5,0	1,5-4,1 (?-4,1)	1,5-4,2	2,4-4,2
Anal rays	8	8	8	usually 9
Vertebrae	37-40	39	...	38-39

In pigmentation, all three of the hybrids are intermediate between the parental species. The mid-lateral band (which is dark and discrete in *C. erythrogaster*, but faint, broad, and diffuse in *N. c. frontalis*) is broader and fainter in the hybrids than in *Chrosomus*, but is better developed than in *N. c. frontalis*. The dorsolateral dark band of *C. erythrogaster* is present in the hybrids, but is less distinct than in that species, and less distinct than the mid-lateral band of the hybrids themselves. The dorsolateral band is not present in *N. c. frontalis*. The color of the peritoneum in the hybrids is the glossy, jet-black of *C. erythrogaster* in two specimens, and the dusky-black of *N. c. frontalis* in one.

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Chrosomus and *Notropis* differ greatly in the length and convolution of the intestine. *Chrosomus* has a long, coiled gut, which is crossed by the mid-ventral line eight or nine times; in *N. c. frontalis*, the intestine forms a flat, S-shaped loop that does not cross the mid-ventral line. In the two largest hybrids (KU 4170 and 4185), the gut is intermediate, crossing the mid-ventral line four times. In the smaller hybrid (KU 3872) the gut crosses the mid-ventral line twice but the configuration of the anterior loops indicates that the same intestinal convolutions that were found in the larger specimens would have developed in KU 3872 as the gut elongated with increase in size of the fish.

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Both Deep and Bluff creeks are clear, gravel-bottomed streams draining parts of the Flint Hills Area of Kansas. A description of Flint Hills streams and lists of fishes occurring in them have been published by Minckley (1956 and 1959), and by Minckley and Cross (1959).

***Chrosomus erythrogaster* × *Semotilus atromaculatus*:** KU 2947 (28.0 mm. in standard length) from Mill Creek, Wabaunsee Co., Kansas, Sec. 30, T. 12S, R. 9E, Mar. 22, 1953. Compared in Table 2 with five specimens of *C. erythrogaster*, KU 2836 (27.2 to 31.0 mm., mean 28.5) from the same locality and of the same date as KU 2947 (above); and with five specimens of *S. atromaculatus*, KU 1954, 2499, 2703, and 2838 (25.5 to 31.1 mm., mean 28.9 mm.) from streams in the same area.

This hybrid is intermediate between the two species in number of scales and pharyngeal teeth, and has a composite of the pigmentation found in the parental fishes (Table 2). For diagnostic purposes, greater importance is attached to the characters mentioned above than to proportional measurements, which are subject to considerable error because of the small size of the specimens. The few measurements that were taken indicate that this hybrid, like *C. erythrogaster* × *N. c. frontalis*, has a larger head than do specimens of like size of either parental species. The enlarged head affects measurements obtained for other structures that are parts of the head; only the length of the upper jaw, which is greatly different in the parental species, is actually intermediate in KU 2947.

Mill Creek is a clear stream, similar to Deep and Bluff creeks but somewhat larger. Mill Creek had an exceptionally large population of fishes at the time the hybrid was found, but *Chrosomus* and *Semotilus* were neither unusually common nor rare.

Two other crosses, both of which have been described in the literature, also have been found in Mill Creek. These are *N. c. frontalis* × *S. atromaculatus*, and *N. c. frontalis* × *Notropis rubellus* (Agassiz).

TABLE 2. COMPARISON OF ONE SPECIMEN OF CHROSOMUS ERYTHROGASTER × SEMOTILUS ATROMACULATUS WITH SPECIMENS OF THE PARENTAL SPECIES (MEANS ARE ABOVE, RANGES IN PARENTHESES BELOW)

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	<i>Chrosomus erythrogaster</i>	KU 2947	<i>Semotilus atromaculatus</i>
Dark lateral band	intense	intense	intense
Light dorsolateral band	well-defined	poorly developed	absent
Dark dorsolateral band	intense	poorly developed	absent
Color of peritoneum	black	black	silvery
Length of gut	long with transverse coils	short, with a single forward loop	short, with a single forward loop
Pharyngeal teeth	0,5-5,0	1,5-5,2	usually 2,5-4,2
Number scales in lateral line	usually 70 or more, embedded	about 67 slightly embedded	usually fewer than 65, not embedded
Barbels	absent	absent	usually present
Vertebrae	37-40	39	42-43
Head-length	272	310	300
Standard length	(266-277)		(292-308)

<u>Upper jaw-length</u>	071	097	110
Standard length	(069-074)		(104-114)
<u>Upper jaw-length</u>	263	310	366
Head-length	(254-273)		(356-382)
<u>Interorbital width</u>	103	114	116
Standard length	(101-106)		(114-118)
<u>Interorbital width</u>	381	372	388
Head-length	(372-400)		(380-400)
<u>Orbital length</u>	081	083	078
Standard length	(075-085)		(076-084)
<u>Orbital length</u>	296	267	261
Head-length	(271-313)		(255-273)

Campostoma anomalum plumbeum* × *Semotilus atromaculatus: KU 4013 (three males, 86.0 to 96.0 mm. in standard length, mean 89.5 mm.) from Timber Creek, Scott Co., Kansas, Sec. 2, T. 16S, R. 33W, June 19, 1958. Compared in Table 3 with five specimens of *C. a. plumbeum*, KU 4034 (85.7 to 93.1 mm., mean 90.2 mm.) from the Smoky Hill River, Wallace Co., Kansas, Sec. 26, T. 13S, R. 39W, June 20, 1958; and with five specimens of *S. atromaculatus*, KU 4012 and 4047 (85.0 to 97.5 mm., mean 91.7 mm.) from the same locality and of the same date as KU 4013 (above), and Sappa Creek, Decatur Co., Kansas, Sec. 29, T. 2S, R. 28W, June 23, 1958, respectively. This hybrid combination has previously been recorded by Johnson (1945).

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TABLE 3. COMPARISONS OF THREE SPECIMENS OF *CAMPOSTOMA ANOMALUM PLUMBEUM* × *SEMOTILUS ATROMACULATUS* WITH SPECIMENS OF THE PARENTAL SPECIES (MEANS ARE ABOVE, RANGES IN PARENTHESES BELOW)

	<i>Campostoma a. plumbeum</i>	KU 4013 (three spec.)	<i>Semotilus atromaculatus</i>
Standard lengths	90.2 (85.7-93.1)	89.5 (85.7-96.2)	91.7 (85.0-97.5)
<u>Predorsal length</u>	511	533	557
Standard length	(505-517)	(523-542)	(547-564)
<u>Head-length</u>	251	276	289
Standard length	(244-258)	(273-278)	(280-299)
<u>Snout-length</u>	090	088	085
Standard length	(086-096)	(087-091)	(082-087)
<u>Orbital length</u>	044	048	049
Standard length	(043-045)	(047-049)	(048-050)
<u>Interorbital width</u>	075	094	110
Standard length	(073-078)	(091-099)	(104-113)
<u>Distance from tip of mandible to tip of maxillary</u>	057	076	098
Standard length	(053-063)	(072-078)	(095-104)
Gill rakers (1st arch)	30 (29-31)	17 (16-18)	9 (8-10)
Number scales in lateral line	54 (53-55)	54 (54-55)	56 (52-64)
Predorsal scale-rows	25 (23-27)	27 (27-28)	35 (34-36)
Anal rays	7 (6-7)	7.3 (7-8)	8 8
Vertebrae	40	42-44[A]	42-43

[A] Three deformed vertebrae in one specimen with 44; other two specimens have 42 vertebrae.

The hybrids seem uniformly intermediate between the parental species. Application of the hybrid index to the characters listed in Table 3 results in a value of 55.7 when *C. a. plumbeum* is assigned the value 0.

The pharyngeal arches of the hybrids are peculiarly deformed. Expressed in terms of the one-or

two-rowed arrangement common to all North American cyprinids, tooth-counts of 0,5-4,1; 1,3(?) -4,0; and 2,5-4,1 best fit the three fish. However, one arch bears only three teeth, all deformed and badly aligned, plus a pit that presumably represents a lost fourth tooth. At the other extreme, one arch bears eight teeth, some of which are attached to the arch between and behind others that are countable as part of the basic main row. Supernumerary teeth and other deformities may have resulted from abnormalities in the replacement process. In some cases, replacement teeth probably failed to develop; in others, replacement teeth seemingly developed, but attached to the arch in abnormal positions, with or without loss of previous teeth, causing irregularity in alignment. Hubbs (1951) described an irregular (seemingly three-rowed) alignment in a fish that Hay (1888:249) reported from western Kansas as *Squalius elongatus*. However, Hubbs considered the specimen to be an aberrant example of *S. atromaculatus*, and the characteristics that he lists for it do not correspond closely with those of the hybrid specimens that we have. Evans and Deubler (1955:32) found three rows of teeth in two of 150 specimens of *Semotilus*, and attributed the abnormality to failure of old teeth to fall out after formation of new teeth. The teeth of *Campostoma* usually number 0,4-4,0, and those of *Semotilus* 2,5-4,2. The pharyngeal arches are much smaller in *Campostoma* than in *Semotilus*.

The peritoneum is mottled dark and silvery in the hybrids; it has a composite of the coloration in the parental species rather than a blended shade. The intestine has two diagonal loops crossing the ventral part of the body cavity, and the hindgut lies high in the cavity, along the left side of the air bladder. In *Campostoma*, the long gut is transversely coiled around the air bladder, whereas in *Semotilus* the gut forms a longitudinal, flattened, S-shaped loop, ventral to the air bladder.

In the hybrids, the mouth is slightly oblique and nearly terminal. The lower lip is thick and fleshy, but has only a suggestion of the projecting mandibular shelf that is unique in *Campostoma*. The upper lip is uniform in width, not medially expanded as in *S. atromaculatus*. One of the hybrids lacks barbels, one has a *Semotilus*-like barbel on the right side only, and one has a vestigial barbel on the right side and an anomalous barbel that is nearly terminal on the left upper lip.

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In coloration, the hybrids lack the spot in the anterior base of the dorsal fin that is characteristic of *Semotilus*, but each has a poorly-developed dark lateral band, and a weak basicaudal spot. This band and spot are usually prominently developed in *S. atromaculatus* and usually are absent in adults of *C. a. plumbeum*.

In the position and obliquity of the mouth, basic color pattern (diffuse lateral band and basicaudal spot), and the presence in one specimen of a nearly terminal, barbel-like structure, the hybrids somewhat resemble *Hybopsis biguttata* (Kirtland), which occurs rarely in the Kansas River Basin. These partial similarities are coincidental, because other characters of the hybrids make relationship with *H. biguttata* implausible. The high number of gill rakers (Table 3) and the length and position of the gut indicate strongly that the three specimens are hybrids with *C. anomalum* as one parent; the pharyngeal arches, though deformed, indicate that the other parental species has two rows of teeth, with five teeth in the main row. Only *S. atromaculatus*, among species in the Kansas River Basin, usually has such a dental formula, and other characters of our three specimens fit expectations in a hybrid between that species and *C. a. plumbeum*.

Timber Creek, where the three hybrids were collected, is a small, spring-fed, sandy-bottomed tributary to Scott County State Lake in the extreme southwestern part of the Kansas River Basin. The stream was less than 10 feet wide and six inches deep, except in three pools near road crossings. The hybrids were found in two of these pools, along with numerous *S. atromaculatus* and one adult *C. a. plumbeum*.

Another specimen of *C. a. plumbeum* × *S. atromaculatus* (KU 4841, 39.3 mm. in standard length) was taken in the North Platte River at Lisco, Garden County, Nebraska, on September 11, 1959. That specimen has 7 anal rays and 52 scales in the lateral line; otherwise, it is similar to the three hybrids described above.

***Gila nigrescens* × *Rhinichthys cataractae*:** KU 4253 (a male, 60.6 mm. in standard length), from New Mexico, Bernalillo County, Rio Grande 12 mi. S Bernalillo on U. S. Highway 85 (Corraleo Bridge). Compared in Table 4 with six specimens of *G. nigrescens*: KU 4251, 4254, and 4262 (63.1-72.4 mm. in standard length, mean 66.4 mm.); and with five specimens of *R. cataractae*: KU 4248, 4258, and 4264 (55.6-65.0 mm. standard length, mean 59.5 mm.). Comparative material was taken at the same locality as KU 4253 and at nearby localities in the Rio Grande.

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The hybrid is intermediate in almost all of the features in which the parental species differ from each other. For six of the characters included in Table 4, the hybrid index is 49.7 per cent, when *Gila* is assigned the value 0 (height of dorsal fin and numbers of fin rays and teeth excluded). There is no enlargement of the head in KU 4253, such as was found in *Gila orcutti* × *Siphateles mohavensis* (Hubbs and Miller, 1943:373), *Chrosomus erythrogaster* × *Notropis cornutus frontalis*, and *C. erythrogaster* × *Semotilus atromaculatus*. The height of the dorsal fin, which Hubbs and Miller (*loc. cit.*) found to be extreme in *G. orcutti* × *S. mohavensis*, exceeds the average for the parental species in *G. nigrescens* × *R. cataractae* also; but, dorsal fins as high as that of the hybrid were found in some individuals of both parental species. In *R. cataractae*, all fins are more rounded and more expansive than in *G. nigrescens*, and fins other than the dorsal have an intermediate size in the hybrid. This intermediacy has doubtful significance, because fin-size in *Rhinichthys* varies greatly with body-size, sex, and probably with the state of sexual

development. *Rhinichthys* matures at smaller size than *Gila*, and never becomes so large as that species.

Gila nigrescens and *R. cataractae* differ strikingly in features involving the snout and mouth, and these differences provide the most conclusive evidence that KU 4253 is a hybrid of these species. The projecting, fleshy snout of *R. cataractae* is bridged to the ventral mouth by a frenum that is approximately 3 mm. wide in specimens 60 mm. in standard length. In *Gila*, the snout does not project beyond the mouth, which is oblique, lacks a frenum, and is larger than in *Rhinichthys*. The snout of the hybrid projects less than in *R. cataractae* and is bridged to the upper lip by a frenum 1.7 mm. wide. The mouth of the hybrid is intermediate in size, obliquity, and thickness of the lips. *Rhinichthys* has barbels, *Gila* lacks them, and the hybrid has one vestigial barbel, on the right side. The lower surface of the head of *Rhinichthys* is broad and flattened, with pronounced rugosity on the gular area and isthmus. In *Gila* the underside of the head is convex, with comparatively smooth membranes; the hybrid is intermediate, but tends toward *Gila*.

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TABLE 4. COMPARISONS OF ONE SPECIMEN OF *GILA NIGRESCENS* × *RHINICHTHYS CATARACTAE* WITH SPECIMENS OF THE PARENTAL SPECIES (MEANS ARE ABOVE, RANGES IN PARENTHESES BELOW)

	<i>Gila nigrescens</i>	KU 4253	<i>Rhinichthys cataractae</i>
Standard lengths	66.4 (63.1-72.4)	60.6	59.5 (55.6-65.0)
<u>Head-length</u> Standard length	282 (277-290)	281	281 (273-293)
<u>Orbital length</u> Standard length	063 (063-065)	054	044 (041-047)
<u>Snout-length</u> Standard length	083 (081-085)	092	106 (099-113)
<u>Dorsal fin-height</u> Standard length	225 (212-238)	234	221 (206-234)
<u>Postorbital length</u> Standard length	140 (134-142)	135	131 (127-136)
Distance from tip of mandible to tip of maxillary Standard length	081 (079-085)	076	066 (064-069)
<u>Length of infralabial groove</u> Standard length	060 (058-064)	045	036 (034-038)
Upper jaw	protractile	non-protractile	non-protractile
Number scales in lateral line	60 (58-63)	63	65 (63-67)
Anal fin-rays	8 (7-8)	7	7 (7)
Pelvic fin-rays	9 (9)	8	8 (8-9)
Pectoral fin-rays	16 (16-18)	16-15	13 (13-14)
Pharyngeal teeth	2,5-4,2	2,5-4,2	2,4-4,2

TABLE 5. COMPARISONS OF ONE SPECIMEN OF *NOTROPIS V. VENUSTUS* × *NOTROPIS WHIPPLEI* WITH SPECIMENS OF THE PARENTAL SPECIES, AND WITH *N. LUTRENSIS* × *N. V. VENUSTUS*. MEASUREMENTS (LENGTHS AND DEPTHS) ARE EXPRESSED AS THOUSANDTHS OF STANDARD LENGTH (MEANS ABOVE, RANGES IN PARENTHESES BELOW)

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	<i>Notropis whipplei</i>	KU 3516	<i>Notropis venustus</i> , KU 3510	<i>Notropis venustus</i> , from Gibbs (1957a)	<i>Notropis lutrensis</i> × <i>N. venustus</i>
Standard length	50.6 (45.0-54.0)	47.8	47.3 (44.5-49.6)		44.7 (43.3-47.3)
Predorsal length	525 (513-535)	523	534 (519-547)	523	532 (528-538)
Dorsal origin to caudal base	497 (493-502)	508	497 (478-504)	496	508 (502-514)
Prepelvic length	505	492	505		499

	(498-518)		(500-510)		(486-517)
Head-length	257 (250-262)	255	261 (256-267)	260	263 (261-267)
Caudal peduncle-length	217 (211-220)	221	224 (213-230)		224 (214-231)
Caudal peduncle-depth	110 (106-116)	119	127 (124-133)	125	126 (122-131)
Head-depth	170 (167-173)	182	186 (182-190)		190 (189-192)
Snout-length	079 (076-083)	079	080 (072-083)		081 (078-082)
Eye-diameter	069 (063-078)	069	070 (066-072)	073 [A]	070 (068-074)
Postorbital length, head	112 (108-115)	115	116 (112-120)		117 (115-120)
Upper jaw, length	078 (076-081)	077	081 (076-082)	079	077 (076-081)
Body depth	239 (233-248)	253	278 (261-288)	274	282 (275-294)
Lateral-line scales	36-37	36	36-38	36.5 (34-39)	
Scales above lateral-line	13	14	15	15 (13-16)	
Anal fin-rays	9	9	8	8 (7-8)	
Pectoral fin-rays	14 (14-15)	14-14	15 (14-16)	14.2 (12-17)	
Caudal spot	Absent	Present	Present	Present	Present
Vertebrae	37-38	38	37		

[A] Orbital diameter.

The air bladder of KU 4253 is nearly as large as in *Gila*, and much larger than the degenerate air bladder of *R. cataractae*. Although the hybrid appears to be male, the gonads (especially the right one) are poorly developed. The hybrid is intermediate in curvature of the lateral line, which is nearly straight in *Rhinichthys* and strongly decurved in *Gila*.

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Specimen No. 4253 is mostly pallid, resembling *Gila* much more than *Rhinichthys* in pigmentation. A mid-dorsal dark streak is conspicuous in the hybrid, especially anteriorly, but is less intense than in *Gila*. *Rhinichthys* lacks a well-developed dorsal stripe. The preorbital and suborbital areas are more heavily pigmented in the hybrid than in *Gila*, but not nearly so dark as in *Rhinichthys*. The hybrid has a faint dark basicaudal spot that is variably developed in *Rhinichthys* but absent in *Gila*.

***Notropis venustus venustus* × *Notropis whipplei*:** KU 3516 (a male, 47.8 mm. in standard length), from Arkansas, Sevier Co., Winters Creek where it is crossed by U. S. Highway 71, 5 mi. N of Little River Bridge, March 8, 1956. Compared in Table 5 with four specimens of *N. whipplei*, KU 3517 (45.0-52.6 mm. in standard length, mean 50.6 mm.), same locality and date as KU 3516; four specimens of *N. v. venustus*, KU 3510 (44.5-49.6 mm. in standard length, mean 47.3 mm.), Louisiana, Winn Parish, Little Naches Bayou on U. S. Highway 71, 8.8 mi. NW Montgomery, March 4, 1956; three specimens of *Notropis lutrensis* (Baird and Girard) × *N. v. venustus*, KU 3510 (43.3-47.3 mm. in standard length, mean 44.7 mm.), same locality and date as *N. v. venustus* above; and with tabulated data on *N. v. venustus* from Gibbs (1957a:185-186). All specimens are from the lower Red River Drainage; other series of *N. whipplei*, *N. venustus*, and *N. lutrensis* × *N. venustus*, from the Red River Drainage and elsewhere, were examined but are not tabulated because of differences in size, and because of geographic variability that has been discussed by Gibbs (1957a).

[Pg 16]

The Subgenus *Cyprinella* of *Notropis*, to which *N. venustus* and *N. whipplei* belong, has been studied intensively by Gibbs (1957a and b). *Notropis venustus* differs conspicuously from *N. whipplei* in having a large dark basicaudal spot; also, *N. venustus* usually has 8 (rather than 9) anal rays, and 15 (rather than 13) scales above the lateral line immediately anterior to the dorsal fin. Specimens of *N. v. venustus* from the Red River Drainage, where the most robust representatives of the species are found, differ from *N. whipplei* in depth of head, body, and caudal peduncle (Table 5).

KU 3516 has a composite of the 9-rayed anal fin of *N. whipplei* and the caudal spot (albeit diffuse) of *N. venustus*; and, the hybrid is intermediate in body-proportions that distinguish the two species, especially depth of head, body, and caudal peduncle. In other features KU 3516 has

values within the overlapping ranges of variation of *whipplei* and *venustus* except that the ratio of postdorsal length to standard length is extremely long in the hybrid, and the ratio of prepelvic length to standard length is extremely short (Table 5). Both extreme values for the hybrid seem to result from the cumulative influence of characters in which the parental species differ slightly in mean value (especially head-length, in which the hybrid is like *whipplei*, and caudal peduncle-length, in which the hybrid approaches *venustus*, despite the 9-rayed anal fin of the hybrid). The basicaudal spot of the hybrid is like that of *N. v. venustus* except for being less intense.

Notropis venustus hybridizes extensively with *N. lutrensis* (Hubbs, Kuehne, and Ball, 1953:226-230; Hubbs and Strawn, 1956), and that combination occurs in streams near the locality where KU 3516 was taken. KU 3516 resembles *N. lutrensis* × *N. v. venustus* in many ways, but is more slender than the latter hybrid. The depth of head, body, and caudal peduncle are greater in *N. lutrensis* than in *N. venustus* (much greater than in *N. whipplei*); therefore, specimens of *N. lutrensis* × *N. venustus* are usually deeper than *N. venustus*, whereas KU 3516 is less deep. KU 3516 has a rather sharp snout and thin, straight lips that are strongly suggestive of *N. whipplei*, rather than *N. lutrensis*, in which the snout is rounded and the lips are more obliquely decurved. There is less pigment underlying the anterior lateral-line scales in KU 3516 than in *N. lutrensis* × *N. venustus*, and melanophores on the scale-pockets of KU 3516 are arranged in narrower, more distinct submarginal bars than in *N. lutrensis* × *N. venustus*. Because of the difference in pigmentation, the lateral scales of *N. whipplei* (and of KU 3516) appear more narrowly diamond-shaped than the lateral scales of *N. lutrensis* or *N. lutrensis* × *N. venustus*. The lengths and heights of the scales are approximately the same in all three species.

[Pg 17]

Winters Creek, where KU 3516 was taken, flowed approximately five cubic feet per second at the time our collection was made; a landowner on the stream stated that it had been dry, except for pools, in the previous two summers. The water was somewhat gray, but nearly clear. The habitat consisted mainly of short riffles, with average depth of four inches, and pools to depths of two feet. Twelve species of fish, including *N. whipplei* but not *N. lutrensis* or *N. venustus*, were found; other minnows were *Semotilus atromaculatus*, *N. chalybaeus*, *N. cornutus*, *N. umbratilis*, and *Campostoma anomalum*.

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