

A PRELIMINARY ANALYSIS OF THE RIVER CARPSUCKER,
Carpiodes carpio (RAFINESQUE), IN THE SOUTHERN PORTION
OF ITS RANGE

Un análisis preliminar del matalote de río, *carpiodes carpio* (Rafinesque).
en la porción sureña de su distribución

ROYAL D. SUTTKUS AND HENRY L. BART, JR.

ABSTRACT. We conducted a preliminary analysis of geographic variation in southern populations of *Carpiodes carpio*, concentrating on samples from the lower Mississippi River Basin and the Rio Grande drainage. We observed little significant variation in meristics over this range, but extensive variation in body proportions. Lower Mississippi River (mode = 24) specimens have a significantly higher average number of dorsal rays than specimens from other southwestern populations (except the Colorado River, mode = 25). Lower Mississippi River specimens exhibited significantly higher means for body depth, body width, head length, head width, head depth, caudal peduncle depth, orbit length, postorbital bony length, dorsal fin base length, dorsal fin height, caudal fin length, pelvic fin length, anal fin length, dorsal origin to postorbital rim, predorsal length, and prepelvic length than Rio Grande specimens. Rio Grande specimens had significantly higher means for caudal peduncle length and pectoral fin length. Number of dorsal rays is positively correlated with proportional length of the dorsal fin. The higher number of dorsal rays in lower Mississippi River specimens is reflected in the longer dorsal base. Our analysis suggests that Red and lower Mississippi River specimens including specimens from the Mississippi River in the vicinity of the Louisiana-

Arkansas state line, which Hubbs and Black (1940) tentatively assigned to *C. c. elongatus* are referable to *C. c. carpio*.

Key words: Analysis, river carpsucker, southern portion, distribution.

RESUMEN. Condujimos un análisis preliminar de la variación geográfica en las poblaciones sureñas de *Carpiodes carpio*, concentrándonos en muestras de la cuenca baja del Río Mississippi y en la cuenca del Río Bravo. Observamos poca variación significativa en la merística sobre la distribución, pero sí extensa variación en las proporciones del cuerpo. Los ejemplares del Bajo Río Mississippi (moda = 24) tienen un número de radios dorsales significativamente más alto que los ejemplares de las poblaciones del suroeste (excepto en Río Colorado, moda = 25). Los ejemplares del Bajo Río Mississippi exhibieron promedios significativamente más altos para altura máxima, anchura del cuerpo, longitud cefálica, anchura cefálica, altura de la cabeza, altura mínima, diámetro de la órbita, longitud postorbital ósea, base de la aleta dorsal, altura de la aleta dorsal, longitud de la aleta caudal, longitud de la aleta pélvica, longitud de la aleta anal, origen dorsal a borde postorbital, longitud predorsal, y longitud prepélvica que los ejemplares del Río Bravo. Los ejemplares del Río Bravo tuvieron promedios significativamente más altos para longitud del pedúnculo caudal, y longitud de la aleta pectoral. El número de radios dorsales está correlacionado positivamente con la longitud proporcional de la aleta dorsal. El alto número de radios dorsales en los ejemplares del Bajo Río Mississippi se refleja en la base dorsal más larga. Nuestro análisis sugiere que los ejemplares del Río Rojo y del Bajo Río Mississippi - incluyendo ejemplares del Río Mississippi en la vecindad de la frontera Louisiana-Arkansas, que Hubbs y Black (1940) tentativamente asignaron a *C. c. elongatus* son referibles a *C. c. carpio*.

Palabras clave: Analisis, matalote de río, porción sureña, distribución.

INTRODUCTION

THE RIVER CARPSUCKER *Carpiodes carpio* (Rafinesque, 1820), as presently recognized, is a wide-ranging species comprising two subspecies: the nominal form *C. c. carpio* in the Mississippi River Basin, and a southwestern form *C. c. elongatus*. The taxonomy of *C. carpio* and related species was reviewed by Hubbs (1930). Hubbs and Black (1940), who provided the only systematic treatment of morphological variation within the species complex, considered *C. elongatus* Meek 1904 and *C. microstomus* Meek 1904, to be conspecific with *C. carpio*. They chose *elongatus* to represent the southwestern form, distinguished primarily on the basis of its elongate body. They gave the range of *C. c. elongatus* as Soto la Marina and Sabinas river systems of northern Mexico, Rio Grande system of Texas and Mexico, coastal streams of Texas, and (tentatively) the Mississippi River near the Louisiana-Arkansas line. Hubbs and Black (1940) expressed some doubt about inclusion of the latter - and thus the rest of the lower Mississippi River - in the range of *C. c. elongatus*, because the specimens on which their record was based were small. They referred Arkansas and Red river specimens to *C. c. carpio*, but added that these specimens approached *C. c. elongatus*. Subsequent workers interpreted this to mean that the Mississippi River in the vicinity of the Arkansas state line was a zone of contact between the two subspecies, and that Arkansas and Red river populations may represent intergrades (Robison and

Buchanan 1988). Hubbs and Black's (1940) analysis primarily involved body proportions, and concentrated on material housed at the University of Michigan and the United States National Museum.

The purpose of this study is to reevaluate the status of southern populations of *C. carpio*. We present a preliminary analysis of populations in the southwestern portion of the range, concentrating on samples from the lower Mississippi River Basin (Red River system, lower main stem of the Mississippi River, the small tributaries to the lower Mississippi River) and the Rio Grande drainage from southern Texas and northern Mexico. We present new data on meristic variation, sexual variation, and additional information on morphometrics for this portion of the range, and we resolve a question about the status of populations in the lower Mississippi River Basin.

We are pleased to offer this paper in recognition of the many accomplishments of Dr. Salvador Contreras-Balderas during his professional career at the University of Nuevo Leon, Monterrey, Mexico. We hope that he will find time during his retirement to continue the important conservation activities that occupied so much of his time in recent years.

MATERIALS AND METHODS

Much of the material for this study was collected during the Environmental Biology Training Program through a grant to the senior author. The program was sponsored by the National Institute of Health during the early to middle 1960s. Reconnaissance trips to determine and make arrangements for summer training camps were instrumental in obtaining many valuable collections. More than a few collecting sites are no longer available for study because of impoundment by dams or diminished flow through irrigation diversions.

Most of the specimens from the Devils and Pecos rivers were obtained by use of trammel and gill nets. Some lower Mississippi River and western Gulf slope drainages also were sampled with trammel and gill nets. Many other samples were taken with a 10-foot seine, 6 feet deep, with 3/16" ace mesh. Most of the specimens used in this study are housed in the Tulane University Museum of Natural History (TU). Additional specimens from southern Texas and Mexico were obtained on loan from the University of Nuevo Leon (UNAL) and the University of Texas (TNHC).

Materials Examined: Red River System. Louisiana, Natchitoches Parish: TU 13388 (40 of 43, 34-90 millimeters (mm) in standard length (SL), Red River, 5 mi N of Natchitoches; 9 August 1956. Louisiana, Rapides Parish: TU 99195 (30 of 40, 21-67), Red River a long right bank at River Mile 79.4; 22 September 1976. Louisiana, Rapides Parish: TU 112992 (5, 81-188), Red River along right bank at River Mile 105; 21 June 1979. Oklahoma, Garvin County: TU 147570 (12, 44-65), Washita River, 2.5 mi N of Hwy 19 at Hwy 77 bridge; 19 February 1986. Texas, Wilbarger County: TU 148611 (1, 253), Red River at US Hwy 283; 12 May 1987. Oklahoma, Tillman County: TU 148628 (12, 44-74), North Fork of Red River at Hwy 5; 12 May 1987. Texas, Wilbarger County: TU 149598 (1, 73), Pease River, 1.4 mi N of Vernon at Hwy 283; 18 August 1987. Louisiana, Rapides Parish: TU 185993 (10, 19-37), Red River along left bank at River Mile 108.1; 6 June 1998. Louisiana, Rapides Parish: TU 186008 (40 of 96, 14-45), Red River along left bank at River Mile 106; 6 June 1998.

Mississippi River, lower main stem. Arkansas, Mississippi County: TU 54528 (50 of 155, 13-71), Mississippi River, 2.2 mi NE of Butler; 8 October 1968. Louisiana, West Feliciana Parish: TU 99584 (9, 46-92), Mississippi River at River Mile 293.5; 1 October 1976. Louisiana, West Feliciana Parish: TU 99601 (50 of 62, 34-101), Mississippi River on inside of island bar at River Mile 293.1; 1 October 1976. Louisiana, West Feliciana Parish: TU 99633 (15, 30-59), Mississippi River at upper end of Iowa

Point, River Mile 280; 2 October 1976. Louisiana, Pointe Coupee Parish: TU 99650 (31 of 315, 44-71), Mississippi River at head end of St. Maurice Towhead, River Mike 273; 2 October 1976. Louisiana, Pointe Coupee Parish: TU 99663 (20 of 92, 23-57), Mississippi River at lower end of St. Maurice Towhead, River Mile 270.2; 2 October 1976. Arkansas, Chicot County: TU 101110 (16 of 53, 61-98), Mississippi River, 8 mi N of Greenville bridge, US Hwy 82 (TI5S, RIE, Sec 30); 11 July 1975. Louisiana, East Baton Rouge Parish: TU 115658 (9, 60-94), Mississippi River at River Mile 250; 6 December 1979.

Mississippi River, lower tributaries. Mississippi, Copiah County: TU 55656 (1, 292), Bayou Pierre, 10.1 mi NE of Hermanville, MS, Hwy 18; 16 November 1968. Mississippi, Jefferson County: TU 55439 (1, 169), South Fork Coles Creek, 9.2 mi SW of Fayette, Hwy 61; 2 November 1968. Mississippi, Jefferson County: TU 66172 (19, 68-214), tributary to South Fork Coles Creek, 7.6 mi SW of Fayette at Hwy 61; 12 December 1970. Mississippi, Wilkinson County: TU 55598 (2, 134 and 220), Homochitto River at US Hwy 61; 15 November 1968. Mississippi, Lincoln County: TU 78760 (5, 166-212), Homochitto River, 4.7 mi E of Union Church, Hwy 550; 27 April 1972. Mississippi, Lincoln County: TU 78790 (1, 220), Homochitto River, 5 mi E of Union Church, Hwy 550; 3 July 1972. Mississippi, Copiah County: TU 84033 (1, 200), Homochitto River, 4 mi N of Caseyville; 14 September 1973. Mississippi, Wilkinson County: TU 55560 (15, 45-235), Buffalo Bayou, 9.6 mi N of Woodville, US Hwy 61; 15 November 1968. Mississippi, Wilkinson County: TU 61631 (1, 212), Buffalo Bayou, 4.1 mi W of Centreville; 30 December 1969. Louisiana, West Feliciana Parish: TU 55305 (64, 53-247), Big Bayou Sara, 4.9 mi NW of St. Francisville, Hwy 66; 1 November 1968. Mississippi, Wilkinson County: TU 59982 (5, 71-82), Bayou Sara, 7.5 mi SW of Woodville; 11 October 1969. Louisiana, West Feliciana Parish: TU 62690 (61, 50-75), Little Bayou Sara, 5.6 mi NW of Bains; 31 January 1970. Louisiana, West Feliciana Parish: TU 63037 (1, 208), Little Bayou Sara, 11.8 mi NW of Bains, Hwy 66; 30 April 1970. Louisiana, West Feliciana Parish: TU 63122 (12, 26-107), Little Bayou Sara at Retreat, 11.8 mi NW of Bains; 30 June 1970. Louisiana, West Feliciana Parish: Bayou Sara, 1.5 mi W of Bains Hwy 66; 30 April 1971. Louisiana, East and West Feliciana Parish: TU 55285 (4, 71-194), Thompson Creek, 5.7 mi SE of St. Francisville, Hwy 61; 1 November 1968. Louisiana, West Feliciana Parish: TU 69629 (2, 154 and 164), Thompson Creek, 0.6 mi NW of Jackson, LA Hwy 10; 30 April 1971.

Rio Grande drainage. Texas, Val Verde County: TNHC 4760 (5 of 6, 132-160), above mouth of Jinagus Springs; 29 May 1954. Texas, Val Verde County: TU 42799 (10 of 49, 34-44), Devils River above Dolan Falls, 20.7 mi SE of Loma Alta; 11 July 1966. Texas, Brewster County: TU 90899 (2, 115 and 120), Terlingua Creek about 4 mi NW of Study Butte, Hwy 170; 15 October 1974. Texas, Terrell County: TU 36960 (50 of 92, 195-289), Pecos River at Chandler's ranch, 28 mi SE of Sheffield; 16 July 1963. New Mexico, Eddy County: TU 38872 (10 of 266), Black River, tributary to Pecos River, 7 mi W of Malaga; 30 July 1965. Mexico, Nuevo Leon: UANL 159 (1 of 2, 87), Rio San Juan, 6 km E de los Aldamas; 16 August 1962. Mexico, Chihuahua: UANL 1978 (1, 56), Rio Conchos en Camago (Sta Rosalia); 12 August 1975. Mexico, Chihuahua: UANL 6917 (1 of 19, 58), Rio Conchos en el Pueblito at 34 km A/E de Carr 16; 17 August 1984. Mexico, Nuevo Leon: UANL 11502 (17, 51-84), Rio San Juan en las Enramadas; 6 April 1977. Mexico, Nuevo Leon: TNHC 1675 (1, 122), Rio Salado, Gonzalez Hacienda, 25 mi SSE of La Gloria; 9 June 1951. Mexico, Chihuahua: TNHC 4056 (8, 16-128), Concho River, 1 km from mouth of Rio Grande; 13 June 1954. Mexico, Durango: TNHC 4643 (25, 46-138), Rio Florida, 11 mi ESE of Villa Ocampo, Mexico 45; 27 June 1954.

In general, we have followed Hubbs and Lagler's (1958) methods for counting fin rays and scales and for determining proportional measurements. Typically, one pored lateral line scale was present posterior to the crease formed by flexing the caudal fin at the posterior margin of the hypural plate. A second pored scale, often smaller, was present on some specimens; neither of these scales was included

in the lateral line scale count. Invariably, the posterior dorsal and anal fin rays were divided to the base and in each case was counted as one. Many juvenile specimens were used for fin ray and scale counts. Fin ray counts were usually more difficult to make on adult specimens because the thickness and opaqueness of the fin membrane.

Morphometrics were based on adult specimens that were 190 mm or greater in standard length. Accurate measurements of predorsal, prepelvic, and postdorsal distances were difficult to make on some of the larger specimens because of their curved bodies. In these instances, an average was taken on measurements on both the left and right sides. The position of the mouth (i.e., closed vs. partially open and distended) introduced variation in snout length measurements and, less so, head, predorsal, and prepelvic measurements. Head length measurements were affected slightly by the presence or absence of a fully distended fleshy opercular flap. Our postdorsal measurement is the distance from the anterior point of insertion of the dorsal fin to the middle of the caudal base whereas the postdorsal measurement of Hubbs and Black (1940) was the distance between the [posterior] end of the dorsal base and the middle of the caudal base.

Measurements of lengths and heights of fins were not recorded where the fins were deformed or their tips broken-off. Measurements smaller than 175 mm were made with needle-point dial calipers to the nearest 0.1mm. Measurements in excess of 175 mm were made with a needlepoint sliding bar calipers and recorded to the nearest 1.0 mm.

Data for 21 morphometric characters were expressed as ratios of standard length. Ratio data for each character were then arcsine transformed for statistical comparisons. We first tested for differences between sexes within the Rio Grande and lower Mississippi River Basin populations. We then tested the combined sex data for differences between Rio Grande and lower Mississippi River populations using ANOVA. We also performed Principal Components Analysis (PCA) on the combined data set, using the covariance matrix derived from arcsine-transformed ratio data.

In order to provide a basis for comparing Hubbs and Black's (1940) findings to ours, we also tabulated a ratio obtained by dividing the length of the dorsal fin base into the distance between the anterior insertion of dorsal fin and the posterior rim of orbit. This is analogous to projecting the length of the dorsal base anteriorly and measuring where it falls relative to the eye, as performed by Hubbs and Black (1940).

RESULTS AND DISCUSSION

Populations from the Sabine River to the Rio Grande (exclusive of the Colorado River) have a low average number of dorsal fin rays (mode = 23, Table 1). Dorsal fin rays number significantly higher in the Mississippi River and tributaries (mode = 24). The Colorado River population is unique in showing a high degree of variation in number of dorsal rays and a mean of more than 25. The San Antonio Bay and Nueces drainages flow into the western Gulf of Mexico between the Colorado and Rio Grande drainages. We were not able to study sufficient material from these two drainages to include them in this comparison. Thus, we are not able to comment on variation in dorsal ray counts in this portion of the range. The modes for anal, caudal, pelvic, and pectoral fin rays are the same across the western Gulf Slope. Tables 2 and 3 show variation in these characters for the Red River, lower Mississippi River (main stem), lower Mississippi River tributaries, and Rio Grande specimens.

The lateral line scale count averages slightly, but not significantly, higher in Rio Grande specimen than in lower Mississippi River Basin specimens (Table 4). The modal number of lateral line scales is 36 scales in Rio Grande specimens and 35 in lower Mississippi River Basin specimens.

An analysis of morphometrics for 24 male and 26 female *C. carpio* from the Rio Grande revealed no significant differences in body proportions between sexes (Table 5). In the lower Mississippi River Basin, the head tended to be slightly deeper and wider in females than in males. However, females were underrepresented in our sample from the lower Mississippi River Basin, so the differences may reflect sampling error. Because sexes did not differ significantly for most body proportions, we combined data for males and females from both the Rio Grande and lower Mississippi River Basin in subsequent analyses.

Lower Mississippi River Basin specimens exhibited significantly higher means for body depth, body width, head length, head width, head depth, caudal peduncle depth, orbit length, postorbital bony length, dorsal fin base length, dorsal fin height, caudal fin length, pelvic fin length, anal fin length, dorsal origin to postorbital rim, predorsal length, and prepelvic length (Table 6). Rio Grande specimens had significantly higher means for caudal peduncle length and pectoral fin length.

Hubbs and Black's (1940) major emphasis involved the length of the dorsal fin base to demonstrate the differences between the more attenuate form *C. c. elongatus* as compared to *C. c. carpio*. They stated, "The length of the dorsal base when projected forward usually falls far back of the eye in *elongatus* but reaches almost to or even beyond the back edge of the eye in *C. c. carpio*". However, they go on to state that individual variation in this measurement was too great to allow statistical comparison.

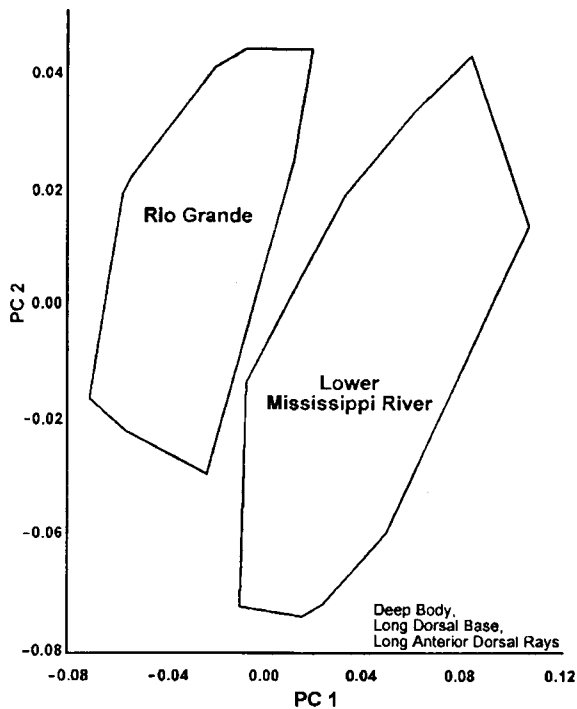


Figure 1. Polygons representing projection of arcsine transformed body proportion data from Rio Grande and Mississippi River specimens of *Carpiodes carpio* on the first two components derived in principal components analysis.

We expressed this measurement as the length of the dorsal base divided into the distance between the anterior insertion of dorsal fin and the posterior rim of orbit. The data are presented in Table 7. Our findings reflect those of Hubbs and Black (1940) to some degree, however, we found more overlap between the two groups of populations than indicated in their analysis. Note that in only two of 55 Rio Grande specimens, the dorsal fin base is equal or exceeds the distance from dorsal fin to posterior orbital rim. However, in 43 of 70 specimens from the lower Mississippi River the dorsal fin base equals (4) or exceeds (39) the distance from dorsal fin insertion to posterior orbital rim. Thus the projected dorsal fin base falls short of the posterior orbital rim in 96% of Rio Grande specimens, but only 39% of the lower Mississippi River specimens. Samples from the other drainages included in Table 7 all show lower percentages of specimens (22 -76%) in which the dorsal base length is less than the distance between dorsal fin and posterior rim of orbit than in the Rio Grande. Principal components analysis supported the results of univariate morphometric comparisons.

Projection of data on the first two components derived in the analysis, which together accounted for 57% of total variability in the data, showed complete separation between Rio Grande and lower Mississippi River populations (Fig 1). Most of the separation was along PC 1. Characters loading highly on this axis were body depth, dorsal base length, and length of anterior dorsal rays.

Interestingly, number of dorsal rays is positively correlated with proportional length of the dorsal fin, both within lower Mississippi River ($r = 0.34$, $P = 0.026$) and Rio Grande populations ($r = 0.28$, $P = 0.046$) and for the combined data for these populations ($r = 0.38$, $P = 0.0002$). The distance from the anterior insertion of the dorsal fin relative to the posterior portion of the body (as measured by our postdorsal distance) is the same in both the lower Mississippi River and Rio Grande populations. What differs most between populations are the anterior body measurements and the relative length and height of the dorsal fin (all shorter in Rio Grande specimens). The longer dorsal fin base of lower Mississippi River specimens reflects the higher number of dorsal rays. Hubbs and Black (1940) undoubtedly were aware of this correlation; however, they did not present any fin ray data to support it.

Knapp (1953), Trautman (1957), Pflieger (1971), Lee and Platania (1980), Robison and Buchanan (1988), and Etnier and Starnes (1993) followed Hubbs and Black (1940) in interpreting southwestern populations as *C. c. elongatus* or intergrades between this form and *C. c. carpio*. Our analysis suggests that Red and lower Mississippi River specimens - including specimens from the Mississippi River in the vicinity of the Louisiana-Arkansas state line - are referable to *C. c. carpio*.

The name *C. elongatus*, by original designation, applies to populations in the extreme southwestern portion of the range (Rio Grande and Gulf coastal streams of northeastern Mexico). The only remaining questions are how far east does this form extend and does it intergrade with *C. carpio*? Conner and Suttkus (1986) identified seven drainages in the U. S. portion of the western Gulf Slope: the Calcasieu, Sabine Lake, Galveston Bay, Brazos, Colorado, San Antonio Bay, Nueces, and the Rio Grande. Sabine and Neches river systems are part of the Sabine Lake drainage; the Trinity and the San Jacinto river systems form the Galveston Bay drainage. They reported records of *C. carpio* from all seven drainages. We have specimens available for study from all of these drainages, except the Calcasieu, Nueces and San Antonio Bay. Thus, we feel confident that we will be able to resolve the status of coastal populations of Louisiana and Texas between the Mississippi River and the Rio Grande.

ACKNOWLEDGMENTS

Many individuals participated in the collection of specimens that were used in this study. The numerous students in the Environmental Biology Training Program, and Biology of Fishes and Ichthyology classes

of the senior author helped collect many specimens over the past forty years. We are especially grateful for the dedicated participation of past graduate students (in alphabetical order): John H. Caruso, Robert C. Cashner, Glenn H. Clemmer, John V. Conner, and Bruce A. Thompson. We owe a debt of gratitude to Clyde Jones and Glenn H. Clemmer who participated in numerous reconnaissance trips to make arrangements for collecting and camp sites for the summer program. We extend our sincere thanks to Clyde Jones for helping the senior author obtain many samples from the upper Red River system.

We extend special thanks to J.V. Conner for making arrangements with Mr. H.K. Fawcett to have access to Devils River at Dolan Falls and we owe a debt of gratitude to Mr. Fawcett for his friendly reception of our group and help in getting our vehicles over some difficult terrain. We also extend our sincere appreciation to Joe Chandler, Sr. for access to his guest ranch and particularly to a campsite at the mouth of Independence Creek at its confluence with the Pecos River. Most importantly he gave us essentially unlimited access to the native plants and animals in the area. We also extend our thanks to Mr. N.D. Blackstone for access to his extensive ranch along the upper reaches of Independence Creek. Mr. and Mrs. W.L. Collett of Sheffield, Texas were very helpful and generous with information about that part of Texas. They allowed us to park our boat and trailer in their yard while we went farther west in Texas and to New Mexico. We deeply appreciate their help and friendly attitude.

For loans or permission to examine specimens in their care, we thank Barry Chernoff, Mark Westneat and Kevin Swagel of the Field Museum of Natural History (types of *Catostomus elongatus* and *C. microstomus*), Ma de Lourdes Lozano-Vilano, Laboratorio de Ictiología, Universidad Autónoma de Nuevo León, Dean Hendrickson and Allison Anderson of the Texas Memorial Museum of Natural History, and Mike Taylor of the Tulane Museum of Natural History. We also thank Linda Bustoz for help with typing the manuscript, and Mike Taylor for help with the figure.

LITERATURE CITED

- CONNER, J. V. & R. D. SUTTKUS 1986. Zoogeography of freshwater fishes of the western Gulf Slope of North America. Chap. 12, 413-456. In: "The Zoogeography of North American Freshwater Fishes." John Wiley & Sons, New York. pp.866.
- ETNIER, D. A. & W. C. STARNES 1993. The fishes of Tennessee. Univ. Tennessee Press, Knoxville. pp.681.
- HUBBS, C. L. 1930. Material for a revision of the catostomid fishes of eastern North America. Univ. Michigan Mus. Zool. Misc. Publ., 20:1-47.
- HUBBS, C. L. & J. D. BLACK 1940. Status of the catostomid fish, *Carpiodes carpio elongatus* Meed. Copeia, 1940 (4):226-230.
- HUBBS, C. L. & K. F. LAGLER 1958. Fishes of the Great Lakes region. Cranbrook Inst. Sci. Bull. 26, pp.213.
- KNAPP, F. T. 1953. Fishes found in the fresh waters of Texas. Ragland Studio and Litho Printing Co., Brunswick, Georgia. pp166.
- LEE, D. S. & S. P. PLATANIA 1980. *Carpiodes carpio* (Rafinesque), River carpsucker. pp.367. In: D.S. Lee, et al. Atlas of North American Freshwater Fishes. North Carolina State Mus. Nat. Hist., Raleigh. pp.854.
- MEEK, S. E. 1904. The freshwater fishes of Mexico north of the Isthmus of Tehuantepec. Publ. Field Columbian Mus., (Zool.) 5:1-252.

PFLIEGER, W. L. 1971. A distributional study of Missouri fishes. Univ. Kansas Publ., Mus. Nat. Hist. 20(3):225-570.

RAFINESQUE, C. S. 1820. Ichthyologia Ohiensis or natural history of the fishes inhabiting the River Ohio and its tributary streams. W.G. Hunt, Lexington, Kentucky. pp.90. (Description of *Catostomus carpio* first appeared in Western Review and Miscellaneous Magazine vol. 2 (5):299-307, June 1820).

ROBISON, H. W. & T. M. BUCHANAN 1988. Fishes of Arkansas. Univ. Arkansas Press, Fayetteville. pp.536.

TRAUTMAN, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press, Columbus.

Table 1. Frequency distribution of dorsal fin rays in *Carpiodes carpio*.

	20	21	22	23	24	25	26	27	28	29	30	31	N	O	S.D.
Mississippi River, upper				3	7	4	1	2				1	18	24.83	1.76
Missouri River			2	7	15	12	4	1					41	24.29	1.10
Red River			9	20	42	46	25	6	3				151	24.58	1.30
Mississippi River, lower			4	38	58	54	32	12	1	1			200	24.58	1.26
Mississippi River, lower tributaries			12	42	83	47	21	1		1			208	24.18	1.17
Sabine River	1	9	26	27	21	9	4	1					98	23.08	1.36
Neches River		2	8	5	4	1							20	22.70	1.08
Trinity River		1	3	11	17	13	4						49	24.02	1.13
Brazos River			4	12	13	6	1						36	23.67	0.98
Colorado River			2	6	16	15	15	9	6	3	1	1	74	25.54	1.85
Rio Grande			17	54	39	15	3						128	23.48	0.95

Table 2. Frequency distribution of anal, caudal, and pelvic fin rays of *Carpiodes carpio*.

	Anal fin rays			Caudal fin rays				Left—right pelvic fin rays							
	6	7	8	16	17	18	19	8-7	8-8	8-9	9-8	9-9	9-10	10-9	10-10
Red River	1	150		6	94	1		1	5	7	115	7	6	10	
Lower Mississippi- River	10	189	1	2	10	186	2	1	4	8	4	155	9	3	16
Lower Mississippi River tributaries*	3	203	2	1	11	196			6	10	10	164	4	3	10
Rio Grande	2	101	2	3	101	1		5		2	71	7	10	9	

*one specimen with 7—9 pelvic rays

Table 3. Frequency distribution of left pectoral fin rays in lower Mississippi River Basin and Rio Grande populations of *Carpiodes carpio*

	Left pectoral fin rays						N	0	S.D.
	14	15	16	17	18				
Red River	2	28	85	32	4		151	16.07	0.74
Mississippi River, Lower	8	34	100	53	5		200	16.06	0.83
Mississippi River, lower tributaries	2	48	115	37	6		208	15.98	0.75
Rio Grande*	2	34	50	18			104	15.83	0.73

*one specimen with 12-13 pectoral fin rays

Table 4. Frequency distribution of lateral line scales in lower Mississippi River Basin and Rio Grande populations of *Carpiodes carpio*.

	Lateral line scales					N	0	S.D.
	33	34	35	36	37			
Red River		17	74	9		100	34.92	0.51
Mississippi River, lower		35	116	44	4	200	35.07	0.7
Mississippi River, lower tributaries		16	122	53	7	198	35.26	0.65
Rio Grande		4	51	63	9	127	35.61	0.67

Table 5. Proportional measurements in thousandths of standard length, mm for *Carpiodes carpio* from Rio Grande drainage.

	Males, N = 24			Females, N = 26		
	Range	\bar{X}	S.D.	Range	\bar{X}	S.D.
Standard length (mm)	205—289	240.1	24.00	195—282	244.1	22.13
Body depth	286—320	298	10.17	284—332	301	12.97
Body width	148—185	167	8.32	151—181	169	7.30
Head length	228—260	243	6.73	223—257	240	7.12
Head width	156—176	167	4.92	152—185	170	6.55
Head depth	176—202	189	6.75	152—198	187	6.49
Caudal peduncle length	122—190	146	12.55	132—160	148	9.08
Caudal peduncle depth	118—138	128	5.58	114—136	127	5.11
Snout length	74—90	81	4.10	71—88	80	4.92
Orbit length	43—55	49	3.58	40—55	49	3.44
Postorbital bony length	113—130	121	4.76	112—125	121	3.09
Dorsal fin base length	323—375	352	13.16	329—378	355	11.11
Dorsal fin height	225—266	246	11.96	220—267	245	13.11
Caudal fin length	298—346	319	13.45	294—353	320	16.30
Pectoral fin length	168—212	186	9.63	167—202	185	9.34
Pelvic fin length	182—215	195	8.11	165—211	193	10.72
Anal fin length	179—212	193	8.58	175—217	190	9.20
Dorsal origin to postorbit	355—399	376	11.06	366—407	380	8.94
Predorsal length	456—506	479	12.00	469—513	483	10.09
Postdorsal length	571—618	592	11.00	560—627	600	14.57
Prepelvic length	494—534	516	9.19	497—537	515	10.10
Distance between pectoral and pelvic insertion	265—303	286	11.63	263—301	286	8.94

Table 6. Proportional measurements in thousandths of standard length, mm for *Carpiodes carpio* from lower Mississippi River and Rio Grande.

	Mississippi River (N = 41)			Rio Grande (N = 50)			F	P
	Range	\bar{X}	S.D.	Range	\bar{X}	S.D.		
Standard length (mm)	191—292	212.8	18.40	195—289	242.2	22.90	—	—
Body depth	306—375	337	14.75	284—332	300	11.71	172.43	0.0001
Body width	155—198	174	11.08	148—185	168	7.78	9.80	0.0023
Head length	240—278	256	8.08	223—260	241	7.01	66.04	0.0001
Head width	160—187	172	6.07	152—185	169	5.90	4.43	0.038
Head depth	185—213	197	6.97	152—202	188	6.59	28.21	0.0001
Caudal peduncle length	126—165	141	9.02	122—190	147	10.83	15.22	0.0002
Caudal peduncle depth	121—141	130	5.05	114—138	127	5.30	6.47	0.013
Snout length	69—94	82	5.24	71—90	81	4.53	0.81	NS
Orbit length	47—61	54	3.40	40—55	49	3.47	50.51	0.0001
Postorbital bony length	122—150	132	6.14	112—130	121	3.94	97.87	0.0001
Dorsal fin base length	372—427	400	13.34	323—378	354	12.10	296.89	0.0001
Dorsal fin height	234—317	275	23.57	220—267	246	12.45	53.58	0.0001
Caudal fin length	289—379	327	22.79	294—353	319	14.86	3.36	0.07
Pectoral fin length	134—197	181	10.83	167—212	185	9.40	8.79	0.004
Pelvic fin length	176—226	200	11.19	165—215	194	9.55	4.32	0.041
Anal fin length	185—231	206	12.21	175—217	192	8.99	36.02	0.0001
Dorsal origin to postorbit	367—449	395	13.46	355—407	378	10.10	33.96	0.0001
Predorsal length	471—534	501	13.99	456—513	481	11.12	46.56	0.0001
Postdorsal length	572—637	597	13.96	560—627	596	13.42	0.55	NS
Prepelvic length	498—571	527	14.83	494—537	516	9.59	11.63	0.001
Pectoral to pelvic distance	248—306	286	12.68	263—303	286	9.81	0.97	NS

Table 7. Proportional measurements in *Carpiodes carpio*. Length of dorsal base divided into distance from dorsal fin insertion to rim of orbit

	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03
Missouri River											2	1	1			2	3	2
Red River				1				1		1				5		1		
Mississippi River	1		2			3			3	1	5	5	3	2	4	2	1	
Mississippi River tribs.		1	1			2	2	5	3	5	4	4	7	5	4	9	5	3
Sabine River								1	1			2	1	1	1	1		2
Trinity River					1					1		1	1	1	3	1	2	4
Brazos River						1					1		1	4	1	2	2	
Colorado River							1					2	1	1	4	5	3	2
Rio Grande														1	1	1	3	6

Table 7. Continued

	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	N	0	S.D.
Missouri River		1				1										14	1.01	0.03
Red River	4	1	3	1						1						19	1.02	0.05
Mississippi River	2		1	1			1									37	0.97	0.05
Mississippi River tribs.	4	2	1	1			1				1					70	0.99	0.05
Sabine River	2	2	1	3		1	1	1	1	1				1		24	1.04	0.06
Trinity River	4	1		1	2	1		3	1					1		30	1.04	0.06
Brazos River	2	2	1			2	1			1		1				23	1.02	0.06
Colorado River	1			1												21	1.00	0.03
Rio Grande	3	6	6	2	4	3	5	7	4	1	1				1	55	1.07	0.04