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Two new species of *Etheostoma* (Osteichthyes: Percidae) from Central Coahuila, Northern México

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Two new darters, *Etheostoma (Oligocephalus)*, are described from streams of the Chihuahuan Desert in central Coahuila, México. Both occur within or near the Bolsón de Cuatro Ciénegas, an intermontane basin with exceptionally high biotic diversity, reliction, and endemicity. *Etheostoma lugoi* is confined to the largely isolated western part of the basin, while *E. segrex* lives in headwaters of the Río Salado de los Nadadores that flows east from the basin as part of the Río Bravo del Norte (Rio Grande) system. Cranial osteology is used along with conventional darter characters to assist in placing the new species in context of related taxa. Ecology, conservation status, and biogeography are discussed.

Se describen dos especies percas nuevos del género *Etheostoma (Oligocephalus)* de arroyos del Desierto Chihuahuense en Coahuila, México. Ambas se distribuyen dentro o cerca de el Bolsón de Cuatro Ciénegas, una cuenca intermontana con una excepcional alta diversidad biótica, presencia de especies relictas, y endemismo. *Etheostoma lugoi* se confina a la parte aislada oeste de la cuenca mientras que *E. segrex* habita en ls cabaceras de Río Salado de los Nadadores, afluente del Río Bravo de Norte que fluye de la parte oriental de la cuenca. Se usó osteología de cráneo y caracteres convencionales de peces percas para determinar las relaciones de las especies nuevas con las especies afines. Se discute la ecología estatus de conservación y biogeografía de las especies aquí estudiadas.

Introduction

The Chihuahuan Desert of northern México includes extensive exposures of thick Cretaceous limestones in part characterized by the presence of subterranean solution channels, and active and inactive springs. Most rivers of the region, e.g., ríos San Juan, Salado, and some tributaries of Río Conchos, are fed by springs, some comparable in size and complexity to those issuing from the vast Edwards Limestone Aquifer of Texas, USA (Brune, 1975).

Both surface streams and underground waters in this region are under increasingly heavy exploitation by burgeoning human populations. Depletion of water resources is accelerating due to development for domestic, agricultural, and industrial uses, stimulated in part by the North American Free Trade Agreement of 1993. As a result, a strikingly endemic aquatic biota of the region, including numerous fishes along with molluscs, crustaceans, and other groups, is in a precipitous decline that may largely be irreversible (Contreras-B., 1978, 1987; Contreras-B. & Lo-

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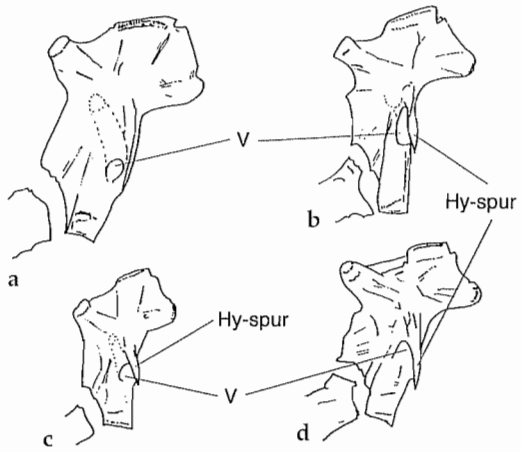

Fig. 1. Hyomandibular and partial metapterygoid (lateral view) from representative species of *Oligocephalus*: **a**, *Etheostoma caeruleum*, ASU 222, 49 mm SL; **b**, *E. grahami*, ASU 1021, 36.5 mm SL; **c**, *E. lugoi*, ASU 5995, 28.9 mm SL; **d**, *E. segrex*, ASU 5985, 37.2 mm SL. Hy-spur, hyomandibular spur; V, foramen for hyomandibular branch of fifth cranial (trigeminal) nerve.

zano-V, 1994; Contreras-B. et al., 1995). The two new darters described here occupy spring-fed waters within and associated with the Bolsón de Cuatro Ciénegas, central Coahuila, northern México, a small, intermontane basin lying generally south of the town of Cuatro Ciénegas de Carranza.

The subgenus *Oligocephalus* of *Etheostoma*, diagnosed or described by Bailey & Richards (1963), Page (1981a), and Bailey & Etnier (1988), embraces 20 or so species. It forms a cohesive unit of apparently related taxa based on shared characters, although remaining problematic as "clear evidence of diagnostic synapomorphies has not been presented" (Bailey & Etnier, 1988: 26). Further complications also exist. Our two new species lack some defining characters given for *Oligocephalus* in works cited above, i.e., breeding males (of both new species) are not highly colored (other *Oligocephalus* generally are) and lack a blue or green band in the anterior dorsal fin (present in other *Oligocephalus*); females exceed males in size (the opposite is the case in other *Oligocephalus*); and the supratemporal and infraorbital cephalic canals are always incomplete (complete in other *Oligocephalus*). However, their general pigmentation (notable is the triad of spots along the caudal-fin base) and general morphology (fusiform body, blunt snout) are nonetheless characteristic of the subgenus *Oligocephalus*, and we are satisfied to so assign them until a thorough phylogenetic evaluation should indicate otherwise. They are phenotypically closest to *E. grahami* (Girard, 1859), an unquestioned species of *Oligocephalus* (Page, 1983).

The few revisionary works on Mexican darters (e.g., Evermann & Kendall, 1894; Page, 1981a-b; Smith et al., 1984) include only three *Etheostoma* from México, *E. grahami*, *E. pottsi* (Girard, 1859), and *E. australe* Jordan, 1889, all *Oligocephalus*. These plus *E. lepidum* (Baird & Girard, 1889) of the Edwards Plateau (Nueces, Guadalupe, and Colorado Rivers, Texas) and several undescribed taxa currently confounded within the above, appear to form an interrelated complex within this subgenus. All (compared to other *Oligocephalus*) are relatively small in body size, all show either loss or substantial reduction of the basisphenoid bone, and most bear a distinctive bony spur on the posterolateral face of the hyomandibular (SMN, in prep.; see Fig. 1). Further, all are confined to arid and semi-arid lands in the Río Bravo del Norte (Rio Grande) basin and other drainages (ríos Nazas, Aguanaval, and uppermost Mezquital) historically associated with that vast, now-disrupted watershed (Smith & Miller, 1986). The two new darters, along with *E. grahami*, share a series of unique characters which may indicate a monophyletic assemblage within this complex (see below).

The two new darters are known only from within or in the vicinity of the Bolsón de Cuatro Ciénegas (Fig. 2), the biota of which is characterized by high levels of diversity and endemicity in a number of groups, including a rich ichthyofauna. A complex series of spring-fed aquatic habitats occurs in the southern and western section of the Bolsón de Cuatro Ciénegas. These form an isolated biogeographic unit distinct from an adjacent eastern part that enjoys a modern, natural (but now highly modified) surface connection to the Río Bravo del Norte (Rio Grande). Both faunas appear derived from one or more invasions by northern, temperate taxa (e.g., *Cyprinella*, *Pylodictis*, *Etheostoma*, *Lepomis*, *Micropterus*) and some from more southern or tropical regions (*Astyanax*, *Xiphophorus*, '*Cichlasoma*'), as well as by older faunal elements more generally distributed in México (*Dionda*, *Ictalurus*, *Cyprinodon*, *Lucania*, *Gambusia*). While critical taxonomic studies of some of the nearly 20 Cuatro Ciénegas fishes (including those of both biogeographic units;

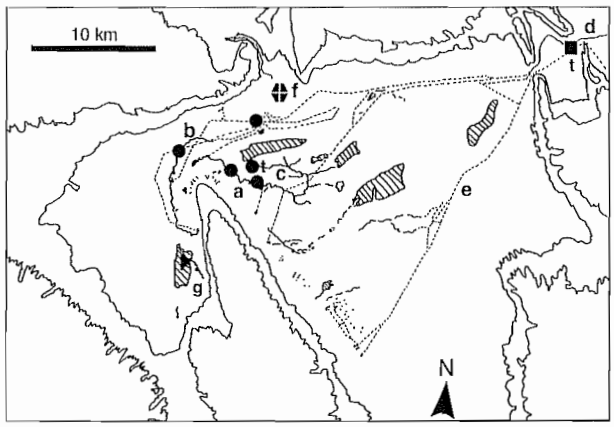

Fig. 2. Sketch map of the Bolsón de Cuatro Ciénegas with distributions of *Etheostoma lugoi* (dots) and *E. segrex* (square); contours = 800 and 1000 m; dashed lines = artifical canals; hatched areas = playas; **a**, Río Mesquites; **b**, Río Garabatal; **c**, Río Puente Chiquito; **d**, Río Salado de los Nadadores (in canyon exiting basin); **e**, Canal de Santa Tecla; **f**, town of Cuatro Ciénegas de Carranza; **g**, Río Churince system; **t**, type localities.

Table 1) remain incomplete or unpublished, many are known or suspected to represent differentiated species or subspecies (Minckley, 1969, et seq.). Similar circumstances exist for higher plants (Pinkava, 1984; 1997), molluscs (Taylor, 1966; Hershler, 1984; 1985), crustaceans (Cole, 1984), and others (see Minckley, 1978, et seq., and Marsh, 1984, for overviews and additional references).

Materials and Methods

Counts and measurements follow Hubbs and Lagler (1958) except for caudal peduncle length (posterior extremity of anal-fin base to ventral margin of caudal-fin base), pre-second dorsal-fin length (distance from tip of snout to base of first soft dorsal-fin ray), postorbital length (distance from posterior orbital margin to dorsal end of the gill slit) and vertical series (number of scales in a line counted from anal-fin origin to base of dorsal-fin base). Osteological observations were made on cleared-and-stained material prepared by methods of Taylor & Van Dyke (1985); vertebral counts are from radiographs. SMN (in prep.) provides evaluations of the osteology of southwestern darters, including more details on unique features of the two new species reported here. Institutional abbreviations follow Leviton et al. (1985), except IBUNAM-P used for the Instituto de Biologica, Universidad Nacional Autonoma de México.

Etheostoma lugoi, new species
perca (dardo, dardito) de toba, tufa darter
(Figs. 3-7)

Etheostoma sp. (in part): Miller, 1968: 6; Minckley, 1969: 44, 1978: 399, 1984: 14, 17; Deacon et al., 1979: 42; Williams et al., 1989: 12.

Etheostoma grahami (in part): Page, 1981a: 7, 1983: 144.

Holotype. UMMZ 233089, 35.4 mm SL, nuptial male; México: Coahuila: Río Puente Chiquito, 4.2 mi. (6.7 km) S Cuatro Ciénegas, 26°55'N 102°05'W; R. R. Miller, G. H. Miller, C. L. Hubbs & W. L. Minckley (WLM), 10 April 1961.

Paratypes. All from Coahuila, México: ASU 5128, 13 ex., 24.9-28.4 mm SL; same locale as holotype; WLM, A. A. Schoenher & S. E. Willoughby, 27 April 1970. – ASU 5928, 30 ex., 18.2-29.1 mm SL; Río Mesquites at Puente Orosco, 5.6 mi. (9.0 km) S Cuatro Ciénegas; WLM and party, 4 Sept. 1970. – ASU 5995, 30 ex. (3 cleared and stained), 19.9-35.4 mm SL; same locale as holotype; WLM and party, 4 Sept. 1970. – IBUNAM-P 8810 (ex-ASU 5995), 8 ex., 22.6-31.9 mm SL. – KU 4408, 1 ex., 24.7 mm SL; Río Mesquites at Puente Orosco, 5.6 mi. (9.0 km) S Cuatro Ciénegas; WLM, J. M. Legler & R. G. Wimmer, 11 Sept. 1958. – KU 7409, 1 ex., 31.5 mm SL; Julio's Canal (from Río Mesquites), 2.3 mi. (3.7 km) S Cuatro Ciénegas; WLM, 17 April 1963. – UANL 13718 (ex-ASU 5995),

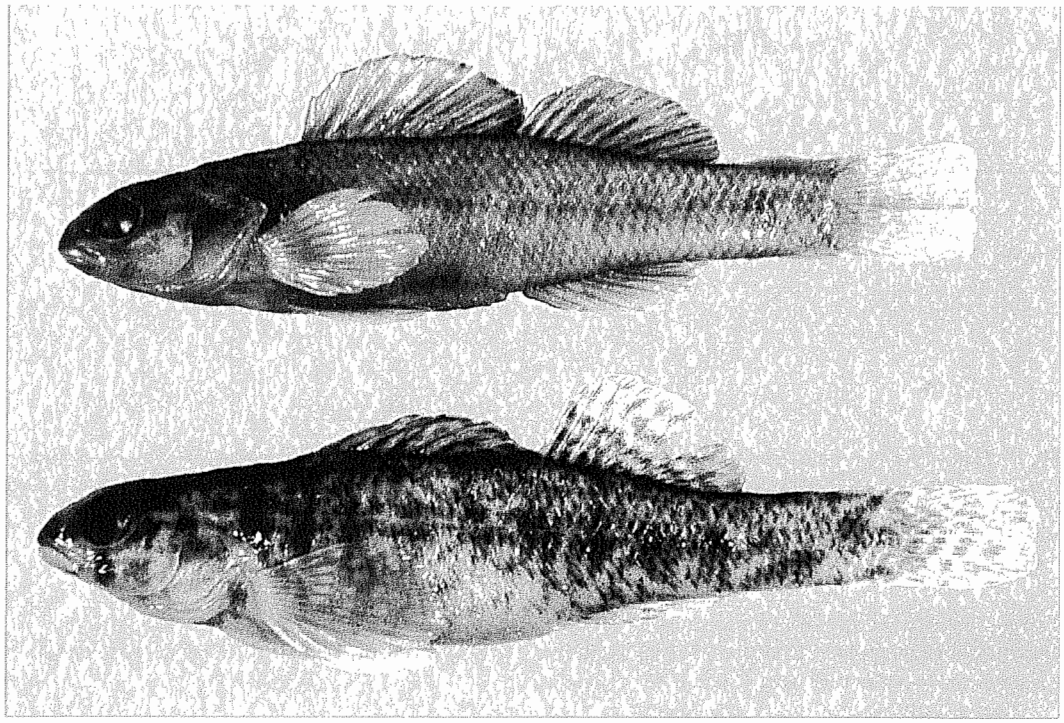

Fig. 3. *Etheostoma lugoi*, above, UMMZ 233089, holotype, nuptial male, 35.4 mm SL, and below, UMMZ 179875, paratype, mature female, 37.2 mm SL.

8 ex., 25.7-31.4 mm SL. – UMMZ 179179, 2 ex., 27.6-30.5 mm SL; same locale as holotype; J. E. Craddock, D. R. Tindall & WLM, 17 Aug. 1960. – UMMZ 197213, 5 ex, 19.5-31.0 mm SL; Río Mesquites at Puente Orosco, 5.6 mi. (9.0 km) S Cuatro Ciénegas; J. E. Craddock, D. R. Tindall & WLM, 21 Aug. 1960. – UMMZ 179862, 11 ex., 26.4-31.3 mm SL; Río Mesquites at Puente Orosco, 5.6 mi (9.0 km) S Cuatro Ciénegas; R. R. Miller, C. L. Hubbs, WLM, D. R. Tindall & J. Lugo-G., 8 April 1961. – UMMZ 179875, 15 ex., 11.8-37.5 mm SL; same locale and data as holotype. – UMMZ 198941, 2 ex., 33.4-34.7 mm SL; small (unnamed) tributary to Río Mesquites at Los Corallos 5.6 mi. (9.0 km) S, 1.8 mi. (2.9 km) W of Cuatro Ciénegas; G. R. Smith & P. Yant, 26 March 1975.

Diagnosis. *Etheostoma lugoi* is distinguishable from other southwestern *Oligocephalus* by its small adult size (to only 37.6 mm SL), and the presence of seven pairs of branchiostegal rays as opposed to six. Nuptial males of this species have a blue throat, something not noted in other southwestern *Oligocephalus*, and all individudals showed subdued body and fin markings compared to other southwestern *Oligocephalus*. An absence of bright or dark green coloration on the flanks distinguishes *E. lugoi* from *E. lepidum* and *E. australe* (the latter is novel in having a single anal-fin spine while the others have two). Meristic values for *E. lugoi* are nearest *E. grahami*, although along with *E. segrex* its body is more slender. *Etheostoma lugoi* compared to *E. segrex* (the species with which it can most easily be confused) is smaller in adult body size (maximum observed SL: 37.6 mm [female], 35.1 mm [male] vs. 43.8 mm [female], 41.1 mm [male]), has fewer pored scales in the lateral line (23-39, mean 29.6 vs. 33-42, mean 37.6), and more dorsal fin rays (modal values 10 vs. 9). The pectoral-fin base is scaleless in *E. lugoi*, while scaled in *E. segrex*.

Description. *Etheostoma lugoi* is small and slender-bodied, not known to exceed 38 mm SL (largest female 37.6 mm SL, mean 32.4, n = 16; largest male 35.1 mm, mean 31.6, n = 20). Meristic and

morphometric data are in Tables 2 and 3, respectively. The snout is moderately pointed from dorsal perspective, rounded in lateral view. The pectoral fins are large and rounded; the caudal fin is square. The vent just anterior to the anal-fin origin bears a small, triangular flap in males and a tubular genital papilla in females. Mature females are notably distended with ova. Branchiostegal membranes are broadly attached across the isthmus, and there are seven pairs of branchiostegal rays in all specimens examined. The premaxillary frenum is narrow. The infraorbital and supratemporal canals are incomplete, as is the lateral line which is slightly arched anteriorly. About a third of scales in the lateral series are without pores. The nape, breast, pectoral-fin bases, and prepelvic region all are naked. The operacle and venter are scaled; the cheek is either naked or infrequently bears a few embedded scales.

There is sexual dimorphism. In addition to sexual dichromatism (described below) morphometric differences also occur (see Table 3). Females are larger than males with deeper and wider bodies (especially when gravid) and longer preanal-fin lengths. Males have longer dorsal- (spinous and soft) and anal-fin bases, and longer or higher fins (excepting the caudal fin).

Coloration. Specimens in ethanol are light brown or tan; markings on body and fins (less clearly defined than seen in other southwestern *Oligocephalus*) are dark brown to black. Scales on the flanks and dorsum have darkened posterior borders. The flanks are further marked with 10-13

Table 1. Fishes of the Cuatro Ciénegas area, central Coahuila, México. General habitat preferences compiled from Minckley (1969, et seq.), Deacon and Minckley (1974), and original observations. Habitats: **1,** western Cuatro Ciénegas bolsón; **2,** eastern Cuatro Ciénegas bolsón; **3,** Río Salado de los Nadadores (Río Bravo del Norte); **4,** headsprings; **5,** creeks and rivers; **6,** marshes; **7,** manmade canals. Endemic (*) and differentiated but undescribed populations (**) marked with asterisks as indicated.

scientific and common names	habitats						
	1	2	3	4	5	6	7
Characidae (tetras)							
*Astyanax mexicanus***	×	×	×	×	×	–	×
Cyprinidae (minnows)							
*Cyprinella rutila***	–	–	×	–	×	–	×
*Cyprinella xanthicara**	×	×	–	×	×	–	–
Dionda sp.**	×	–	×	–	×	×	×
Catostomidae (suckers)							
Scartomyzon congestum	–	–	×	–	×	–	–
Ictaluridae (freshwater catfishes)							
Ictalurus sp. cf. *lupus***	×	×	×	×	×	–	×
Pylodictis olivaris	–	×	?	–	×	–	–
Cyprinodontidae (killi- and pupfishes)							
*Cyprinodon atrorus**	×	×	–	–	–	×	×
*Cyprinodon bifasciatus**	×	–	–	×	–	–	–
*Lucania interioris**	×	–	–	–	–	×	–
Poeciliidae (livebearers)							
*Gambusia longispinis**	×	–	–	–	–	×	–
*Gambusia marshi***	×	×	×	×	×	×	×
*Xiphophorus gordoni**	–	×	–	×	–	×	–
Cichlidae (cichlids)							
*'Cichlasoma' cyanoguttatum***	–	×	×	×	×	×	×
*'Cichlasoma' minckleyi**	×	×	–	×	×	×	×
Centrarchidae (sunfishes)							
*Lepomis megalotis***	×	×	×	×	×	–	–
*Micropterus salmoides***	×	×	×	×	×	×	×
Percidae (perches and darters)							
*Etheostoma lugoi**	×	–	–	–	×	–	–
*Etheostoma segrex**	–	–	×	–	×	–	–

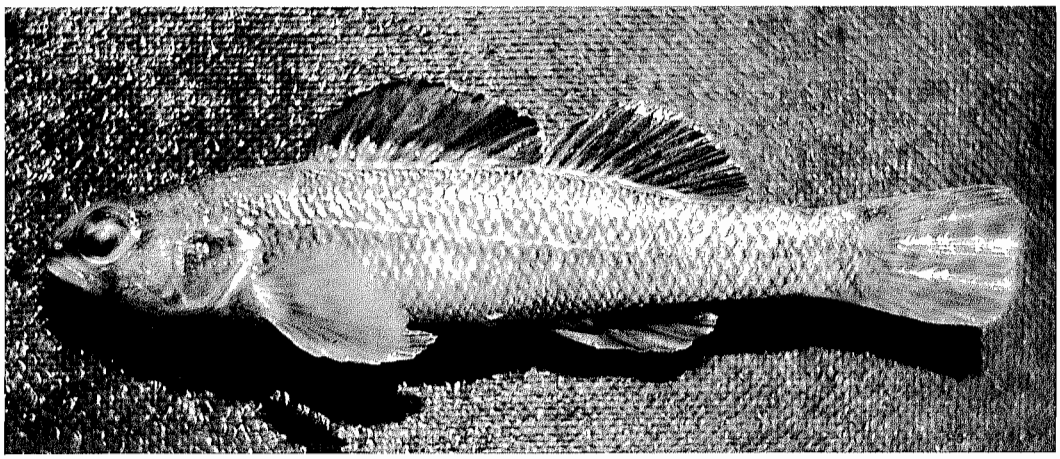

Fig. 4. *Etheostoma lugoi*, freshly preserved male in breeding color, April 1961, UMMZ 233089 or UMMZ 179875 (field photograph by R. R. Miller).

Fig. 5. *Etheostoma lugoi*, pair (male behind female), in situ, Río Mesquites at Puente Orosco, April 1994 (specimens not collected) (photograph by G. Grall).

blotches along the lateral midline, with corresponding darkened saddles passing over the dorsum. Midline blotches and saddles are sometimes linked by faint vertical bars. An elongate spot is evident anterior to the pectoral fin base in many specimens. All have a well developed black

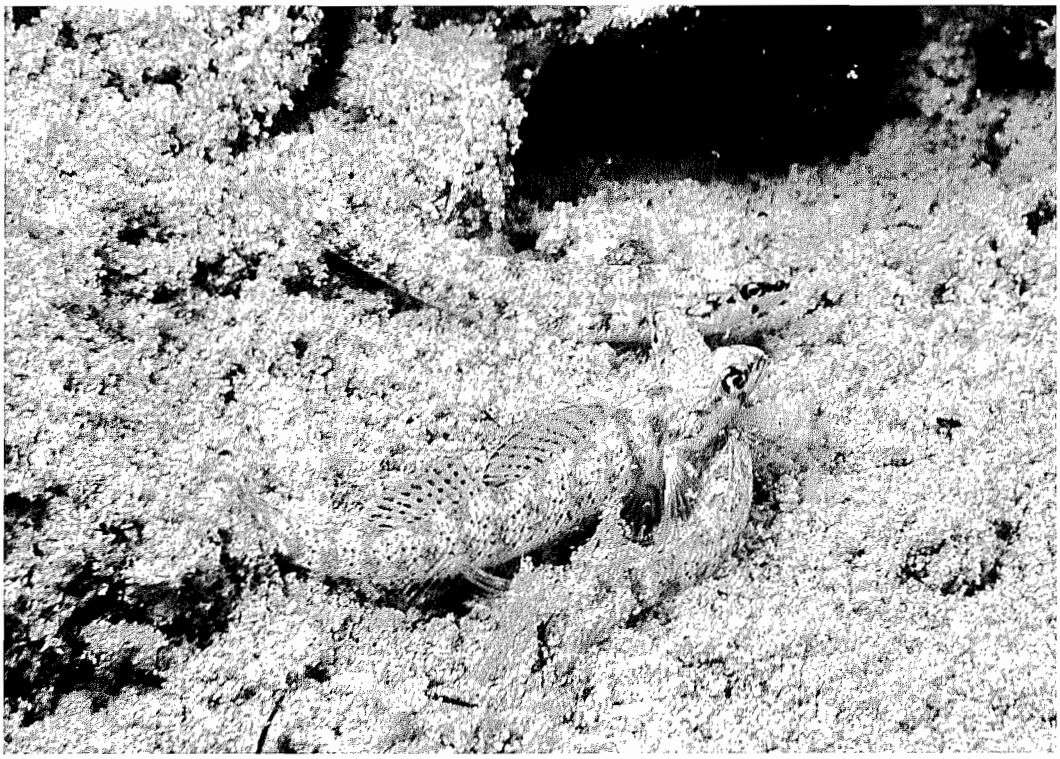

Fig. 6. *Etheostoma lugoi*, two males in agonistic interaction, female in background; note cryptic nature of pigmentation, in situ, Río Mesquites at Puente Orosco, April 1994 (specimens not collected) (photograph by G. Grall).

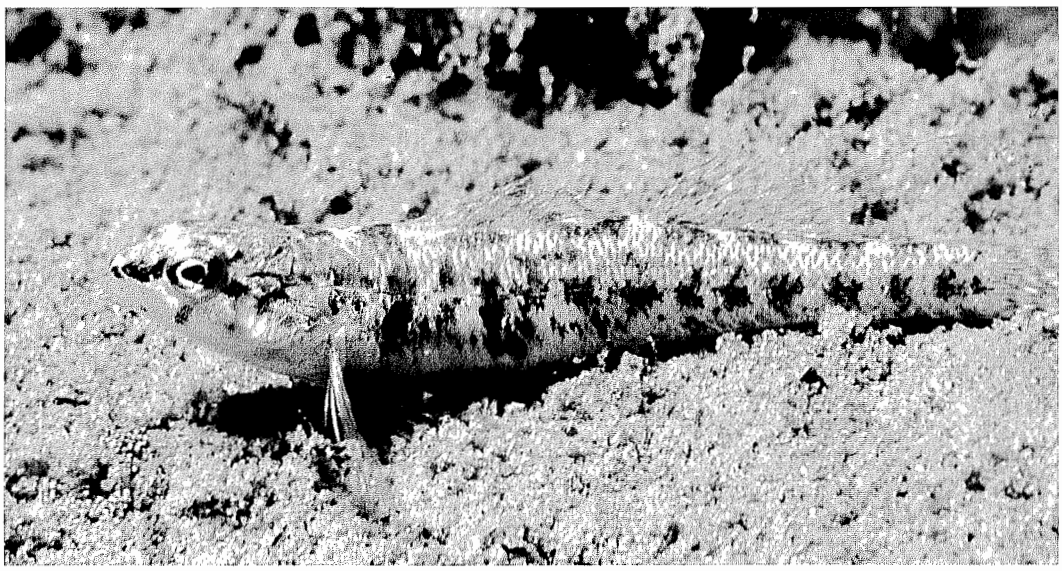

Fig. 7. *Etheostoma lugoi*, adult female, in situ, Río Mesquites at Puente Orosco, April 1994 (specimen not collected) (photograph by G. Grall).

humeral spot and suborbital tear-drop. A narrow bar, unconnected with its counterpart on the opposite side of the snout, extends anteriorly from the orbit to the snout tip; another such bar crosses under the mandibles. A faint stripe passes caudad from the posterior orbital margin for a

Table 2. Meristic data for members of the *Etheostoma grahami* group from the Rio Grande/Rio Bravo del Norte drainage. Numbers of specimens are in parentheses and data for holotypes are marked with an asterisk (*).

	dorsal-fin spines					dorsal-fin rays					anal-fin rays		
	8	9	10	11	12	8	9	10	11	12	6	7	8
E. lugoi (37)	1	12	23*	1	–	–	9	24*	4	–	18*	17	2
E. segrex (27)	1	13*	12	1	–	4	20*	3	–	–	14	13*	–
E. grahami													
Texas (28)	–	4	12	11	1	–	9	14	4	–	5	23	–
Salado (8)	–	2	5	1	–	–	1	3	4	–	1	7	–
San Juan (15)	–	5	7	3	–	–	1	2	8	4	2	9	4

	vertebrae										scales above lateral line			
	abdominal			caudal			total							
	14	15	16	20	21	22	35	36	37	38	3	4	5	6
E. lugoi (9)	–	1	8*	1	4	4*	–	1	5	3*	–	19	15*	–
E. segrex (15)	1	5*	9	8	6*	1	1	12*	2	–	–	7	17*	3
E. grahami														
Texas (28)	no data										–	12	15	1
Salado (8)	no data										–	–	3	5
San Juan (13)	no data										1	6	6	2

	scales below lateral line					scales in vertical series						scales around caudal peduncle					
	5	6	7	8	9	11	12	13	14	15	16	16	17	18	19	20	21
E. lugoi (34)	1	8	19	6*	–	–	15	11	4	4*	–	2	8	12*	8	4	–
E. segrex (27)	–	7	11	9*	–	–	4	5	10	8*	–	–	–	9	13	5*	–
E. grahami																	
Texas (28)	–	3	13	8	4	2	7	8	4	2	2	1	3	11	7	6	–
Salado (8)	–	–	3	4	1	–	–	1	3	4	–	–	–	3	1	3	1
San Juan (15)	–	4	11	–	–	1	4	10	–	–	–	1	2	4	6	2	–

	scales in lateral series																
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
E. lugoi (34)	–	–	1	–	–	1	2	4	5	5*	2	7	3	–	2	1	1
E. segrex (27)	–	–	–	–	–	–	–	–	2	–	10	4	5	2	1	2*	1
E. grahami																	
Texas (26)	–	–	2	–	–	2	–	2	1	4	1	4	5	2	1	1	1
Salado (8)	–	–	–	–	–	–	–	3	2	2	–	–	–	–	–	–	1
San Juan (15)	–	–	–	–	2	2	2	2	2	3	1	–	1	–	–	–	–

	pored scales in lateral series																		
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
E. lugoi (34)	1	–	1	5	2	3	5	5*	3	4	1	1	2	–	–	1	–	–	–	–
E. segrex (27)	–	–	–	–	–	–	–	–	–	–	1*	3	4	2	1	5	5	3	1	2
E. grahami																				
Texas (26)	–	–	1	3	1	–	3	–	–	7	1	–	3	1	3	2	1	–	–	–
Salado (8)	1	–	–	–	1	1	1	2	–	1	–	–	–	–	–	1	–	–	–	–
San Juan (15)	–	–	–	–	1	4	–	3	1	3	2	1	–	–	–	–	–	–	–	–

Table 3. Means ± standard deviation and limits for proportional measurements (in thousandths of SL) for members of the *Ethcostoma grahami* group from the Rio Grande/Rio Bravo del Norte drainage. Numbers of specimens are in parentheses; abbreviations: L, length; HT, holotype.

	E. lugoi			*E. segrex*			*E. grahami*					
							Texas		Rio Salado		Rio San Juan	
	HT	(20) males	(16) females	HT	(16) males	(11) females	(18) males	(10) females	(3) males	(5) females	(7) males	(6) females
SL (mm)	35.0	31.6±2.2 27.8-35.1	32.4±2.8 28.4-37.6	40.1	34.0±3.0 28.5-40.1	36.1±3.9 31.2-43.8	34.3±5.0 29.1-44.5	36.8±1.8 34.5-39.9	36.7±2.8 34.2-39.8	35.9±1.8 33.4-38.4	32.3±2.1 30.0-35.9	37.6±2.2 34.6-40.4
Head length	266	268±9.5 248-289	268±13.9 236-299	252	257±8.3 246-278	245±6.8 234-258	273±9.2 254-292	262±7.0 248-272	262±8.7 256-271	260±7.8 247-268	266±4.2 260-272	259±7.8 249-269
Snout length	68	69±4.8 60-80	65±5.1 57-74	62	64±3.4 57-70	60±4.6 54-68	66±4.8 58-77	66±3.2 63-73	68±9.2 58-76	65±4.1 60-71	70±3.4 65-73	63±3.9 59-70
Eye diameter	71	75±5.5 66-84	73±6.0 63-86	67	70±4.6 64-80	70±5.0 63-78	78±4.2 69-85	78±4.0 70-85	71±2.8 68-73	73±3.2 69-76	77±3.2 72-81	75±4.9 70-83
Postorbital length	120	128±7.9 115-146	117±7.0 105-126	132	126±8.7 110-143	118±6.7 103-127	121±13.4 100-129	111±10.6 102-127	117±15.4 100-129	115±11.4 102-127	128±10.0 118-143	110±6.5 99-119
Interorbital width	46	46±4.6 39-58	47±4.2 41-56	48	50±3.4 42-56	45±3.2 45-56	51±4.8 44-62	50±3.3 45-56	48±2.3 45-50	50±3.3 47-54	47±3.3 41-50	48±3.5 43-52
Body L before 1st dorsal fin	351	353±7.1 336-367	350±10.6 330-376	352	347±6.3 338-360	342±11.1 326-365	360±8.3 348-372	352±8.4 336-365	350±3.6 347-354	358±8.7 349-372	355±8.1 345-365	356±7.8 344-367
Body L before 2nd dorsal fin	609	618±15.3 594-648	617±15.3 593-644	626	613±9.9 596-627	621±5.7 605-627	634±11.2 618-654	631±6.3 623-641	630±1.5 629-632	639±9.8 628-653	625±10.9 613-640	638±16.1 613-653
Body L before anal fin	614	620±12.8 595-648	640±14.5 614-676	621	609±20.6 546-636	636±18.0 615-684	620±11.9 601-646	640±14.5 614-676	632±11.8 623-645	636±15.5 621-662	636±13.8 625-660	655±12.2 644-671
Body L before pelvic fin	311	322±13.2 293-345	319±8.3 303-338	314	308±11.4 291-330	310±10.3 292-329	313±10.5 288-328	320±12.1 302-345	316±12.5 302-325	306±14.0 290-323	304±6.0 295-313	317±8.6 305-328
Body L before pectoral fin	280	283±12.7 241-297	280±9.5 258-301	272	273±9.5 250-292	268±9.7 251-289	281±7.8 268-295	276±6.0 266-284	282±9.5 271-289	273±5.6 265-280	279±7.1 269-290	270±5.7 265-281
Body depth	200	207±12.4 183-231	211±9.3 195-225	214	209±7.6 193-224	207±11.3 179-219	221±9.0 205-238	223±11.2 200-239	208±5.6 202-213	230±9.3 218-242	219±4.8 211-225	215±10.6 199-226
Body width	120	119±9.9 101-138	131±7.9 114-149	107	118±5.2 107-126	128±11.3 112-144	130±6.9 115-144	144±11.7 125-162	121±6.0 116-128	153±9.7 141-165	125±6.9 114-133	136±5.7 127-141
Caudal peduncle length	260	248±17.3 215-279	247±16.4 215-268	239	247±11.8 223-266	234±14.7 212-260	243±16.2 218-289	244±12.7 226-268	231±5.4 224-234	235±18.7 209-256	223±11.1 208-235	219±11.1 199-231
Caudal peduncle depth	117	112±4.0 106-120	108±5.7 95-115	125	119±6.9 107-136	114±3.6 109-122	120±4.7 109-127	114±7.0 105-125	114±3.1 111-117	116±11.1 102-132	122±5.3 114-129	121±4.6 113-126
L base spinous dorsal fin	223	219±12.0 199-243	203±11.8 189-235	214	231±23.6 193-277	223±14.7 200-248	253±18.0 221-284	223±22.5 178-257	243±6.9 235-249	244±5.6 234-251	237±19.6 208-259	231±7.3 223-244
L base second dorsal fin	157	191±17.1 157-225	174±14.6 151-210	197	189±18.6 163-230	183±12.9 154-208	187±13.7 162-210	184±16.6 157-215	188±9.9 181-199	167±8.5 161-182	182±19.9 153-210	189±16.4 176-218
L base anal fin	123	139±11.5 119-162	119±13.2 96-144	125	144±13.8 125-178	132±12.3 118-153	138±14.6 117-160	126±8.5 116-141	153±16.7 136-169	118±13.6 105-138	152±11.6 137-169	122± 12.1 103-136
L caudal fin	177	190±11.2 174-211	191±10.0 166-209	190	196±10.6 178-212	195±9.0 179-208	197±13.8 175-227	183±9.1 164-193	202±10.6 193-213	200±6.0 193-208	201±11.4 181-213	182±11.7 161-196
L pectoral fin	249	249±12.7 224-276	235±15.6 200-258	219	235±14.4 207-264	228±14.5 193-249	236±18.3 207-269	215±24.1 164-241	233±9.6 224-243	226±8.9 212-234	237±21.5 203-269	219±13.2 205-243
L pelvic fin	211	206±8.2 195-227	193±12.5 172-215	195	211±12.3 195-243	202±16.0 178-242	206±10.8 184-228	187±16.8 163-217	195±6.0 191-202	184±4.8 180-192	217±18.0 198-248	193±12.8 183-218
L longest dorsal-fin spine	140	137±9.9 119-163	106±12.4 82-131	140	140±8.4 123-152	107±14.5 83-132	149±15.8 116-186	104±16.8 82-139	122±11.2 111-132	104±10.9 88-118	142±13.3 123-165	94±5.3 89-100
L longest dorsal-fin ray	146	145±8.7 129-161	137±16.3 109-163	147	153±9.0 139-169	140±11.0 117-158	161±16.0 130-188	145±10.7 127-165	160±9.1 151-169	159±3.8 55-164	147±5.7 140-156	149±13.9 136-166
L longest anal-fin spine	83	82±8.8 64-97	69±10.8 54-92	87	96±8.6 84-113	84±9.8 71-99	96.9±13.0 62-113	72±6.2 62-85	96±6.0 90-102	77±4.5 72-84	101±10.4 89-116	73±4.5 67-81
L longest anal-fin ray	109	143±24.2 109-218	121±12.6 97-149	105	134±12.0 105-150	125±14.5 96-149	134±17.3 106-178	120±17.5 88-151	141±18.0 121-155	137±12.1 125-157	139±16.7 118-160	121±8.2 110-131

variable distance along the posttemporal canal. Three dark spots mark the caudal-fin base, one at the midline and one each across its ventral and dorsal edges. The caudal fin has 4 to 5 ill-defined vertical bars, with pigment concentrated on the fin rays to produce a checkered appearance. In males, both dorsal fins, pelvic fins, and the anal fin are dusky, without well-formed bands. Females have 2 to 3 dark horizontal bands on both dorsal fins, unpigmented pelvic fins, and a single band on the anal fin. Juveniles examined (ca. 15 mm SL) have all fins unpigmented and about 13 dark blotches along the lateral midline, with a like number of dorsal saddles.

Life colors of breeding and non-breeding fish were compiled from field notes and color transparencies by Robert R. Miller (on file at UMMZ, M61-52 [UMMZ 179862] and M61-54 [UMMZ 2330892 and UMMZ 179875], April 1961), supplemented by color transparencies taken by George Grall (National Aquarium at Baltimore) at Río Mesquites, 9.0 km S Cuatro Ciénegas in April 1994 (Figs. 4-7). The first dorsal fin of males has diffuse (not blotched or banded) rusty-orange on the interradial membranes, intensified distally to produce a narrow, orange, distal margin. The interradial membranes are increasingly darkened proximally with concentrated olive-green pigment. The second dorsal fin has rust-orange blotches arranged on its interradial membranes in uneven longitudinal bands. Interradial membranes of the anal fin are deeply colored with similar but darker rusty-orange, sometimes to the distal margin. The pelvic fins are blackened on the outer rays and rusty-orange on inner rays. Although the Grall photographs appear to portray individuals engaged in courtship or breeding behavior, they do not show bicolored pelvic fins, as observed by WLM in more intensely colored individuals in the field and portrayed in the Miller photographs. The head and body are whitish in ground color, the breast and throat blue-gray, facial markings dark olive-green, and bars and saddles on the flanks are light olive-green. The flanks and venter have scattered, rusty-orange flecks about the same size as scales, arranged in unorganized, horizontal rows. Living females (Fig. 7) have no orange or blue. Saddles, bars, and fin and facial markings are darker olive-green than those of males.

Comparisons and relationships. Within southwestern *Oligocephalus*, *E. lugoi* belongs along with *E. grahami* and *E. segrex* to an assemblage we refer to as an "*E. grahami* group" (SMN, in prep). They share body sizes smaller than other *Oligocephalus* (including other southwestern species), ill-defined banding on the first dorsal fin, and an absence of dark green markings on the flanks and venter of males (refer to Kuehne & Barbour, 1983, and Page, 1983, for color illustrations and complete distributions of other species). There is variation in morphometry and merisitics among various disjunct populations of *E. grahami* (Tables 2-3); but small sample sizes for some areas preclude interpretation.

Distribution and habitat. *Etheostoma lugoi* is known only from the southwestern quarter of the Bolsón de Cuatro Ciénegas (Fig. 2), where it is restricted to Río Mesquites and its tributaries (Fig. 8), most notably Río Puente Chiquito. Outside the immediate Río Mesquites, localities include a single specimen (KU 7409) from an artificial canal leading from that stream (Minckley, 1969) and another from Río Garabatal to the west (UANL 6178; apparently now lost). Minckley (1978: fig. 1) collected several individuals (but preserved none) in 1969 from another site on Río Garabatal even further west of other localities. Most of that stream channel is presently ephemeral and fishless because of canals that intercept and divert flow from its spring sources (WLM, unpubl.).

This species most often occupies open (unvegetated) although complex bottoms comprised of gravel- to cobble-sized fragments of tufa and tufa stromatolites. Such substrate is formed largely by calcareous material accreting through physical and biological precipitation of calcium salts (Winsborough, 1990) as well as by transport of fragmented tufa from upstream that deposits to form armored bars where channels widen abruptly. Shoals created by these bars promote strong, low-turbulence currents so the substrate remains scoured of algae, silt, and detritus. Bottom relief is only of a few centimeters but the irregular, jagged nature of tufa produces a diversity of crevices and miniature caves for bottom-dwelling fishes as well as ample habitat for their invertebrate foods. The marked constancy of discharge in the bolsón's watercourses, with only a few centimeters vertical fluctuation in water level over three decades of observation (Minckley, 1992), allows the special habitat to persist.

Natural channels where *E. lugoi* has been

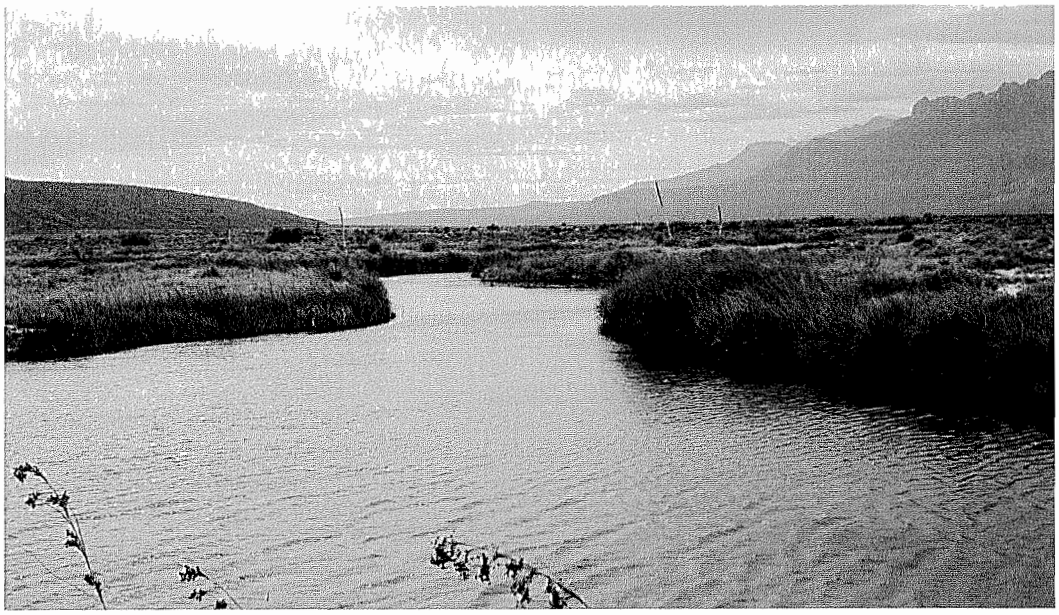

Fig. 8. Habitat of *Etheostoma lugoi*, Río Mesquites near Puente Orosco, upstream view, Coahuila, México, July 1992.

caught or observed with face mask and snorkel are from 1.5 to 15 m wide and 30 cm to 1.2 m deep with currents of 10 to 25 cm·s^{-1}. None has been recorded during extensive sampling and underwater observation in larger or smaller, shallower or deeper, or slower or swifter habitats, despite virtually hundreds of hours of effort. Springs and other spring-fed habitats of the basin have waters of crystalline clarity (for underwater photographs see Taylor, 1966; Grall, 1995). The darter is, however, remarkably cryptic and difficult to collect when on its preferred substrate and is usually not even seen unless specifically hunted. A notable capture of two fish (UMMZ 179179) was by artificial light and dipnet ~3.0 m inside the cave-spring stream origin of Río Puente Chiquito.

Although up to 10 species of fishes may be caught at a single sampling site in Río Mesquites (see Table 1; Minckley, 1984), only two are intimately associated with *E. lugoi*. Juvenile and rarely adult headwater catfish *(Ictalurus* sp. cf. *lupus)* forage over open bottoms at night, and small schools of Mexican tetra (*Astyanax mexicanus*) feed from bottom to surface in daytime, mostly on drifting materials. Tiny, darter-like young of Cuatro Ciénegas pupfish (*Cyprinodon bifasciatus*) occur uncommonly on tufa bottoms in summer. Flathead catfish (*Pylodictis olivaris*) are even rarer; only four individuals have been taken or seen in the basin by WLM in 38 years, all in Río Mesquites or Río Puente Chiquito.

Conservation status. *Etheostoma lugoi* seems nowhere abundant. In fact, all known specimens and record localities are listed here. Nonetheless, although critical surveys of distribution and status have not been made, collections and observations suggest it is widespread in the mainstem Río Mesquites. The darter is difficult to collect because of its spotty distribution and the heterogeneity of bottoms it inhabits. As noted before, however, individual fish are readily observed with facemask and snorkel; large samples have been secured either by laboriously capturing fish one by one or through specific and judicious use of ichthyocides.

Beyond habitat preference little is known of the natural history of *E. lugoi*. Its narrow ecologic and geographic distribution makes it clear that physical modifications of existing stream channels or even minor alterations of discharge or water quality would likely have adverse affects on this diminutive, endemic species. Conservation efforts now include designation of much of the Bolsón de Cuatro Ciénegas as a biological

preserve (Secretaría de Desarrollo Social, 1994), which may alleviate some potential threats. A disturbing recent development is the introduction of an alien cichlid, possibly *Hemichromis* sp. (nesting pairs and young seen, but no specimens yet secured for verification), to the Río Churince system. These were first observed by D. A. Hendrickson and M. Stephens (Univ. Texas, Austin, pers. comm.) in August 1996 and again by WLM and party in March 1997. Darters do not inhabit this isolated system, and thus are not immediately threatened by this alien species, however, other basin species may well be, and its spread to other systems may be difficult to prevent.

Etymology. The specific name *lugoi* is in remembrance of Sr. José ('Pepé') Lugo-Guajardo, a longtime resident of Cuatro Ciénegas, irrevocably dedicated to its conservation, and a sincere friend who assisted biologists and other researchers in the valley for almost 40 years (see Proceedings of the Desert Fishes Council, 26: 129-130, 1995). Pepé Lugo passed away in August 1996.

Remarks. The body cavities of specimens dissected for clearing and staining (ASU 5995) were heavily infested with infective larvae (cystacanths) of an acanthocephalan (Rhadinorhynchidae: *Leptorhynchoides thecatus* [Linton]). It is a common parasite in smaller freshwater fish species of diverse families from México into Canada, that achieves maturity in guts of a comparable diversity of larger fish species (Omar Amin, Arizona State University, pers. comm.). Several potential piscine piscivores occur with *E. lugoi* (see Table 1).

Etheostoma segrex, new species
perca (dardo, dardito) del Salado,
Río Salado darter
(Fig. 9)

Etheostoma sp. (in part): Miller, 1968: 6; Minckley, 1969: 44; Deacon et al., 1979: 42; Williams et al., 1989: 12.

Etheostoma grahami (in part): Page, 1981a: 7, 1983: 144.

Holotype. UMMZ 233090, nuptial male, 41.0 mm SL, México, Coahuila, Río Salado de los Nadadores at El Cariño de la Montaña, 27°0'N 101°48'W; R. R. Miller, C. L. Hubbs, WLM & D. R. Tindall, 5 April 1961.

Paratypes. All from Coahuila, México: ASU 918, 44 ex. (3 cleared and stained), 19.6-40.7 mm SL; Río Salado de los Nadadores at Celemania, 27°02'N 101°48'W; WLM and party, 6 June 1964. – ASU 1728, 3 ex., 22.0-33.5, same locale as holotype; WLM & W. E. Barber, 13 April 1965. – ASU 5985, 11 ex. (2 cleared and stained), same locale as holotype; W. L. Minckley and party, 1 Sept. 1970. – IBUNAM-P 8811 (ex-ASU 918), 15 ex., 26.5-37.7 mm SL. – TU 84762, 4 ex., 31.6-39.0 mm SL; Río Salado de los Nadadores, about 15 mi. (24 km) W Monclova, R. D. Suttkus and party, 19 May 1961. – TU 87573, 35 ex., 22.9-43.3 mm SL; Río Salado de los Nadadores, 9 mi. (14.4 km) W Nadadores, R. D. Suttkus and party, 5 April 1961. – UANL 2961, 5 ex., 22.1-30.2 mm SL, same locale as holotype; S. Contreras-B. and party, April 1977. – UANL 7315 1 ex., 36 mm SL, same locale as holotype; S. Contreras-B. and party, 1984. – UMMZ 179174, 8 ex., 28.8-34.4 mm SL; Río Salado de los Nadadores, 2 mi. (3.2 km) NE Sacramento along Hwy 30, 26°58'N 101°50'W; WLM, J. E. Craddock & D. R. Tindall, 16 Aug. 1960. – UMMZ 179815, 1 ex., 22.4 mm SL; Río Salado de los Nadadores at Celemania, 27°02'N 101°40'W; R. R. Miller, C. L. Hubbs & WLM, 5 April 1961. – UMMZ 179824, 42 ex., 21.9-44.0 mm SL, same locale and data as holotype.

Diagnosis. *Etheostoma segrex* lacks well-defined banding in the first dorsal fin and green flank pigmentation; these, and its relatively small size (not observed to exceed 44 mm SL) separate it from other southwestern *Oligocephalus* (e.g., *E. lepidum* and *E. australe*). Within *E. grahami* species group (delineated above), *E. segrex* is distinguishable from both *E. grahami* and *E. lugoi* by its smaller scales (e.g., pored lateral line scales, mean 37.6 in *E. segrex*, 29.6 in *E. lugoi* and 29.6, 30.4 and 32.2 for various populations of *E. grahami*; Table 2) and smaller number of dorsal rays (modal values 9 [*E. segrex*] vs. 10 [*E. lugoi*] and 10-11 [*E. grahami*]). *Etheostoma segrex* is unique among southwestern *Oligocephalus* (and other *Oligocephalus* examined) in having a small patch of scales at the pectoral-fin base. *Etheostoma segrex* is more slender and elongate than *E. grahami*, notably lacking the distinct dorsal swelling of the epaxial musculature just posterior to the occiput in the latter. Additionally, 4 of 6 skeletal preparations of *E. segrex* showed a unique bony splint on the prootic that splits the anterior opening of the trigemenofacialis chamber (Fig. 10). This splint is

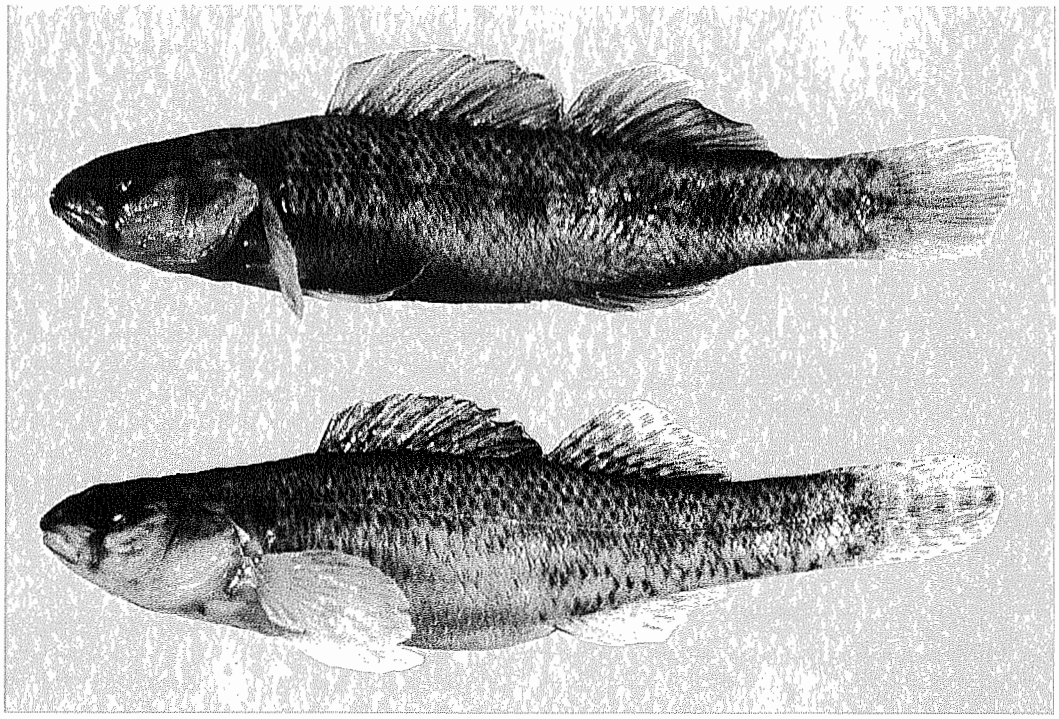

Fig. 9. *Etheostoma segrex*, above, UMMZ 233090, holotype, nuptial male, 41.0 mm SL, and below, UMMZ 179824, paratype, mature female, 39.7 mm SL.

found in scattered darter taxa (K. Shaw, Univ. Kansas, pers. comm.), although not in other southwestern *Oligocephalus* examined (SMN, in prep.)

Description. Similar to *E. lugoi* (see diagnoses for differences), although the prepelvic area is scaled; differences in coloration are noted below. This is another small darter, although slightly larger than *E. lugoi*, largest female 43.8 mm SL (mean 32.6, n = 42); largest male 41.1 mm SL (mean 31.6, n = 30). The holotype has a squamation irregularity on its right flank, likely the result of injury; scale counts on this specimen were made on the left side. Meristic and morphometric data are in Tables 2 and 3, respectively.

Coloration. Ethanol-preserved specimens of *E. segrex* are marked almost identically to *E. lugoi*; however, all pigmentation in *E. segrex* is darker and more clearly defined. Particularly notable are a distinctive spot on the base of the pectoral fin and dark margins of scales on the flank, the latter giving *E. segrex* an overall speckled appearance. Sometimes contradictory observations on life colors are incomplete or based on a male in less than maximal breeding condition. Brief field descriptions by R. R. Miller (notes on file at UMMZ, M61-43 [UMMZ 233090, UMMZ 179824], 5 April 1961) noted breeding males with bright orange pelvic fins and anal fin, breast a less conspicuous orange; pigmentation of the dorsal fins was not recorded. D. A. Hendrickson (pers. comm.) provided the following observations (Field No. DAH 96-08-06-01) of a single colorful male among 35 individuals observed and released near Celemania, Coahuila (27°02.48'N 101°42'W), 6 August 1996. Rust-orange blotches were scattered on the first dorsal fin and in vague longitudinal lines on the second. The orange pigment was on the interradials; blotches were more proximal than distal in position; orange pigmentation was less blotchy (more diffuse) distally on both fins, but there were no hints of distal, orange finmargins nor proximal, darkened interradials. The anal fin had rusty-orange interradial membranes, less intense distally. The pelvic fins had an orange leading ray, orange and black on the second ray, and medial parts black; orange pigment was on

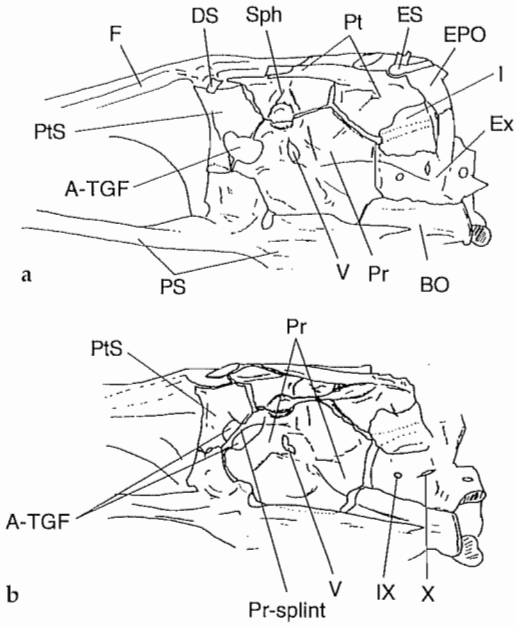

Fig. 10. Neurocranium (oblique ventral view) of: a, *Etheostoma grahami*, ASU 1021, 36.5 mm SL; b, *E. segrex*, ASU 595, 37.2 mm SL. A-TGF, anterior opening of trigeminal-fascialis chamber; BO, basioccipital; DS, dermosphenotic; EPO, epiotic; ES, extrascapular; Ex, exoccipital; F, frontal; I, intercalar; Pr, prootic; Pr-splint, prootic splint; Pt, pterotic; PS, parasphenoid; PtS, pterosphenoid; Sph, sphenotic; V, foramen for fifth cranial (trigeminal) nerve; IX, foramen for ninth cranial (glossopharyngeal) nerve; X, foramen for tenth cranial (vagus) nerve.

both rays and interradial membranes and black only on the interradials. The head and body were whitish, with blue-gray on the cheeks extending ventrally onto the branchiostegals. The breast was whitish and the sides and venter rusty orange.

Comparisons and relationships. As noted above, this species is a member of the *E. grahami* species group, resembling both *E. grahami* and *E. lugoi* in pigmentation and morphometry. Its relatively small size and slender body are closer to the latter. Scales on the pectoral-fin base have not been noted on other southwestern *Oligocephalus*, and the subdivided anterior opening to the trigemenofascialis chamber is likewise unique. The closest (downstream) population of any other darter examined was from the Río Sabinas at Cuidad Muzquiz (TU 87574). These specimens fall within our conception of *E. grahami* in their meristic values and morphometry.

Distribution and habitat. *Etheostoma segrex* has been collected only from the uppermost Río Salado de los Nadadores, a stream formed by outflow of the Bolsón de Cuatro Ciénegas. It is tributary to the Río Salado which in turn flows into the Río Bravo de Norte (Rio Grande) (Figs. 2, 11).

Habitats from which WLM has seined this species were invariably riffles 1.5 to 3 m wide and from 10 to 25 cm deep, of moderate turbulence over gravel and small cobble substrate. Fil-

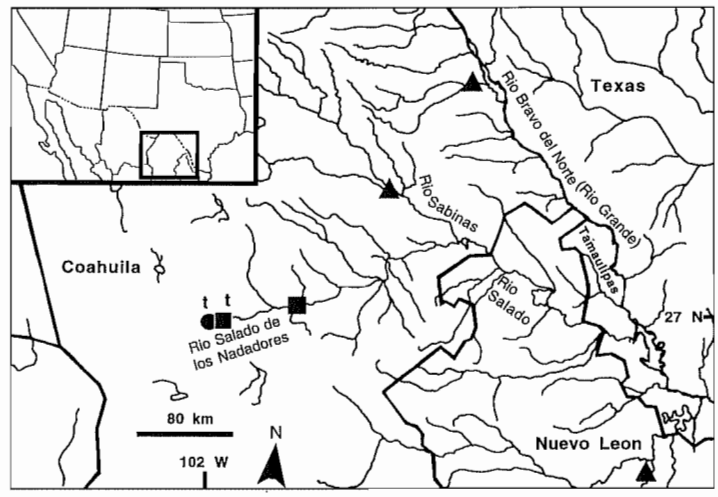

Fig. 11. Distributions of members of the *Etheostoma grahami* complex: *E. segrex* (squares); *E. lugoi* (circle); *E. grahami* (triangles). t, type localities.

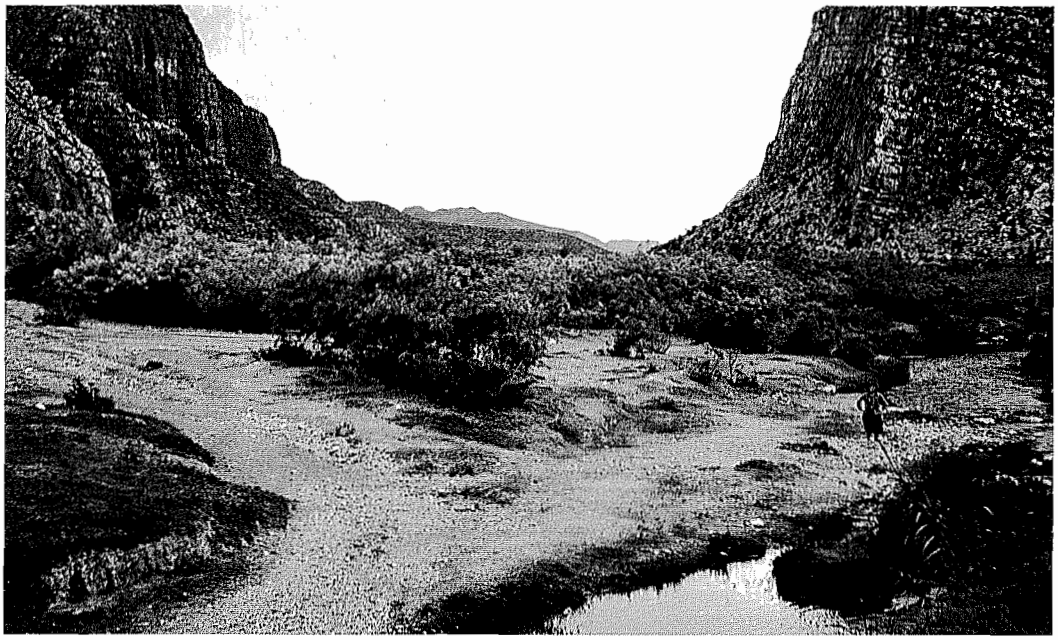

Fig. 12. Habitat of *Etheostoma segrex*, Río Salado de los Nadadores at El Cariño, upstream view, looking towards the Bolsón de Cuatro Ciénegas, Coahuila, México, 5 April 1961 (figure is F. H. Miller) (photograph by R. R. Miller).

iform higher plants *(Potamogeton, Zannichellia)* or the green alga *Cladophora glomerata* were often present, growing prostrate in currents estimated at 0.1-0.3 $m \cdot s^{-1}$. The darter seemed to concentrate in vegetated areas when present. A few were caught in eddying currents along vegetated (*Nasturtium, Justicia*) or cobble shorelines. None was found in deeper, soft-bottomed eddies or pools, nor in turbulent, 'whitewater' rapids.

Species caught in association with *E. segrex* included Río Salado shiner *(Cyprinella rutila)*, Mexican tetra *(Astyanax mexicanus)*, juvenile headwater catfish *(Ictalurus sp. cf. lupus)*, Rio Salado gambusia *(Gambusia marshi)*, and juvenile Rio Grande cichlid *('Cichlasoma' cyanoguttatum)*. The last two were most likely startled into the current from along quieter shorelines. Other associated fishes are listed in Table 1.

Conservation status. *Etheostoma segrex* has been relatively adundant at the few closely adjacent sites where it has been collected. Its conservation status is difficult to assess due to the lack of data regarding past, possibly wider, distribution and in light of little recent collecting in the vicinity. All verified specimens are from within or just downstream from the canyons leading from the basin in water flowing through an upland zone. Habitats immediately downstream of these canyons are substantially different, lowland, soft-bottomed streams. This darter would not be expected in such habitat, but the ichthyofauna of streams below the canyons remains poorly explored. WLM and party found it common on a single riffle at Celemania in winter 1989, and D. A. Hendrickson (pers. comm.) observed the species at or near that same site three times since 1991 (last in 1996).

Based on a revealing letter by Captain G. W. Hughs (in Traas, 1993), describing a military reconnaissance from Monclova, Coahuila, to Cuatro Ciénegas, Río Salado de los Nadadores was quite different in 1846. After leaving Monclova the column first came upon a large, hot-water well excavated for irrigation, with the surplus being lost "in ... swamps near Nadadores". Proceeding west they encountered "San Pedro Spring, the source of a large creek flowing in a northwesterly direction down the valley of the Sacramento, which we followed for about three miles". To our knowledge, neither the well nor San Pedro Spring and its creek exist today. Of Puerto del Sacramento, a pass leading ultimately to Cuatro Ciénegas (Fig. 2d), he wrote: "the road follows

up this gorge ..., through which flows a large and rapid stream, called the San Juan" (= Río Salado de los Nadadores). The last observation was made in the stream reach where most specimens of *E. segrex* have been collected (see above) and the creek today consists of a small, pool-riffle stream that is completely overgrown by common reeds *(Phragmites communis)* within the canyon itself.

Thus, a far better watered and extensive system existed in 1846 than today, but it had even then been subject to considerable development and modification. Significant darter habitat must have already been lost. Estimated base flow of Río Salado de los Nadadores (0.1-0.2 $m^3 \cdot s^{-1}$ in 1989-96, five observations) is no more than half the discharge present in 1958-70 and certainly not comparable to the "large and rapid stream" noted by Hughs. Both groundwater and surface drainages feeding the stream have suffered continuing alterations through diversion and canal construction, both here and within the Bolsón de Cuatro Ciénegas, and increasing amounts of groundwater are being extracted. Alterations of channels and water-use patterns occur periodically within canyons and the intervening wider places along the stream itself, as the area is populated by humans, grazed by livestock, and farmed. Assuming *E. segrex* occurs nowhere else in the Río Salado drainage, as with *E. lugoi*, future development of water resources will doom it to extinction.

Etymology. The name *segrex*, treated as a noun in apposition, is from the Latin, meaning separate or apart, and applied in allusion to the geographic segregation of this new Mexican darter from *E. lugoi* and other *Oligocephalus* of the region.

Remarks. Headwaters of the Río Salado de los Nadadores originate along the eastern margin of the Bolsón de Cuatro Ciénegas. Artificial diversions and canals have, however, obliterated much of the original path of the stream(s), the lower part of which probably paralleled the modern Canal de Santa Tecla and was presumably buried during its construction (Minckley 1969). Upper parts of the system are now overgrown by dense, woody vegetation. Biotas of Río Salado de los Nadadores and associated waters remain incompletely evaluated, although known to be far more typical of the Río Bravo del Norte (Rio Grande) basin than of the western Bolsón de Cuatro Ciénegas. Faunal differences between the two areas indicate long isolation. Despite the former now receiving water via artificial canals from the latter, few species appear as yet to have crossed from one part of this complex area to the other (Minckley, 1978).

Comparative material. *Etheostoma australe*: ASU 13628, UAIC 7910.05, UMMZ 211128, 211140. *E. caeruleum*: ASU 222. *E. grahami*: ASU 1021, 1046, 2807, 3620, TNHC 10157, TU 84777; 87574, UMMZ 162135, UAIC 9876.01, UANL 1861, 4439, 6494, 11606. *E. lepidum*: ASU 936, 1756, 4854, 13885, TNHC 1984, 6093, 6246, 7957, 17029, 21758, MSB 67, 5137, 5190. *E. pottsi*: ASU 9185, CAS 54384, 131947, FMNH 3527, UA 68-106. UMMZ 179656, 209849. *E. spectabile*: ASU 2138.

Key to Mexican *Etheostoma* (*Oligocephalus*)

1. - One anal spine; broad vertical dark bars on sides; branchiostegal membranes broadly connected across isthmus. ..... *E. australe*
   - Two anal spines; no broad vertical bars on sides; branchiostegal membranes separate or connected across isthmus. 2

2. - Opercle unscaled; branchiostegal membranes separate, not joined across isthmus; dorsal-fin spines usually 10-12. ..... *E. pottsi*
   - Opercle fully or partly scaled; branchiostegal membranes narrowly or broadly joined across isthmus; dorsal-fin spines usually 9 or 10. 3

3. - Branchiostegal rays 7; markings on body and head subdued. ..... *E. lugoi*
   - Branchiostegal rays 6; markings on body and head generally well-defined and dark. 4

4. - Pectoral fin bases scaleless; dorsal fin rays 10-11 (modal values); distinct swelling in hypaxial musculature just posterior to occiput. ..... *E. grahami*

- Pectoral fin bases scaled; dorsal fin rays 9 (modal value); dorsal profile relatively even, without pronounced swelling in hypaxial musculature posterior to occiput. ..... *E. segrex*

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