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Allotoca goslinei, A New Species of Goodeid Fish from Jalisco, Mexico

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***Allotoca goslinei* is a new goodeid fish from the Río Ameca basin of Jalisco, Mexico. It is diagnosed on the basis of coloration, karyotype, and numbers of fin rays, scales, vertebrae and sensory head pores. Derived characters show that it is a member of a group that includes *Allotoca* and three species formerly classified in *Neoophorus*.**

***Allotoca goslinei* es nuevo goodeido de la cuenca del Río Ameca de Jalisco, México. Está diagnosticado en base a la coloración, cariotipo, números de vertebras, escamas, rayos de las aletas, y los poros del canal sensorial cefálica. Carácteres derivados muestran que es miembro de un grupo que incluye a *Allotoca* y tres especies que antes estaban clasificados en el género *Neoophorus*.**

THE goodeid genera *Allotoca* and *Neoophorus* were diagnosed by Hubbs and Turner (1939) as monotypic segregates of *Zoogoneticus* Meek. As a result of collecting since their work, additional species have been assigned to both genera and a new species is described below. Additional forms that are probably referable to *Allotoca* have been collected in the Río Armería basin, Río Balsas basin and Lake Chapala, but they are as yet known from poor material and identification to species remains problematical.

Derived characters of the sensory head canals and embryonic trophotaeniae, discussed below, show that the described species of *Allotoca* and *Neoophorus* constitute a monophyletic group and that recognition of separate genera is unwarranted. We reclassify the species of *Neoophorus* in genus *Allotoca* which therefore comprises the type species *Allotoca dugesi* (Bean), *A. maculata* Smith and Miller, *A. diazi* (Meek), *A. catarinae* (deBuen), *A. meeki* (Alvarez) and *A. goslinei*, n. sp.

METHODS

Methods for most counts and measurements are those of Miller (1948). "Width at pectoral fin" is body width at the base of the uppermost pectoral ray. "Maxilla to orbit" is the shortest distance from the distal tip of the maxilla to the closest border of the orbit. Measurements of the dorsal and anal fins are depressed lengths. The hypural is included in the vertebral counts, taken from radiographs. The rudimentary anterior anal-fin ray is included in the ray counts, and the last two rays of the dorsal and anal fins are counted as a single ray. In the meristic data below, the number of specimens with each count is given in parentheses and the value for the holotype is indicated by boldface. For bilateral structures, the count for each member of the pair is reported. All material is catalogued in The University of Michigan Museum of Zoology (UMMZ) except as otherwise noted.

Allotoca ***goslinei*** n. sp.
Figs. 1–3

Banded *Allotoca*

Neoophorus sp. Uyeno et al., 1983:500, 504–5 (karyotype). Radda, 1985:35 (photo of live male from type loc., size range, karyotype, related to *Neoophorus diazi*, associate). Miller, 1986: Table 1 (Ameca basin). Miller and Smith, 1986:503 (Ameca basin).

Diagnosis.—A small, cone-toothed goodeid (max. SL ca. 50 mm) assigned to genus *Allotoca* with which it shares the following uniquely derived characters: divided preorbital and preopercular sensory canals and trophotaeniae in an elongated rosette. It is distinguished from other *Allotoca* by the presence of pores 2b–4a in the supraorbital canal system, by having many (12–18) narrow vertical bars along midside, and by having more numerous vertebrae (35–38 vs 31–35). It differs further from *A. dugesi* in having more anal-fin rays (modally 14 vs 11 or 12) and more diploid chromosomes (2N = 48 telocentrics and subtelocentrics vs 2N = 26 including 22 metacentrics); from *A. maculata* in having

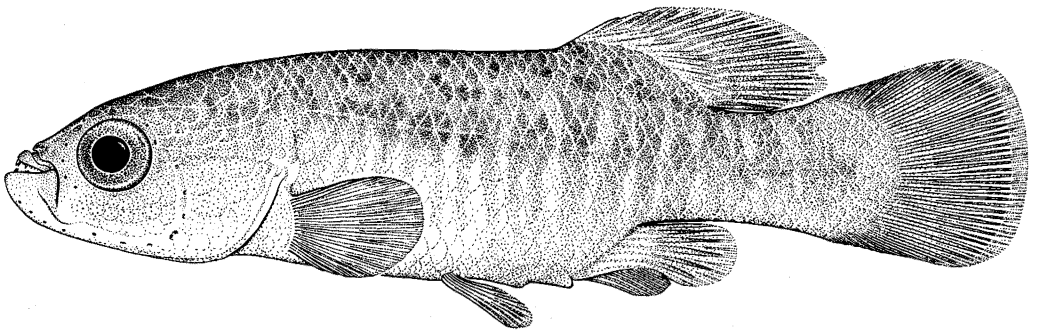

Fig. 1. Holotype of *Allotoca goslinei,* UMMZ 213450, adult male, 34.3 mm SL, Río Potrero Grande, Jalisco, Mexico. Drawing by S. V. Fink.

more dorsal-fin rays (modally 16 vs 13 or 14) and in having mandibular pores (4 vs 0); from *A. diazi, A. catarinae* and *A. meeki* in having fewer preopercular pores (modally 8 vs 10 or 11), fewer preorbital pores (modally 4 vs 5), no metacentric chromosomes, and a dark band on the male caudal fin.

Type material.—Holotype, 213450, mature male, 34.3 mm SL; Río Potrero Grande (trib. to Río Ameca), ca. 10 km W of town of Ameca on road to Atenguillo, Jalisco, Mexico; R. R. and F. H. Miller and D. I. Lyons, 23 Feb. 1976. Paratopotypes, 198851, 5 adults including male and females, 28.6–40.1 mm SL, and 213395, 16 newborn young, 9.3–12.1 mm TL, from female collected with holotype. Paratypes, 178345, 5 females, 21–50 mm SL, from type locality, 4 March 1957. 191678, 16 males and females, 23.1–37.5 mm SL, including 5 karyotyped specimens, and AMNH 55720, 4 males and females, 29.0–35.2 mm SL, from type locality, 14 Feb. 1971. 212324, mature male, 27.0 mm SL; Río Ameca ca. 1 km E of Estación Pacana at bridge crossing, Jalisco, Mexico; R. Vrijenhoek and M. Douglas, 20 Jan. 1981.

Description and comparisons.—The new species is known from early embryos, juveniles and adults. Most aspects of morphology resemble those of *A. maculata* and *A. dugesi* as described by Smith and Miller (1980). General body form and pigmentation are shown in Figure 1, and proportional measurements are given in Table 1.

Allotoca goslinei resembles other cone-toothed goodeids in the posterior position of the median fins. The dorsal fin originates well behind the pelvic-fin insertion and slightly in advance of the anal-fin origin. Posterior fin position is inferred to be primitive, because it also occurs in the sister group to the goodeids, *Empetrichthys* and *Crenichthys,* and in remotely related cyprinodontoids such as *Fundulus* and *Profundulus.* The

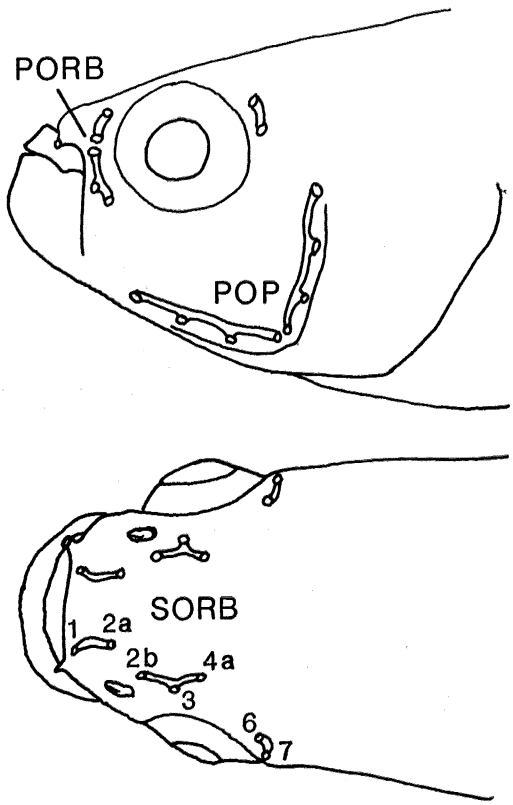

Fig. 2. Cephalic sensory pore system of *Allotoca goslinei.* Numbering for supraorbital canal is that of Gosline (1949). POP = preopercular; PORB = preorbital; SORB = supraorbital canals.

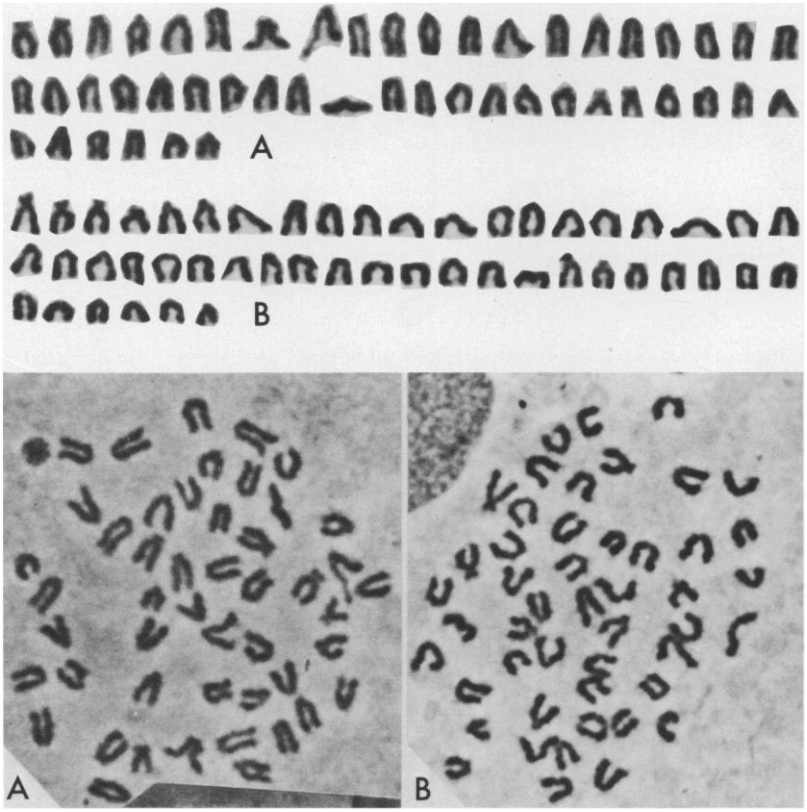

Fig. 3. Karyotype of *Allotoca goslinei*, 2N = 48, Río Potrero Grande (M71-5). (A) Male; (B) female.

predorsal length equals 65–68% SL in the nine known males, 68–73% SL in 12 females.

The new species differs from *A. dugesi* and *A. maculata* in number of vertebrae and rays in the dorsal and anal fins (Table 2), but shows comparable values for the following meristic characters: scales in lateral series 33(1), 34(3), 35(7), **36**(8), 37(6), 38(2); body circumference scales 34(1), 35(2), **36**(7), 37(4), 38(11), 39(2); scales around caudal peduncle 19(3), 20(13), **21**(8), 22(2), 23(1); principal caudal-fin rays 20(5), 21(2), **22**(16), 23(4); pectoral-fin rays 15(2), **16**(9), 17(33), 18(2); pelvic-fin rays 5(4), **6**(50). Gill rakers (total on first arch) 11(2), **12**(6), 13(14), 14(4), 15(1). The gill rakers are longer than those in *A. maculata*. Branchiostegals 4(4), 5(1).

The conic jaw teeth are arranged in an outer row of large teeth (16–20 in both upper and lower jaws) followed by a narrow band of smaller inner teeth. The teeth are firmly attached to the jaws, and the lower jaw is robust. Similar dentition occurs in other *Allotoca*, *Alloophorus* and *Zoogoneticus*, but the condition is probably primitive in goodeids because it also occurs in *Empetrichthys*. It has also been observed in the early ontogeny of *Characodon*, but adults develop bi- or tricuspid teeth in that genus (Smith and Miller, 1986).

The acoustico-lateralis system consists of a combination of pit organs, canals, and pores. As in other *Allotoca*, the preopercular canal is broken at the posterior angle (Fig. 2), a condition that is not observed in other cyprinodontoids and which is therefore inferred to be derived. The number of preopercular pores is 7(6), **8**(38), 9(2); these counts are similar to those of *A. maculata* (modally 7 or 8), but *A. dugesi*, *A. diazi*, *A. catarinae* and *A. meeki* each have modes of 10 (Fitzsimons, 1981). The number of preorbital pores is **4**(33), 5(11). The preorbital canal is divided (Fig. 2) in 7 of 22 adults; a divided canal is the modal condition in other *Allotoca*, but it is unknown in other goodeids and is therefore interpreted as a derived feature of *Allotoca*. The number of mandibular pores is 2(2), 3(2), **4**(36), 5(1). The supraorbital canal is interrupt-

TABLE 1. PROPORTIONAL MEASUREMENTS OF ADULTS OF *Allotoca goslinei* IN THOUSANDTHS OF STANDARD LENGTH. Based on UMMZ 191678, 198851, 212324 and 213450.

Character	9 Males			12 Females	
	Holotype	Range	Mean	Range	Mean
Standard length, mm	34.3	26.7–40.1	31.9	28.2–39.6	33.6
Predorsal length	656	646–682	658	685–727	700
Prepelvic length	519	500–537	514	506–543	519
Preanal length	668	644–678	663	642–682	654
Anal origin to caudal base	362	352–378	364	341–374	357
Dorsal origin to caudal base	359	359–400	380	317–363	342
Dorsal origin to anal origin	265	253–273	264	222–253	243
Width at pectoral fin	155	140–162	152	151–177	161
Head length	300	265–300	287	264–293	277
Interorbital width	114	100–114	106	96–116	106
Snout length	87	70–87	77	71–86	80
Orbit length	76	76–82	79	61–80	71
Maxilla to orbit	50	41–50	45	39–51	44
Mouth width	85	71–92	79	67–91	80
Mandible length	87	74–87	80	69–88	80
Dorsal-fin length	321	285–321	304	202–237	220
Anal-fin length	198	167–198	183	158–177	168
Caudal-fin length	195	185–202	195	181–212	198
Pectoral-fin length	160	159–174	166	148–165	158
Pelvic-fin length	114	89–115	104	80–101	92

ed and modally consists of a canal between pores 1–2a, 2b–4a, 6b–7.

The anterior rays of the male anal fin are modified to form a lobe that is associated with copulation (see Turner et al., 1962, for comparison to some other goodeids). Rays 1–7 and sometimes 8 are reduced in length, 54–64% as long as the longest unmodified ray. Ray 1 is a rudimentary nob. Rays 1–7 are not bifurcated. Rays 2–5 are more crowded than those that follow and are segmented throughout their length, but they are not recurved as in *Skiffia*, *Girardinichthys*, or the fossil genus *Tapatia*. Rays 6–7 are thickened basally and unsegmented proximally.

Trophotaeniae were examined in 16 new-born young, 9.3–12.1 mm TL, from a wild-caught female paratopotype, 213395, and in six embryos (4.2 mm TL) dissected from a wild-caught female, 191678. The trophotaeniae are unpigmented and are similar in size and shape to those of *A. maculata*. They consist of a rosette of lobate processes of the perianal lip. Four processes are prominent and form symmetrical an-

TABLE 2. FREQUENCY DISTRIBUTION OF CERTAIN MERISTIC CHARACTERS IN THREE SPECIES OF *Allotoca*.

	Dorsal-fin rays						Anal-fin rays				
	12	13	14	15	16	17	10	11	12	13	14
A. goslinei				2	17	7				6	21
A. dugesi			6	16	17	5		20	23	1	
A. maculata	6	23	21	2			2	12	27	10	1

	Vertebrae							
	31	32	33	34	35	36	37	38
A. goslinei					9	11	7	1
A. dugesi		4	21	11	1			
A. maculata	5	23	16	1				

terior and posterior pairs as in *A. dugesi*; an irregular number of minor processes arise laterally from the perianal lip as in *A. maculata.*

The karyotype was determined from gill epithelial cells of specimens collected at the type locality (UMMZ 191678). Chromosomes were counted in 63 metaphase spreads from one male and one female and no sexual dimorphism was detected. The modal count (57 spreads) was 2N = 48 chromosomes consisting of 42 telocentrics and six subtelocentrics (Fig. 3). The karyotype is similar to that of *A. maculata* which also has the primitive number of 48 chromosomes with no metacentrics (Smith and Miller, 1980). It is thereby distinguished from the karyotypes of *A. diazi, A. catarinae* and *A. meeki* which share a derived state of two large metacentrics, and from *A. dugesi* which has a derived karyotype with 22 large metacentrics (Uyeno et al., 1983).

Sexual dimorphism.—In addition to anal-fin modifications described above, the sexes of *A. goslinei* differ in the size and position of the dorsal fin. This fin is less posterior in males than in females, resulting in differences in predorsal length, dorsal-fin origin to caudal base, and dorsal-fin origin to anal-fin origin (Table 1). Pronounced dimorphism in fin position distinguishes the new species from other *Allotoca* and is interpreted as an autapomorphy. The dorsal fin is longer in males than in females, but there is no dimorphism in the number of rays as in *Characodon* and *Girardinichthys.* The sexes are also distinguished by coloration as described below.

Coloration.—In life this species has no bright colors. The male shows a dark, elongate spot at midside that lies above the posterior half of the pelvic fin. There may be one or two similar spots anteriorly. These marks are scarcely distinct from adjacent marks after preservation. Posterior to the single spot are about nine blotches and irregular vertical bars; anteriorly five or six additional markings become fainter toward the head (Fig. 1). An intensification of pigment occurs on the distal parts of the bifurcate anal rays. The female in life typically shows three dark spots on the midside, one in the same position as in the male and two positioned anteriorly; the most anterior one lies well in front of the pelvic-fin insertion. The adult female also has a black spot at the anal-fin origin and a smaller one on each side of the vent.

In alcohol, both sexes are brownish. In the mature male there is an intensification of melanophores near the tips of the caudal-fin rays, with the outer fifth to seventh of this fin essentially clear of pigment, producing a pale margin. The female has no pale border on any fins. There may be a narrow crescent, bar or triangular wedge of dark pigment at the caudal-fin base in females; in males it is usually absent or only faintly developed. Irregular but prominent dark spots occur at or near the dorsal-fin base in both sexes.

Adults have a maximum of 18 irregular lateral bars along the midside. Their ventral extensions, usually bifurcate (forming a pattern similar to mammalian tooth roots), fall short of the base of the caudal peduncle or barely reach it (Fig. 1). It is these numerous lateral bands in both sexes that is reflected in the common name of the species, since none of its relatives has as many.

Juveniles possess a mottled or blotched midlateral pattern with a few small spots along the ventral surface of the caudal peduncle.

Habitat and associates.—At the type locality, Río Potero Grande flows through a steep-walled, twisting canyon of high gradient that is well shaded by willows and the canyon walls. The new species was taken only from a quiet pool of clear to murky water that was about 23 m long and 3.2–3.8 m wide, up to 1.2 m deep at the steeply shelving south bank and with a substrate of sand, silt, rocks and boulders. Filamentous algae were abundant, and there were small patches of floating vascular plants. In the dry season the current was slight to nil. This was the terminal pool before the creek emerged from the canyon and dropped precipitously to the Río Ameca.

Allotoca goslinei was found primarily in shallow water (15–26 cm) underneath floating plants (water hyacinth, algae, and a nasturtium-like plant) along the gradually sloping north side of the pool. The largest series came from beneath a single patch of floating plants about 3 m long and extending no more than 1 m into the pool. Water temperatures during three visits were 16.4–20 C from mid-day to late afternoon, mid-Feb. to early March.

Other fishes taken in the same pool were a catostomid, *Moxostoma mascotae,* a goodeid, *Allodontichthys* n. sp., and a poeciliid, *Poecliopsis infans. Rana* sp. was also captured, including tadpoles and adults.

Relationships.—Regan (1906–08) defined a subgroup of the Goodeidae (which he treated as genus *Zoogoneticus*) sharing a robust lower jaw set with conic teeth in the outer row followed by an inner row of smaller teeth. On the basis of these traits, the group can be readily diagnosed from other goodeids, but the characters are probably primitively shared and therefore neither indicate nor preclude close relationships. Hubbs and Turner (1939:48) recognized that *Zoogoneticus* was defined by "retention of the primitively strong jaws and conic teeth," but rather than propose alternative relationships, they segregated the species into four monotypic genera as follows: *Zoogoneticus quitzeoensis* (Bean), *Alloophorus robustus* (Bean), *N. diazi* (Meek), and *Allotoca dugesi* (Bean). The names *Neoophorus* and *Allotoca* had been used by Turner (1937) prior to the diagnosis of the genera by Hubbs and Turner (1939).

Hubbs and Turner (1939) distinguished *Allotoca* and *Neoophorus* on the basis of the trophotaeniae which they characterized as a rosette of irregular lobate processes in *A. diazi* (the type species of *Neoophorus*) and as two symmetrical pairs of processes with minor branches scarcely developed in *A. dugesi* (Turner, 1937: Pl. I). Additional material of *A. diazi* (UMMZ 198831) shows, however, that paired processes are predominant; as in *A. dugesi*, the rosette is elongated anteroposteriorly and the main branches form a distinct anterior and posterior pair. Similar trophotaeniae occur in *A. meeki*, *A. catarinae*, *A. maculata* and *A. goslinei*, and these species are thereby distinguished from other goodeids including the cone-toothed species *Z. quitzeoensis* and *Alloophorus robustus*. On the basis of trophotaeniae, we find no reason to separate *Allotoca* and *Neoophorus* and conclude that the presence of anteroposteriorly elongated rosettes is a shared derived character uniting the group.

The species of *Allotoca* are further characterized by the derived nature of their sensory head canals. In most goodeids and in outgroups such as *Fundulus* and *Profundulus*, the adult supraorbital canal is developed between pores 1–2a, 2b–4a, 4b–7 (Gosline, 1949). In adults of *Allotoca*, a section of the canal fails to develop (Fitzsimons, 1981). The deleted section is short (pores 4b–6a) in *A. goslinei*. Longer sections are deleted in *A. diazi*, *A. catarinae* and *A. meeki* (modally 3b–6a) and in *A. maculata* and *A. dugesi* (modally 2b–6a). The monophyly of *Allotoca* is also indicated by a break in the preopercular canal at the angle of the preopercular bone (Fig. 2); this character has not been observed among outgroups.

Etymology.—We name this species for William A. Gosline in appreciation for his basic work on sensory canals in cyprinodontoid fishes.

Acknowledgments

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Geographic Variation in *Cyprinella lutrensis* (Pisces: Cyprinidae) in the United States, with Notes on *Cyprinella lepida*

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***Cyprinella lutrensis*, red shiner, as presently defined includes a widespread complex of variable forms in the United States and Mexico. Contreras-B. (1975) summarized variation and systematics of this complex in Mexico; this study uses univariate and multivariate methods to analyze variation in *C. lutrensis* throughout its native range in the United States and to compare *C. lutrensis* to the problematic *C. lepida*. Meristics exhibit clinal increases from Illinois west and south in the Great Plains, but are low in Gulf coastal populations. Mantel analyses and spatial autocorrelations show that meristics vary regionally and meristic similarities are more distinct across direct geographic distances than by stream connectivity distances. Individuals from Great Plains drainages are larger than those of Gulf coastal drainages and have deeper bodies, but much variation in morphometrics was evident at a local level. However, mean sheared principal components scores, which describe shape of body parts (excluding standard length) independent of overall size effects, showed no significant non-random patterns. Morphometrics were uncorrelated with latitude or longitude, upland vs lowland stream characteristics, or stream size; they were correlated with flow regimes of collecting localities. Three populations with unusual yellow coloration are described from Kansas-Missouri, and nuptial colors of *C. lepida* of the Nueces and Frio rivers, Texas, are described in detail.**

Overall results of meristics, morphometrics, and nuptial coloration suggest that the putative subspecies *C. lutrensis suavis* is likely valid, and that an Illinois-upper Mississippi river drainage form might represent *C. l. forbesi*, but more detailed study of these taxa is needed. *Cyprinella l. blairi* may no longer exist. *Cyprinella lepida* of the Nueces and Frio rivers is highly distinctive in nuptial coloration and morphology, and warrants recognition as a species.

SINCE its original description (Baird and Girard, 1853), 25 junior synonymns have been applied to *Cyprinella lutrensis* (Gilbert, 1978), reflecting the variability of this species complex (C. L. Hubbs and Ortenburger, 1929; Gibbs, 1957; C. Hubbs, 1977). Much of the variation in the *lutrensis* complex is in Mexico (Contreras-B., 1975, 1977), but 18 junior synonyms have been applied in the United States (Gilbert, 1978). Much early confusion was from the incomplete materials available; as the complex became better known, it was merged into the single taxon

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