7 July 1983

PROC. BIOL. SOC. WASH.
96(2), 1983, pp. 253–269

A NEW SPECIES OF POLYMORPHIC FISH, *CICHLASOMA MINCKLEYI*, FROM CUATRO CIÉNEGAS, MEXICO (TELEOSTEI: CICHLIDAE)

Irv Kornfield and Jeffrey N. Taylor

Abstract.—*Cichlasoma minckleyi* is described from the Cuatro Ciénegas basin, Coahuila, Mexico. Discrete morphological variants occurring sympatrically within this taxon incorporate differences normally separating distinct congeners. Variation is partitioned into two non-overlapping body forms (deep-bodied and slender-bodied) within which occur two distinct pharyngeal morphs (papilliform and molariform), each maintained at high frequencies in natural populations. Field observations of matings both between morphs and between forms have established conspecificity of morphological variants. The dichotomous intraspecific variation presented by *C. minckleyi* suggests that phenetic characterization alone may be insufficient to delineate biological species within some members of the Cichlidae.

An unusual neotropical cichlid has received considerable attention from evolutionary biologists because of discrete, pronounced morphological and trophic variation. The specific status of this fish had been unresolved because the magnitude of morphological variation suggested the existence of at least three closely related taxa (LaBounty 1974), while biochemical analysis strongly supported the existence of a single polymorphic species (Sage and Selander 1975). Recent field studies (Kornfield *et al.* 1982) have confirmed the biochemical analyses and established conspecificity among morphological variants. Described here is *Cichlasoma minckleyi*, a new species of polymorphic cichlid endemic to the Cuatro Ciénegas basin, Coahuila, Mexico.

Methods

Standard counts and measurements were recorded following the procedures of Taylor and Miller (1980). Measurements and qualitative shape descriptions of pharyngeal jaws were taken from Barel *et al.* (1977) with the following additions: mid-pharyngeal jaw width (MPW) is the distance between the margins of the dentigerous area of the lower pharyngeal jaw at the midpoint of lower pharyngeal length parallel to the line of measured lower pharyngeal width; pharyngeal jaw horn width (PHW) is the maximum distance across one horn (ramus) of the lower pharyngeal jaw. Head width (HW) is the maximum distance between opercula measured over the body (with no caliper compression) at the central, fullest portion of the operculum.

Specimens are deposited in the Museum of Zoology, the University of Michigan (UMMZ) and the National Museum of Natural History, Washington, D.C. (USNM).

Cichlasoma minckleyi, new species
Figs. 1–9, Tables 1–3

Cichlasoma cf. *cyanoguttatum* Hubbs and Miller, 1965:52.

Cichlasoma sp. Taylor and Minckley, 1966:19–21 (including radiographs of trophic morphs).—Taylor, 1966:161–162, pl. 8, fig. 2; pl. 9, figs. 1–2.—Miller, 1968: 6.—Minckley, 1969:44–45.—Kornfield and Koehn, 1975:427–437.—Sage and Selander, 1975:4669–4673.—Hoogerhoud and Barel, 1978:52–56.—Hutchinson, 1978:180–181, fig. 113.—Kornfield, 1978:336.—Minckley, 1978:394–397, 399–401.—Vermeij and Covich, 1978:836–837.—Deacon *et al.*, 1979:42.—Liem, 1979: 121.—Thompson, 1979:680–681, fig. 9e.—Graves and Rosenblatt, 1980:243.—Turner and Grosse, 1980:259,269.—Jimenez *et al.*, 1981:409–411.—Kornfield *et al.*, 1982:658–664.

Parapetenia sp. LaBounty, 1974:5, 46, 54–64, 73, 99, figs. 7–9, 11, 15, 23, 25, 33, 34, tables 1, 3, 5–8.

Cichlasoma minckleyi Kornfield, 1981:96–97 (nomen nudum).

Diagnosis.—A polymorphic species endemic to the Cuatro Ciénegas basin in Coahuila, Mexico, placed tentatively in the *Parapetenia* group (Regan 1906–08) and distinguished from other members of the group by the sympatric occurrence of individuals of two discretely-variant body forms (deep-bodied and slender-bodied) within each of which two distinct pharyngeal morphs (papilliform and molariform) are represented. In addition, there are typically XVI, 10–11 dorsal ray elements, V, 8–9 anal fin elements, 14 pectoral fin rays, 11–12 gill rakers, and 29 vertebrae. The caudal peduncle is relatively slender with the length equal to or (usually) greater than the least depth. Sexual dichromatism, as developed in breeding adults, is uniquely diagnostic for this species: males are dark-green to black with the body and fins peppered with pale bluish spots, while females are snowy-white with distinctly contrasting black markings along the flank.

Holotype.—UMMZ 209434, 93.4 mm SL male, deep-bodied form, papilliform morph, Posos de la Becerra, 15.7 km by road SSW of Cuatro Ciénegas de Carranza, Coahuila, Mexico, R. R. Miller and family, C. L. Hubbs, W. L. Minckley, D. R. Tindall, and J. E. Craddock, 6 Apr 1961.

Paratypes.—(all from Coahuila, Mexico): UMMZ 130385 (9), 20–54 mm, and UMMZ 130395 (19), 18–70 mm, Cuatro Ciénegas, E. G. Marsh, Jr., 18 Sept 1939; UMMZ 179180 (2), 69 and 84 mm, Escobeda, hot spring 10.1 km S of Cuatro Ciénegas, W. L. Minckley and J. E. Craddock, 17 Aug 1960; UMMZ 179184 (1), 28 mm, irrigation ditch (La Angostura) from El Garabatal River, 2.6 km S of Cuatro Ciénegas, Minckley and Craddock, 18 Aug 1960; UMMZ 179194 (148), 14–34 mm, ditch (La Angostura canal) from El Garabatal, 6.6 km WSW of Cuatro Ciénegas, Minckley, Craddock, and others, 19 Aug 1960; UMMZ 179200 (9), 14–74 mm, Laguna San Marcos at San Marcos, 24.2 km by road SSW of Cuatro Ciénegas, Minckley, Craddock, and others, 20 Aug 1960; UMMZ 179216 (5), 9–144 mm, Rio Mesquites, 9.0 km S of Cuatro Ciénegas, Minckley, Craddock, and others, 21–22 Aug 1960; UMMZ 179224 (12), 15–31 mm, Altamira (6.4 km ENE of El Candido), 16 km S and 4.8 km E of Cuatro Ciénegas, Minckley and Craddock, 23 Aug 1960; UMMZ 179832 and USNM 229347 (155), 25–135 mm, collected with holotype; UMMZ 179838 (25), 28–114 mm, Puente Colorado, 10.2 km S of Cuatro Ciénegas, Miller, Hubbs, Minckley, and Tindall, 6 Apr 1961;

Table 1.—Measurements of *Cichlasoma minckleyi* in thousandths of the standard length (holotype UMMZ 209434; others from UMMZ 179832, 179838, and 198947). Figures in parentheses are means.

Measurement	Holo-type	Deep-bodied form		Slender-bodied form	
		Papilliform morph (n= 7)	Molariform morph (n= 7)	Papilliform morph (n =11)	Molariform morph (n= 4)
Standard length, mm	93.4	52.4–96.7 (83.2)	50.7–86.6 (70.4)	54.3–110.4 (72.6)	67.1–144.7 (92.1)
Predorsal length	440	421–459 (452)	434–467 (446)	414–449 (433)	411–445 (428)
Preanal length	696	694–724 (709)	677–707 (695)	676–709 (695)	706–735 (721)
Prepelvic length	411	406–426 (417)	416–448 (431)	421–451 (442)	455–490 (470)
Body depth	433	412–448 (426)	396–448 (423)	355–388 (376)	356–380 (368)
Head length	357	361–375 (368)	361–386 (374)	366–393 (383)	369–386 (381)
Postorbital length	142	132–141 (138)	138–144 (141)	135–146 (142)	134–145 (140)
Snout length	142	135–155 (148)	138–163 (150)	134–161 (147)	140–166 (156)
Preorbital depth	97	73–107 (95)	79–103 (91)	89–109 (96)	97–115 (103)
Interorbital body width	95	92–104 (100)	85–103 (95)	75–103 (87)	82–136 (98)
Orbit diameter	87	84–113 (98)	97–108 (103)	92–116 (107)	80–109 (98)
Cheek depth	150	122–146 (140)	126–154 (139)	128–149 (138)	136–151 (142)
Mandible length	138	131–147 (140)	126–149 (139)	159–188 (175)	171–184 (177)
Upper-jaw length	112	105–126 (117)	105–129 (117)	113–141 (128)	129–137 (132)
Caudal-peduncle length	164	141–156 (148)	142–153 (149)	147–165 (155)	155–170 (161)
least depth	139	134–146 (139)	133–140 (136)	129–141 (134)	133–137 (135)
Dorsal-base length	542	525–553 (537)	522–548 (533)	488–534 (512)	486–516 (504)
Longest (=last) dorsal spine length	149	149–181 (167)	144–182 (164)	149–198 (158)	142–173 (161)
Anal-base length	217	189–213 (206)	199–219 (209)	188–227 (210)	198–218 (208)
Pectoral length	234	243–262 (253)	235–273 (257)	228–260 (243)	236–254 (246)
Pelvic length	236	236–271 (245)	227–258 (246)	223–263 (243)	245–284 (260)
Gut length	2141	1551–3403 (2715)	1155–2170 (1725)	1283–2000 (1645)	1242–1341 (1302)
Width of pharyngeal plate (dentigerous portion)	118	120–133 (128)	134–169 (147)	116–126 (121)	109–126 (119)
Width of last, medial pharyngeal tooth	3.2	2.7–4.8 (3.9)	9.9–18.5 (14.8)	2.8–4.5 (3.5)	4.5–8.9 (7.3)

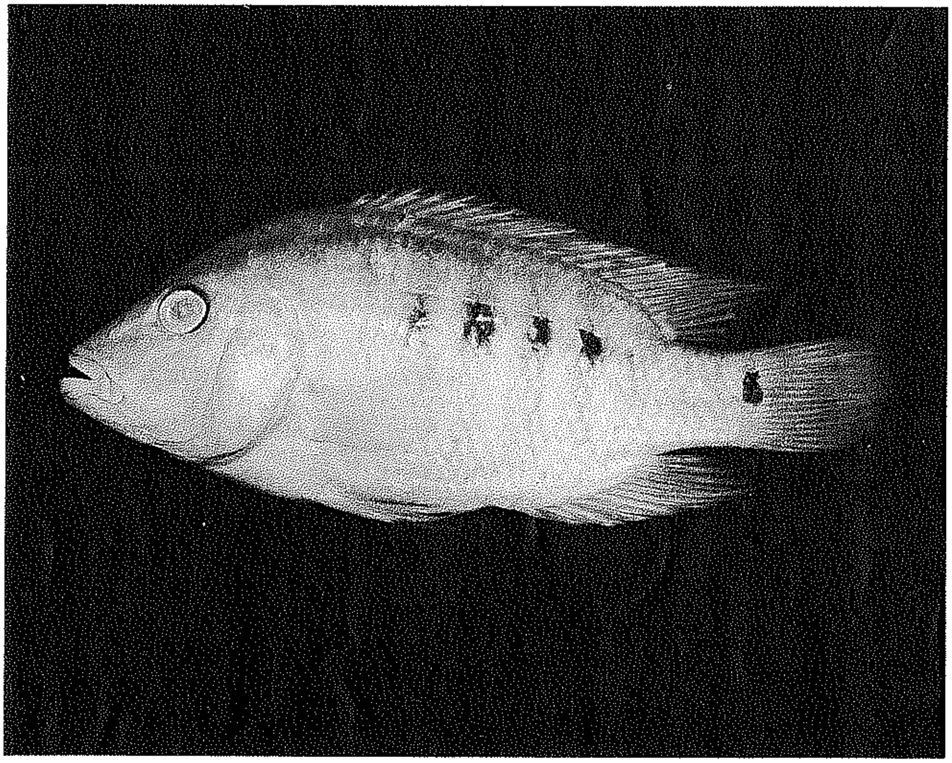

Fig. 1. *Cichlasoma minckleyi*, new species, UMMZ 209434, male, 93.4 mm SL, holotype, deep-bodied form, papilliform pharyngeal morph, Posos de la Becerra, Cuatro Ciénegas de Carranza, Coahuila, Mexico, 1961.

UMMZ 179859 (74), 25–164 mm, Tierra Blanca, 10.2 km WSW of Cuatro Ciénegas, Miller, Hubbs, Minckley, and P. Lugo, 8 Apr 1961; UMMZ 179877 (2), 20 and 25 mm, Puente Chiquito, 6.7 km S of Cuatro Ciénegas, Miller, Hubbs, and Minckley, 10 Apr 1961; UMMZ 179881 (27), 10–91 mm, Laguna Churince, 21.6 km by road SSW of Cuatro Ciénegas, Miller family, Hubbs, Minckley, and Tindall, 10 Apr 1961; UMMZ 180465 (one skeleton), 169 mm, pools along La Angostura canal near Garabatal River, *ca.* 8 km WNW of tip of San Marcos Mt., Cuatro Ciénegas basin, W. L. and B. A. Minckley and P. Lugo, 18 Apr 1963; UMMZ 198937 (28 preserved and 3 skeletons), 28–149 mm, Río Mesquites at Los Corrales, Cuatro Ciénegas basin, G. R. Smith, J. N. Taylor, and P. Yant, 25 Mar 1975; UMMZ 198942 (1), 39 mm, small tributary to Río Mesquites at Los Corrales, Cuatro Ciénegas basin, Smith and Yant, 26 Mar 1975; UMMZ 198947 (89 preserved and 36 skeletons), 18–98 mm, lagunas at El Mojarral, 8.7 km SW of Cuatro Ciénegas, Smith, Taylor, and Yant, 26 Mar 1975; USNM 231944 (3), 123–140 mm, lagunas at El Mojarral, I. L. Kornfield and D. C. Smith, 29 July 1979; USNM 231945 (126), 54–77 mm, Posos de la Becerra, Kornfield and Smith, 12 Aug 1979; USNM 231946 (38), 23–51, lagunas at El Mojarral, D. C. Smith, 7–12 July 1980; USNM 231947 (2 skeletons), 120 mm, lagunas at El Mojarral, Kornfield, 16 July 1981.

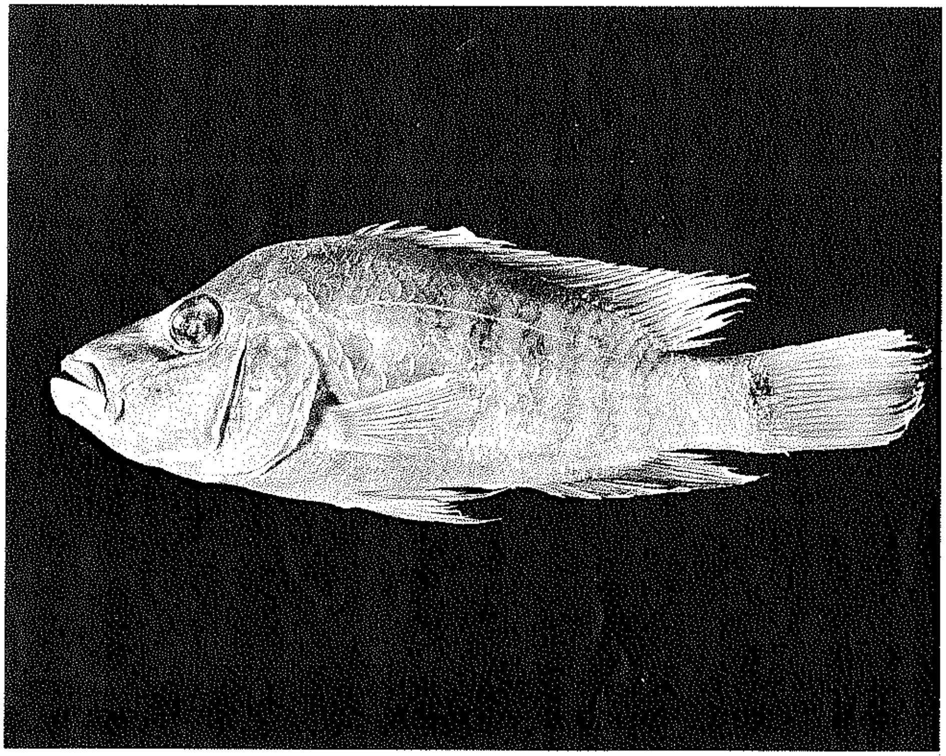

Fig. 2. *Cichlasoma minckleyi*, new species, UMMZ 179832 (ID #122.1), male, 93.5 mm SL, paratype, slender-bodied form, papilliform pharyngeal morph, Posos de la Becerra, Cuatro Ciénegas de Carranza, Coahuila, Mexico, 1961.

Description.—Body forms and color pattern are shown in Figs. 1–2. Proportional measurements are given in Table 1, and meristic data appear below (no significant differences in counts exist between either body forms or pharyngeal morphs).

Dorsal spines, XV(7), XVI(66), XVII(1); dorsal soft rays, 9(3), 10(24), 11(43), 12(4); anal spines, IV(1), V(68), VI(5); anal soft rays, 7(4), 8(55), 9(15); pectoral rays (both fins counted in 25 specimens), 13(3), 14(38), 15(9).

Scales: lateral series, 28(2), 29(1), 30(5), 31(14), 32(1); upper lateral line, 17(1), 18(2), 19(7), 20(7), 21(5), 22(1), and lower lateral line, 10(3), 11(6), 12(8), 13(6); scale-row overlap of upper lateral line on lower, −1(3), 0(4), 1(9), 2(5), 3(2); transverse scales, 17(6), 18(14), 19(2); upper lateral line to soft dorsal origin (not including scales on scaly sheath along fin base), 3(20), 3½(3); upper lateral line to origin of anal fin, 11(20), 12(3); rows around caudal peduncle, 17(1), 18(3), 19(12), 20(3); rows on cheek, 5(4), 6(14), 7(3).

Gill rakers on first arch (total including all anterior rudiments): upper limb, 3(30), 4(40); lower limb, 7(5), 8(46), 9(19); total, 11(25), 12(36), 13(9).

Vertebrae: precaudal, 13(21), 14(17); caudal, 15(23), 16(15); total, 28(7), 29(30), 30(1).

Deep-bodied form (Fig. 1): Body relatively stout, depth 2.2–2.5 in SL; head

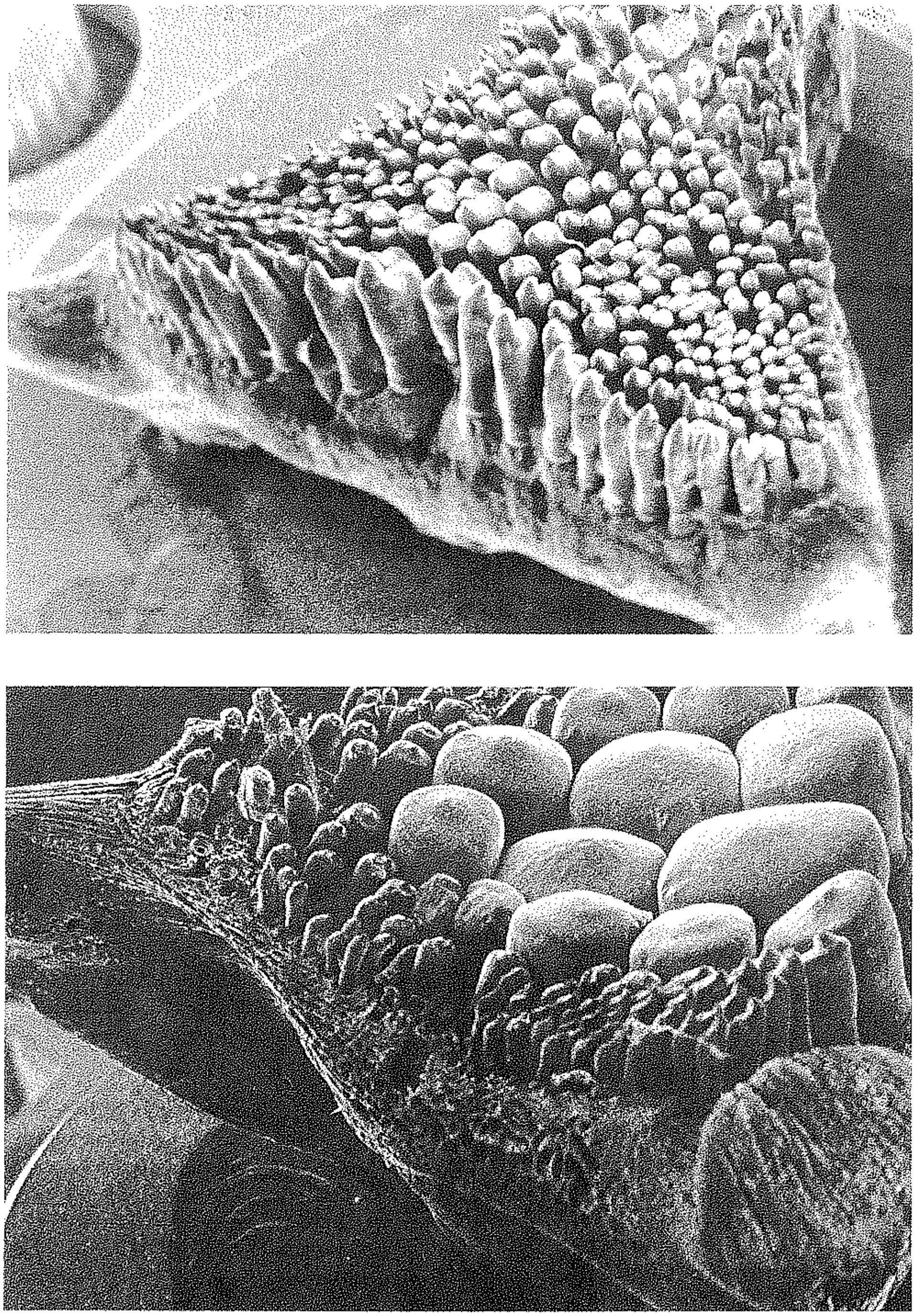

Fig. 3. Lower pharyngeal jaws defining papilliform pharyngeal morph (above) and molariform pharyngeal morph (below). Both specimens 120 mm SL, male, USNM 231947.

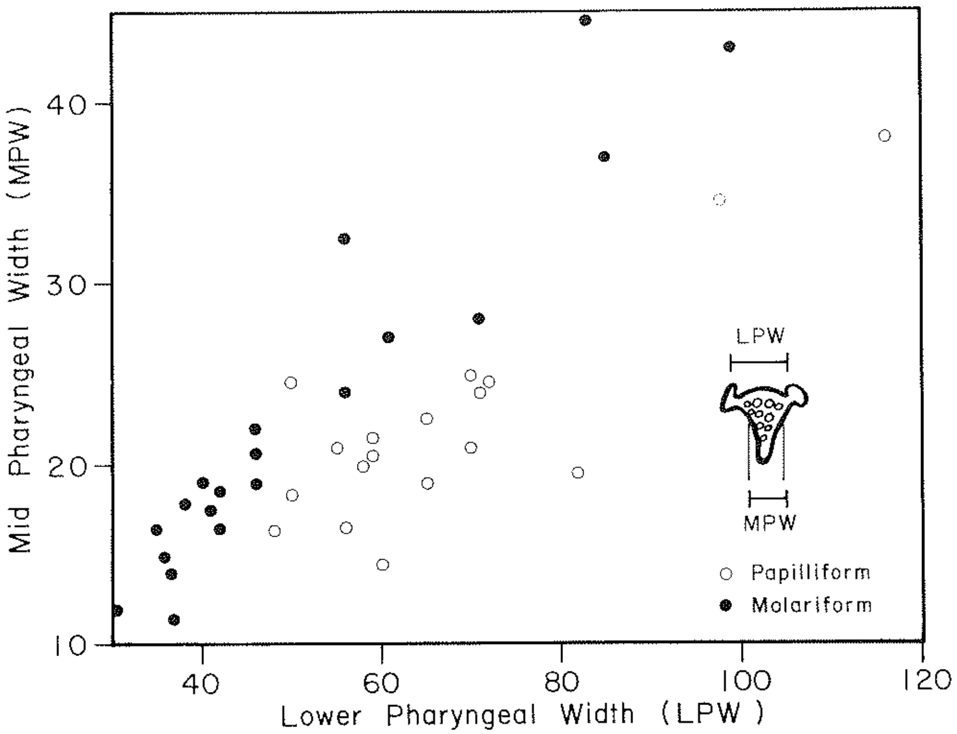

Fig. 4. Regression of mid-pharyngeal width (MPW) on maximum width of lower pharyngeal (LPW) for papilliform and molariform pharyngeal jaw morphs.

short, length much less than body depth over pelvic base; predorsal contour smoothly convex in subadults, becoming straighter and steeper with age (large adult males often develop a pronounced nuchal hump, producing a concavity over the orbit); prepelvic contour approximately straight, not so steep as predorsal; greatest body depth at or near origin of dorsal. Mouth relatively small, horizontal to slightly oblique; jaws approximately equal anteriorly. Ascending process of premaxillary extending to above anterior margin of orbit. Frenum along margin of lower lip generally weak or absent. Gill rakers well-spaced, short and stout.

Dorsal base of moderate length, originating above or slightly behind insertion of pectoral fin; dorsal spines increasing rapidly in length to fifth or sixth, then more gradually to last, which is approximately 0.45 head length in individuals over 70 mm SL. Soft rays of dorsal fin when relaxed not reaching beyond anterior third of caudal fin (except when prolonged in adults). Pectoral fin rounded, asymmetric, equal to approximately two-thirds head length, rarely extending to anal fin origin. Pelvic fin usually extending to vent or beyond. Caudal fin rounded; peduncle length equal to or greater than least depth.

Dental arcade rounded, jaw teeth unicuspid, widely and regularly set, implanted erect in few bands with outer row prominent. Anterior pair in outer row of upper jaw largest, conical and acutely pointed, with tips slightly to strongly recurved

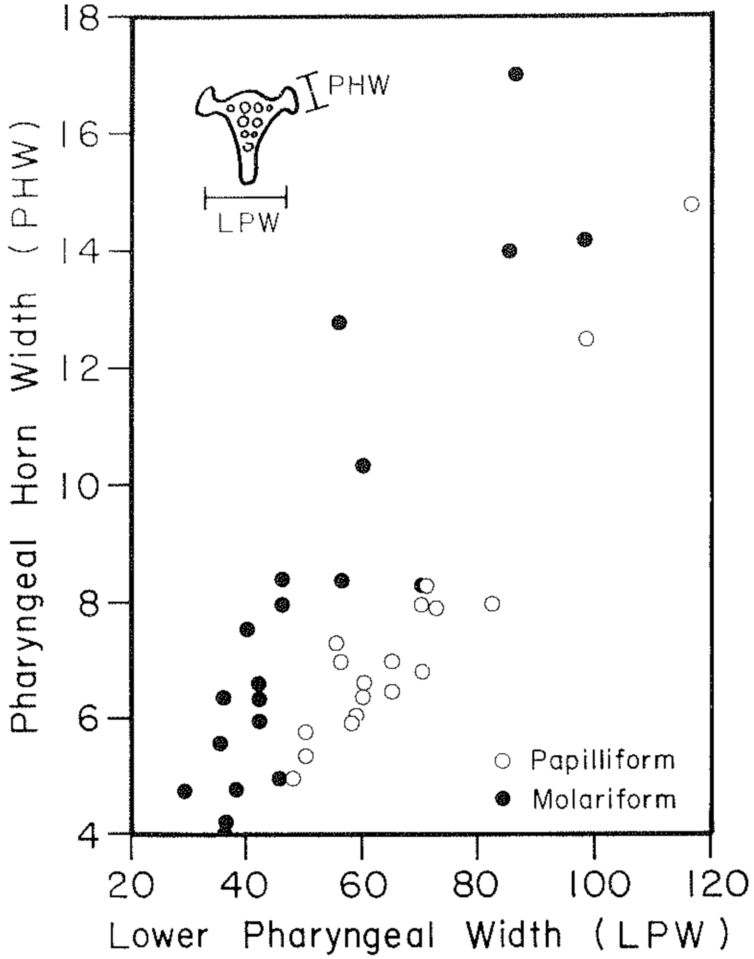

Fig. 5. Regression of pharyngeal jaw horn width (PHW) on maximum width of lower pharyngeal jaw (LPW) for papilliform and molariform pharyngeal jaw morphs.

(often worn in large specimens), usually lacking posterior cusp. Flanking teeth in upper jaw less recurved, gradually decreasing in size laterally. Anterior pair of teeth in lower jaw similar in shape but smaller than central pair in upper, equivalent to flanking teeth which gradually decrease in size.

Occlusal surface of lower pharyngeal jaw with dentigerous portion 1.1 to 1.3 times broader than long (in 20 individuals 51–121 mm SL). Pharyngeal dentition dimorphic, with molars in central rows either well-developed (=molariform morph) or lacking (=papilliform morph; see Fig. 3). Dentition in papilliform morphs with numerous slender unicuspid teeth arranged in irregular rows; dentition in molariform morphs with 4–8 massive molars in each of two median rows, decreasing in size anteriorly, increasing in number with SL, flanked laterally by 1–2 irregular rows of smaller molars, with small papilliform teeth distributed irregularly over remaining occlusal surface. Lower pharyngeal of papilliform morph with narrower mid-occlusal width and narrower rami (Figs. 4–5).

Slender-bodied form (Fig. 2): Body elongate, depth 2.6–2.8 in SL (n = 15, 54.3–144.7 mm SL); head relatively long, length equal to or greater than body depth over pelvic base. Mouth relatively large, oblique; lower jaw projecting beyond upper. Caudal peduncle slender, length greater than least depth.

Coloration.—Basal color (in preservation) variable, ranging from tan to dark brown or black; a series of 4–7 black rectangular blotches centered between the upper lateral line and anterior extension of the lower lateral line (Fig. 1), the first typically originating above midpoint of pectoral fin and the last under the posterior soft dorsal. Blotches often overlie fainter crossbars, most conspicuous in subadults but frequently obscured by dark basal coloration in adult males. Caudal spot, centered above lower lateral line at peduncle base, present in subadults, but often faint or lacking in dark-colored adults. Adults also occasionally develop diffuse black speckling over the flanks and lighter, irregular spotting on the unpaired fins. Paired fins dusky or hyaline.

In life, basal color in nonreproductive individuals varies from light grey or tan through yellowish-green to dark green or grey, while markings on the flank are black; both ground color and development of flank pattern are subject to rapid alterations in particular individuals. Sexual dichromatism in breeding adults is marked. Adult males are dark-green to black (often with the flank pattern completely obscured) with light blue spots distributed over much of the head, flanks, and vertical fins. In spectacular contrast, the ground color in breeding females is an intense, snowy white; the black flank markings are conspicuous, but blue spotting is absent.

Comparisons.—Characters that distinguish *C. minckleyi* from other *Cichlasoma* species are summarized in the diagnosis above. Though its origins are obscure, *C. minckleyi* appears to be more closely related to endemic cichlids of the Río Pánuco drainage, the first major river south of the Rio Grande, than to *C. cyanoguttatum*, which ranges northward into Texas and has recently gained access to the Cuatro Ciénegas basin via newly constructed irrigation systems. This hypothesis of relationships is supported by association of both the Pánuco species—specifically, *C. labridens* (Pellegrin), *C. bartoni* (Bean), and *C. steindachneri* Jordan and Snyder—and *C. minckleyi* with the *Parapetenia* group within *Cichlasoma* (Regan 1906–08; LaBounty 1974; Taylor and Miller, in press), while *C. cyanoguttatum* is a member of the *Herichthys* group (recognized as a genus by Regan 1906–08, but placed in *Cichlasoma* by Meek 1904, and most subsequent authors). These two groupings have traditionally been distinguished on the basis of jaw dentition; *Parapetenia* species have fewer, more widely-spaced, conical teeth, with one or more anterior pairs in each jaw enlarged to form canines, while the teeth in *Herichthys* species are more numerous, closely-spaced, compressed and incisor-like distally. Unfortunately, such a distinction is not as clear-cut as originally formulated. Several so-called *Parapetenia* species, including *C. minckleyi* and *C. labridens*, have only weakly enlarged anterior teeth at best, providing intermediate dentitional types between *Parapetenia* and *Theraps*, a third grouping within *Cichlasoma* characterized by generalized conical jaw teeth but no canines (Regan 1906–08). Further, variability in jaw dentition within populations of *C. cyanoguttatum* can be extensive and include relatively noncompressed, conical patterns; indeed, *C. pavonaceum* (Garman), a species recently placed in the synonymy of *C. cyanoguttatum* (Taylor and Miller, in press) was included in the *Theraps* group by Regan (1906–08). Clarification of supraspecific relationships

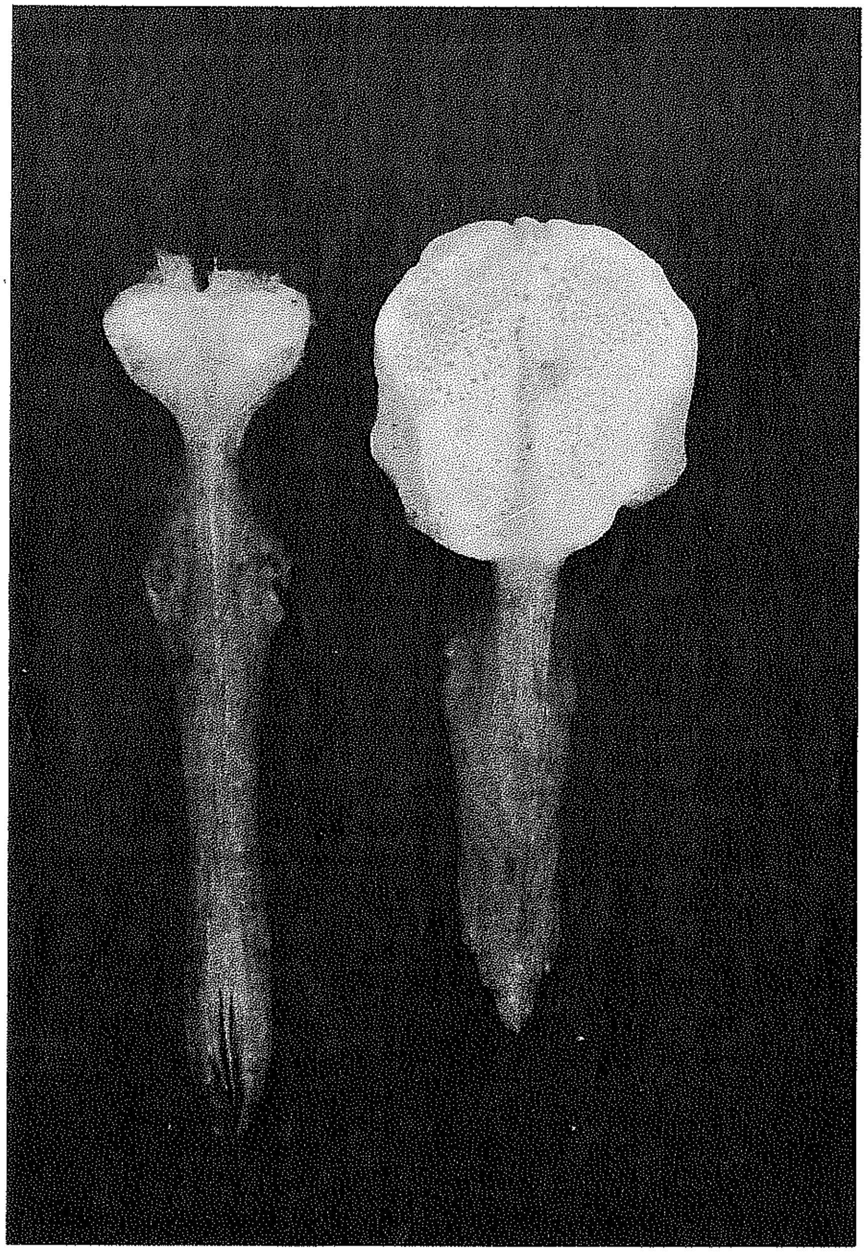

Fig. 6. Pharyngobranchial apophysis from molariform pharyngeal jaw morph (right) and papilliform jaw morph (left). Both specimens 120 mm SL, male, USNM 231947.

among these species awaits renewed phylogenetic study of subgroupings within the genus *Cichlasoma*.

Intraspecific variation observed in *Cichlasoma minckleyi* mimics morphological diversity encountered among other species within *Cichlasoma*. In *C. minckleyi*, variation related to both pharyngeal architecture and body shape is present. In

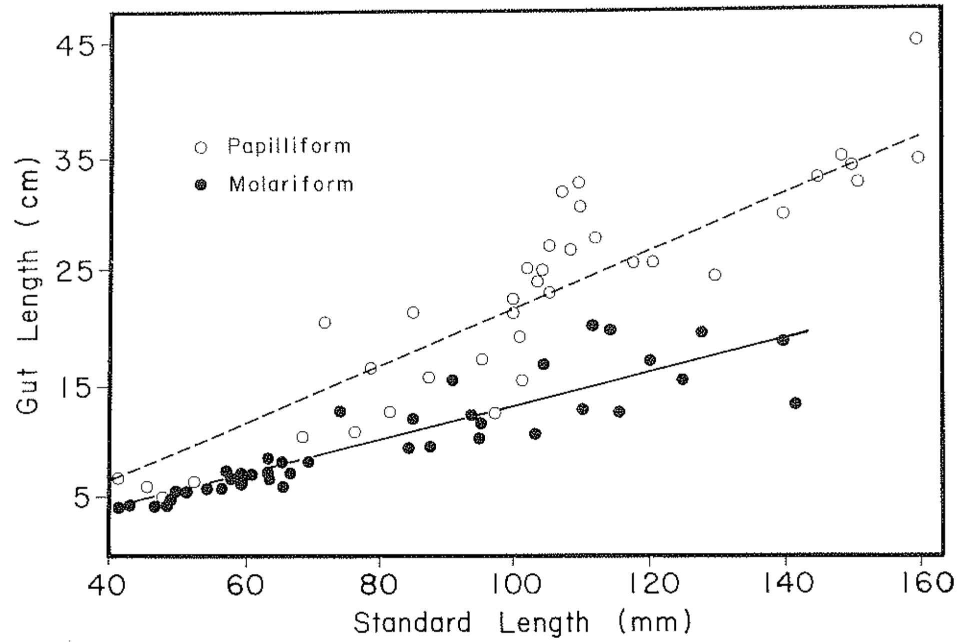

Fig. 7. Regression of gut length on standard length for papilliform and molariform pharyngeal jaw morphs.

the deep-bodied form (Fig. 1), two suites of integrated morphological characters accompany the dichotomy in pharyngeal dentition (Table 2). The lower pharyngeal jaw in papilliform morphs is more delicate, possessing a significantly narrower outline (Fig. 4) with smaller horns (Fig. 5) than the molariform morph. The size and position of branchial musculature differs conspicuously between morphs. The molariform pharyngeal apparatus is characterized by general hypertrophy with marked enlargement of the levator externis, levator posterior and retractor dorsalis muscles (Hoogerhoud and Barel 1978). Differences in neurocranial articulation of the upper pharyngeal jaw are dramatic, with dorsal support in the molariform morph provided by a massive pharyngobranchial apophysis (Fig. 6). Correlated with the pharyngeal modifications in deep-bodied forms is a dimorphism in intestinal length; gut length in the molariform morph is significantly less than that in the papilliform morph (Fig. 7). A degree of trophic (dietary) specialization occurs between pharyngeal morphs (Taylor and Minckley 1966; LaBounty 1974; Sage and Selander 1975), but is not as pronounced as originally believed (Smith 1982). Gut content analysis indicates that gastropods occur in molariform morphs but are usually, though not invariably, absent from guts of papilliform morphs. However, gastropods form only a minor component of all food items and dietary overlap between morphs is relatively great, particularly in juvenile and subadult fishes.

In addition to these internal characters, pharyngeal morphs of deep-bodied forms can be distinguished externally by a significant difference in head width (Fig. 8; C. D. N. Barel, pers. comm.) caused by the massiveness of pharyngeal and associated musculature in the molariform morph. In the field, this difference

Table 2.—Morphometric dichotomy between papilliform and molariform morphs of deep-bodied *Cichlasoma minckleyi* analyzed by linear regression.

Character	Test for equality of slope		Regression equations	
	df	F	Papilliform morph	Molariform morph
Mid-pharyngeal width (MPW)	1,34	12.30**	MPW = 3.49 + 0.28 LPW	MPW = −2.12 + 0.49 LPW
Pharyngeal horn width (PHW)[a]	1,35	36.46**	PHW = −1.53 + 0.14 LPW	PHW = −0.62 + 0.17 LPW
Gut length (GL)	1,34	10.58**	GL = −8.74 + 0.30 SL	GL = −2.30 + 0.19 SL
Head width (HW)	1,28	34.93***	HW = 10.74 + 0.26 HL	HW = −1.08 + 0.55 HL

** $P < 0.01$; *** $P < 0.001$.

[a] Slopes are statistically homogeneous; comparison of Y-intercepts by covariation analysis is presented.

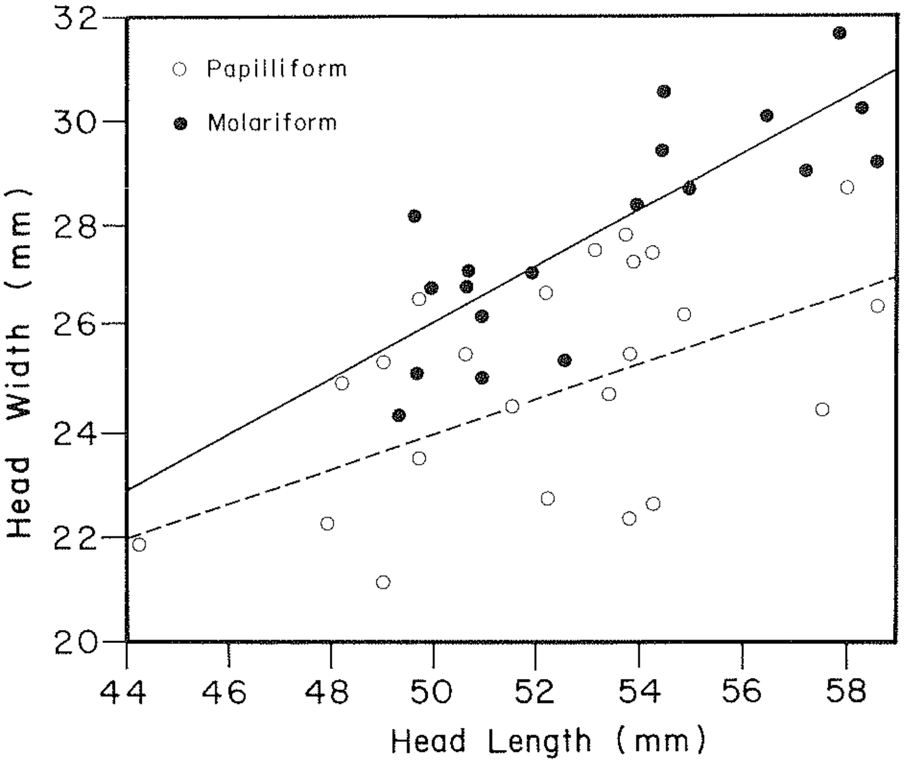

Fig. 8. Regression of head width (HW) on standard length for papilliform and molariform pharyngeal jaw morphs.

is not apparent to the human observer, but may perhaps be perceptible by the fish, particularly since opercular extension is a frequent element of territorial behavior in this and allied species (Baerends and Baerends-Van Roon 1950; pers. observ.). If perceptible, head width dimorphism could provide a convenient signal potentially preadapting pharyngeal morphs for assortative mating.

Morphological diversity encountered between deep-bodied and slender-bodied forms is pronounced. The streamlined form (Fig. 2) is characterized by differences in a number of external characters (Table 1) that become more marked with age. Though the differences may not be apparent in small fish, no adults with completely intermediate morphology have been recognized. Gut analysis of slender-bodied forms suggests that they principally consume other fishes (Taylor and Minckley 1966; LaBounty 1974; Sage and Selander 1975), a rare food item in the diet of deep-bodied forms; correspondingly, gut length in slender-bodied forms is usually shorter than that seen in deep-bodied individuals (Table 1). The external shape and dietary dichotomy between body forms does not involve pharyngeal morphology; both papilliform and molariform dentitions have been observed among slender-bodied individuals (LaBounty 1974).

Sympatric representation of dichotomous morphologies with respect to pharyngeal dentition and body form has provided a compelling basis to recognize multiple taxa within the Cuatro Ciénegas basin (Taylor and Minckley 1966;

Table 3.—Relative frequency of the molariform phenotype, by sex, in deep-bodied forms from five localities in the Cuatro Ciénegas basin. Sample size in parentheses.

	Laguna El Mojarral	Rancho Orozco	Escobeda	Posos de la Becerra	Laguna Churince
♂♂	0.583 (26)	0.500 (16)	0.462 (13)	0.384 (86)	0.375 (24)
♀♀	0.400 (35)	0.294 (17)	0.111 (9)	0.122 (156)	0.250 (28)

Minckley 1969; LaBounty 1974; Kornfield and Koehn 1975). The diversity seen within *C. minckleyi* is precisely the kind which characterizes differences among distinct biological species within the genus *Cichlasoma*, as illustrated, for example, by the endemic cichlid fauna of the Río Pánuco basin (Taylor and Miller, in press). In the Río Verde, a sympatric pair of deep-bodied species, *Cichlasoma bartoni* and *C. labridens*, exhibits a comparable dichotomy in pharyngeal dentition, while in the Río Gallinas system, *C. labridens* and *C. steindachneri* differ in both body form and pharyngeal dentition. Unlike the Cuatro Ciénegas situation, however, the Río Pánuco species can also be distinguished on the basis of breeding coloration, electrophoretic comparisons, and a number of meristic characteristics. Nevertheless, conventional morphological treatment of *C. minckleyi* concluded that the taxa consisted of at least three species within the Cuatro Ciénegas basin. However, biochemical studies demonstrating parallel variation in isozyme frequencies between pharyngeal morphs among isolated localities strongly supported a single-species hypothesis (Sage and Selander 1975). This systematic problem has been resolved by field observations of reproductive behavior. Successful matings both between deep-bodied fish of different pharyngeal morphs (Kornfield *et al.* 1982) and between different body forms (Taylor, unpubl.) convincingly established conspecificity. As a corollary, this finding emphasizes the potential insufficiency of phenetic (=morphological) criteria in delimiting species within the family Cichlidae.

The relative contributions of genetic and environmental factors to total phenotypic variation within *C. minckleyi* are unclear. While most deep-bodied specimens can be easily assigned to a specific pharyngeal morph, a small percentage of fish (<5%) exhibit intermediate pharyngeal morphologies and gut lengths. The genetic basis for intermediacy is unknown, but cannot be due to hybridization in the conventional sense. Proportions of the two pharyngeal morphs vary in different size-classes and also can differ considerably among localities. However, within localities, the proportion of individuals with molariform dentition is substantially greater in males than in females (Table 3). While such a difference might reflect differential selective pressures, its consistency across localities suggests a simple model for the inheritance of alternate pharyngeal states. Assuming that pharyngeal phenotype is regulated by a single diallelic locus with a recessive molariform allele, the difference in the relative proportion of the two types between males and females is consistent with sex linkage (Fig. 9). However, accurate recognition of control over dentition and body form will require further studies of formal inheritance.

Distribution.—*Cichlasoma minckleyi* is known only from the Cuatro Ciénegas basin, Coahuila, Mexico. Within the basin it is common and widely distributed in most streams, ponds and lagunas. At a few localities, in the southeastern part

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(IK) Department of Zoology and Migratory Fish Research Institute, University of Maine, Orono, Maine 04469; (JNT) Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida 33432.

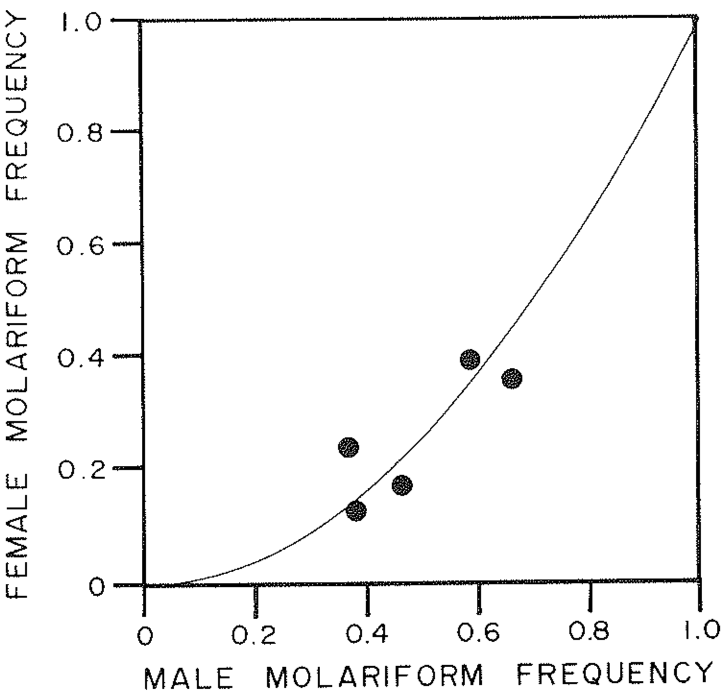

Fig. 9. Observed relative frequencies of molariform pharyngeal jaw phenotype in males and females from five localities in the Cuatro Ciénegas basin. Curve represents expected relationship when molariform phenotype is recessive and sex-linked.

of the basin, including Laguna Santa Tecla, it occurs sympatrically with the recent colonist, *C. cyanoguttatum*. The associated fish fauna of the basin has been described by Minckley (1969, 1978).

Etymology.—The species is named after Dr. W. L. Minckley of Arizona State University who has investigated the biota of Cuatro Ciénegas for many years.

Acknowledgments

We sincerely appreciate the guidance of C. D. N. Barel in our morphological analyses. Invaluable assistance was provided by David C. Smith. Our thanks to Hugh DeWitt for reading the manuscript; E. C. Theriot and W. N. Watkins prepared Figures 1 and 2, respectively. We gratefully acknowledge the cooperation of Carlos Tovar Flores, Of. Coordinadora de Investigaciones Pesqueras Externas, Direccion General del Instituto Nacional de la Pesca, for permitting our field work in Cuatro Ciénegas. This research was supported by NSF grant DEB 78-24074 (IK), the Migratory Fish Research Institute, Faculty Research Fund, University of Maine, and Earthwatch, The Center for Field Research, Belmont, Massachusetts.

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