

- macrocheilus* (Pisces: Catostomidae). J. Fish. Res. Bd. Can. 25:101–150.
- RAKOCINSKI, C. F. 1980. Hybridization and introgression between *Campostoma oligolepis* and *C. anomalum pullum* (Cypriniformes: Cyprinidae). Copeia 1980:584–594.
- ROSS, M. R., AND T. M. CAVENDER. 1981. Morphological analyses of four experimental intergeneric cyprinid hybrid crosses. *Ibid.* 1981:377–387.
- ROWHER, S. A. 1972. A multivariate assessment of interbreeding between meadowlarks, *Sturnella*. Syst. Zool. 21:313–338.
- SCHREIBER, D. C., AND W. L. MINCKLEY. 1982. Feeding interrelations of native fishes in a Sonoran Desert stream. Great Basin Nat. 41:409–426.
- SCHUELLER, F. W., AND J. D. RISING. 1976. Phenetic evidence of natural hybridization. Syst. Zool. 25:283–289.
- SMITH, G. R. 1966. Distribution and evolution of the North American catostomid fishes of the subgenus *Pantosteus*, genus *Catostomus*. Misc. Publ. Mus. Zool. Univ. Mich. 129:1–133.
- . 1973. Analysis of several hybrid cyprinid fishes from western North America. Copeia 1973:395–410.
- , AND R. K. KOEHN. 1971. Phenetic and cladistic studies of biochemical and morphological characteristics of *Catostomus*. Syst. Zool. 20:282–297.
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A New Species of *Allodontichthys* (Cyprinodontiformes: Goodeidae), with Comparative Morphometrics for the Genus

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Allodontichthys polylepis, new species, is described from two localities in the upper reaches of the Rio Ameca basin, Jalisco, Mexico. Its distribution is disjunct from that of the rest of the genus, which is restricted to the Rio Armeria and Rio Coahuayana systems. The new species differs from the other three species of *Allodontichthys* primarily in a higher lateral-line scale count. Shape differences between the four species and between the sexes are examined using multivariate morphometrics, and growth patterns for each sex (as shown by allometric coefficients) are compared. These analyses distinguish *A. hubbsi* from its congeners, but do not resolve the remaining three species.

Se describe *Allodontichthys polylepis*, una nueva especie de la familia Goodeidae, de la cuenca del Rio Ameca, cerca de las villas de Ameca y Guachinango, Jalisco, México. Su distribución es descoyuntado de la distribución de los otros de este género, que se limita a las cuencas de los ríos Armeria y Coahuayana. *Allodontichthys polylepis* se distingue de los tres otros especies de *Allodontichthys* basicamente por el grande número de escamas de la línea lateral. Las diferencias de la forma del cuerpo entre las cuatro especies de este género y entre los dos sexos de *A. polylepis* se examenen con la metodología de morfométrico, y los crecimientos alométricos por cada sexo de las cuatro especies que son presentados. *Allodontichthys hubbsi* se distingue de sus congeneres en estos analisis, pero los tres otros especies no se resuelven.

THE upper reaches of the Rio Ameca system, in Jalisco, Mexico, hold a rich and endemic fish fauna (Miller and Smith, 1986). In this paper, I describe a new species of goodeid

from this locality. The new form is allopatric with respect to the rest of the genus, which is confined to the Rio Armeria and Rio Coahuayana systems, in Jalisco and Colima, Mexico. Fol-

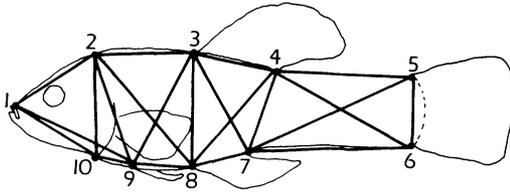


Fig. 1. Truss network for species of *Allodontichthys*. Numbered points represent landmarks listed in text; interlandmark distances defined by these points were used in PCA.

lowing the species description, a comparison of the four species uses morphometrics to investigate differences in body shape, sexual dimorphism, and allometry.

METHODS

Standard length (SL) was used throughout. Proportional body measurements (Table 1) and

counts were taken as described by Miller (1948), with the exception of head canals, which were counted following Gosline (1949). The rudimentary, anterior anal ray is included in the anal-ray count, and the last two, closely approximated rays of the dorsal and anal fins are counted as one ray. For each meristic character, the number of specimens counted is given in parentheses; the count for the holotype is indicated by an asterisk. For paired fins and head canals, both sides were counted. Institutional acronym follows Leviton et al. (1985).

For morphometric analyses, a box-truss scheme, anchored at the following landmarks, was used: 1) snout tip; 2) occiput; 3, 4) dorsal-fin base; 5, 6) hypural plate; 7, 8) anal-fin base; 9) pelvic origin; and 10) cleithral symphysis. The 22 interlandmark distances shown in Figure 1 provided even coverage for comparisons of body form (Humphries et al., 1981). Measurements

TABLE 1. PROPORTIONAL MEASUREMENTS OF ADULTS OF *Allodontichthys polylepis*, EXPRESSED IN THOUSANDTHS OF SL. Based on UMMZ 213951, 198850, and 189587. Data for males includes holotype.

Measurement	Holotype	10 males		10 females	
		Range	\bar{x}	Range	\bar{x}
Standard length (mm)	42.37	33.06–46.19	39.08	32.13–50.02	41.98
Predorsal length	636	588–651	619	609–650	633
Prepelvic length	515	457–515	489	464–528	499
Anal origin to caudal base	403	392–425	410	347–414	384
Body depth	302	262–305	287	229–268	244
Body width	177	142–177	163	144–177	154
Head length	270	264–300	284	255–294	273
Head depth	226	210–246	228	197–226	209
Head width	182	171–190	179	156–183	168
Caudal peduncle					
length	274	274–306	284	263–306	283
depth	151	137–156	149	122–150	136
Interorbital width	111	106–115	110	95–116	105
Snout length	89	78–92	88	74–91	84
Orbit length	74	61–77	69	56–68	63
Mouth width	82	82–101	88	68–83	78
Mandible length	54	52–75	62	41–66	56
Dorsal fin					
Basal length	160	150–182	162	122–168	146
Depressed length	319	291–338	312	232–308	257
Anal fin					
Basal length	129	115–129	124	90–120	103
Depressed length	242	208–255	231	186–215	201
Caudal-fin length	196	171–208	196	155–190	177
Pectoral-fin length	215	180–234	211	156–199	181
Pelvic-fin length	126	111–133	122	100–123	112

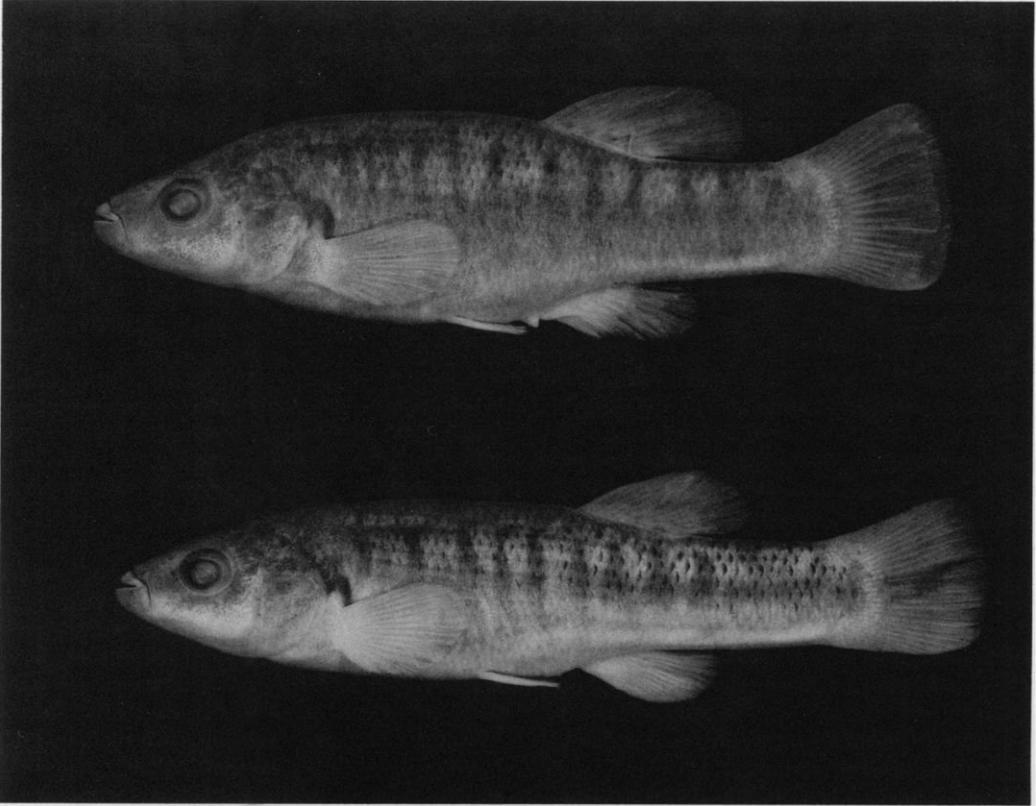


Fig. 2. *Allodontichthys polylepis*, paratypes, UMMZ 198850: above, male, 43.0 mm SL; below, female, 44.4 mm SL.

were taken with a video-digitizing system described by Fink (1987). I measured 80 specimens of each species, including both sexes, evenly distributed over the size range of these fishes (15–55 mm).

Principal components were calculated from the covariance matrix of log-transformed distance measurements for: a) all species, pooled; b) males only, all species; c) females only, all species; d) adults only (35–55 mm), all species; and e) young only (15–35 mm), all species. Subsequent analyses were similar, but contained only three species (*Allodontichthys hubbsi* removed) or only two species. Finally, within-group principal components were calculated for each species, separated by sex, to derive allometric coefficients (Jolicoeur, 1963) and to examine sexual dimorphism in each species. All statistical analyses were performed using the IBM-PC version of SAS (Version 6, SAS Institute, North Carolina).

Allodontichthys polylepis n. sp.
Fig. 2

Allodontichthys sp. Fitzsimons, 1981:6 (sensory head pores listed). Uyeno et al., 1983:499–510 (karyotype). Miller, 1986:139 (listed). Miller and Smith, 1986:502 (listed). Smith and Miller, 1987:614 (locality noted).

Holotype.—UMMZ 213951, adult male, 42.37 mm, R. R. Miller et al., 23 Feb. 1976, Rio Potrero Grande (Rio Ameca drainage), 9.6 km east of Ameca on road to Guachinango, Jalisco, Mexico.

Paratypes.—Taken with the holotype were 20 juvenile and adult males and females (UMMZ 198850). Two other collections of this species have been made in the Rio de la Pola, a tributary of the Rio Atenguillo, 4.8 km east of Guach-

TABLE 2. FREQUENCY DISTRIBUTION OF LATERAL-LINE SCALES FOR SPECIES OF *Allodontichthys*.

Species	Number of lateral line scales																
	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
<i>A. tamazulae</i>	1	5	10	16	12	4	5	3	2								
<i>A. zonistius</i>			4	6	8	6	1										
<i>A. hubbsi</i>				1	12	9	9	3	2								
<i>A. polylepis</i>							4	1	6	5	5	8	10	3	2		2

inango, Jalisco: 49 juveniles to adults, R. R. and M. Miller, 5 March 1957 (UMMZ 178348), and 27 juveniles to adults, R. R. Miller and J. Fitzsimons, 21 Feb. 1970 (UMMZ 189587).

Diagnosis.—An *Allodontichthys* differing from the other three species of the genus principally in the greater number of scales in the lateral line: most commonly 48 in *A. polylepis* (range 42–52); scale counts of 39 or 40 are more usual for the other species of the genus (range 36–44).

Description.—The form and coloration of preserved adult specimens are portrayed in Figure 2, proportional measurements are given in Table 1, and frequency distributions of lateral-line scale counts appear in Table 2.

Dorsal rays: 13*(16), 14(23), 15(8); anal rays: 14(3), 15*(34), 16(10); pectoral rays: 15(6), 16*(58), 17(25); pelvic rays: invariably 6; principal caudal rays: 20(3), 21(12), 22*(21), 23(9), 25(2); lateral-line scales: 42(4), 43(1), 44(6), 45(5), 46(5), 47(8), 48*(10), 49(3), 50(2), 52(2); vertebral counts (taken from radiographs, counting hypural complex as one): 34(5), 35(2), 36(3).

Counts of sensory pores very consistent: mandibular, invariably 4-4; lacrimal, 4-3(1), 4-4*(35); preopercular, 6-7(2), 7-6(2), 7-7*(29), 7-8(3). Supraorbital canal discontinuous between pores 2a and 2b (Type II of Gosline, 1949).

In ethyl alcohol, the body is dark brown dorsally, lighter on ventral half of flanks and cheek; dorsolaterally, edges of scale pockets are blackened, giving a flecked appearance; scapular blotch dark and prominent; 8–11 medium brown vertical bars from behind the pectoral fin onto caudal peduncle; lateral bars may be obscured by a general darkening in larger males; dorsum with irregular spotting in juveniles and females; pectoral and pelvic fins relatively pale; dorsal fin in fish 20–40 mm with a basal row of spots followed distally by 1 or 2 more irregular rows of larger spots; spotting in dorsal and anal fins sometimes obscured in larger fish, espe-

cially males, by dusky-dark pigmentation on basal three-fourths of fin.

Comparisons.—The genus *Allodontichthys* was erected for *A. zonistius* (Hubbs) by Hubbs and Turner in 1939. *Allodontichthys tamazulae* Turner was added in 1946, and *A. hubbsi* Miller and Uyeno in 1980. These are medium-sized (to 60 mm) members of the family Goodeidae. The new species shares with them two defining characters: outer jaw teeth recurved, shouldered, or strongly tricuspid, rather than bifid; and a dark, crescent-shaped scapular blotch situated just posterodorsal to the base of the pectoral fin. Members of this genus also have a single, median, entire ovary, with the septum attached both dorsally and ventrally. The embryonic trophotaeniae, in those species for which these structures have been described (Turner, 1946; Miller and Uyeno, 1980), are flat and ribbon-shaped, with 6–10 termini (where known); none of the collections of *A. polylepis* contained a gravid female. The anal fin of males has the first ray reduced to a nub and rays 2–7 shortened and crowded. The branchiostegal rays number four.

Allodontichthys zonistius: the pigmentation patterns of *A. zonistius* are essentially as described for *A. polylepis*, but with highly intensified hues. The proximal two-thirds to three-quarters of the dorsal fin bears jet-black blotches, larger than those found in the other species; as in *A. polylepis*, these sometimes merge into a single, large black blotch. The caudal fin also shows a thick band of dark pigment. The edging of the scales of the dorsal part of the body is also quite dark, giving an almost black appearance from above. The scapular blotch is ink-black. The overall dark appearance of this fish tends to obscure the vertical bars, but these can still be seen on smaller fish.

Allodontichthys tamazulae: except for the number of lateral-line scales, which average 39.6, this species is quite similar to the new species. The vertical bars along the sides of the body are thinner and more numerous (17–22), and

a distinct dark mid-lateral stripe is evident in *A. tamazulae*. The dorsal- and caudal-fin patterns described for *A. polylepis* are found here also, although in general are not as well expressed, except in the larger males (over 40 mm).

Allodontichthys hubbsi: this is the most distinct species of the genus. It has tricuspid outer-jaw teeth, while most of the outer-jaw teeth of the other three species are best described as shouldered or "incipiently tricuspid" (Miller and Uyeno, 1980; Fig. 2). Furthermore, *A. hubbsi* has a sexually dimorphic karyotype, with a diploid number of 41 in the male and 42 in the female. The other three species of the genus have a karyotype of $2n = 48$ (Uyeno et al., 1983). Also, *A. hubbsi* has 3-3 mandibular head pores, vs 4-4 in the other species. Pigmentation is much like that of *A. polylepis*; however, the vertical bars are less distinct, and a thin lateral stripe (as in *A. tamazulae*) is often present, especially in smaller specimens. Dorsal body pigment is reduced in places, giving a blotchy appearance. Fins are pale in many specimens; larger fish (over 40 mm) show dusky caudal fins and dorsal fins with 1-3 irregular rows of spots near the base, with dusky extensions of these spots further onto the fin.

Distribution and relationships.—The new species is disjunct in distribution with respect to its congeners (Fig. 3). The upper reaches of the Rio Ameca have been found in recent years to contain several endemics, including two cyprinids and five goodeids (Miller and Smith, 1986). Before the discovery of *A. polylepis*, *Allodontichthys* was not known from the Mesa Central, where most of the diversity of the family is found. In the Rio Armeria and Rio Coahuayana systems, *Allodontichthys* is associated with two other goodeid genera, *Ilyodon* and *Xenotoca*, and a third, *Xenotaenia*, is found nearby. *Allodontichthys polylepis*, however, occurs with a completely different goodeid fauna that includes *Allotoca*, *Ameca*, and *Skiffia*.

Relationships within the genus have not been studied. The high number of lateral-line scales in *Allodontichthys polylepis* may prove interesting in this regard. The genera *Ilyodon* and *Xenotaenia* have been thought to be related to *Allodontichthys* (Turner, 1946); scale counts are high in *Ilyodon* (comparable to *A. polylepis*) and lower in *Xenotaenia* (comparable to the other *Allodontichthys* species). A more comprehensive study of relationships among the genera of the Goodeidae is needed to determine the utility of

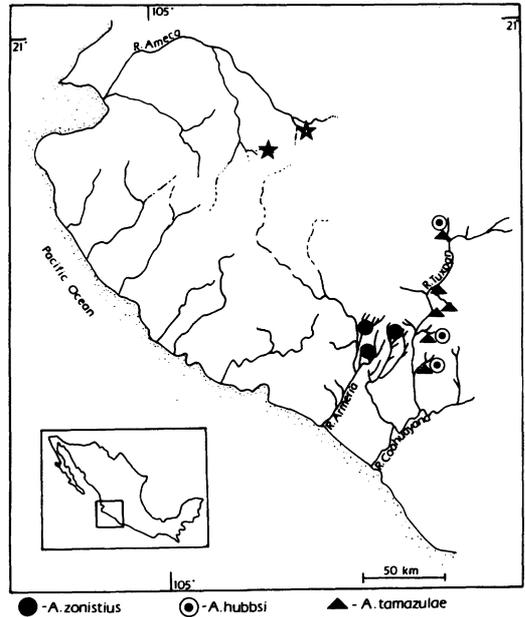


Fig. 3. Distribution map of the four species of *Allodontichthys*, based on materials examined.

this character for intrageneric relationships in *Allodontichthys*.

Etymology.—The name derives from the Greek poly- (many) and lepis (scale), used as a noun in apposition.

Morphometric comparisons.—In a principal components analysis (PCA) incorporating measurements from all four species, the first component (PCI) accounted for 94.3% of the total variance. Since the sample covered a wide size-range, the high positive loadings suggest that PCI represents a general size factor. The shear method of Humphries et al. (1981) was not needed here; the second component (PCII) and subsequent components seem not to be confounded with size differences, asserted because the clusters of points are parallel to PCI (Fig. 4A). PCII accounts for 1.8% of the total variance (Table 3). Scores on PCII separate *A. hubbsi* from the other three species, as shown in a scatter plot of PCI vs PCII (Fig. 4A).

Variable loadings on PCII show that *A. hubbsi* has a relatively longer anal-fin base (segment 7-8) than the other species, and the high loading on (4-5) and low loading on (2-3) suggest that the dorsal fin is more anteriorly positioned in *A. hubbsi* than in the others.

Because of the sexual dimorphism in body

TABLE 3. FACTOR PATTERN FOR PCA OF TRUSS MEASUREMENTS OF *Allodontichthys*. (See Fig. 1 for definition of truss measurements.)

Variable	All four species, pooled		<i>A. polylepis</i> , adults only	
	PCI	PCII	PCI	PCII
SL	.997	.012	.973	-.198
1-2	.977	.059	.872	-.088
1-10	.968	-.018	.946	-.066
9-10	.958	-.137	.887	-.231
2-9	.981	-.151	.966	-.011
2-10	.990	-.005	.914	.055
1-9	.987	-.098	.948	-.161
2-3	.965	-.205	.889	-.320
3-8	.985	-.041	.909	.369
8-9	.930	-.156	.854	-.325
2-8	.985	-.155	.958	-.155
3-9	.983	-.095	.930	.242
3-4	.961	.105	.875	.184
4-7	.984	-.080	.970	.072
7-8	.892	.336	.691	.661
3-7	.990	.026	.950	.267
4-8	.984	.048	.926	.338
4-5	.947	.218	.876	-.145
5-6	.985	-.043	.975	.126
6-7	.955	.158	.830	.282
5-7	.979	.088	.925	-.157
4-6	.972	.160	.955	-.074
% of variance	94.3	1.8	83.2	6.2

shape in these fishes (see below), further analyses were run separately on the two sexes. Separate analyses were also run for young (15–35 mm) and adult (35–55 mm) fish. In all four of these analyses, *A. hubbsi* clustered outside of the other three species, and the patterns of the loadings on PCII were similar to those presented in Table 3.

The other three species, however, do not seem to be distinguishable on the basis of body shape (as measured by this truss system). PCA was performed using pooled measurements from *A. tamazulae*, *A. zonistius*, and *A. polylepis*; scatter plots of the first five components revealed no discrimination. Similarly, pairwise analyses were unenlightening.

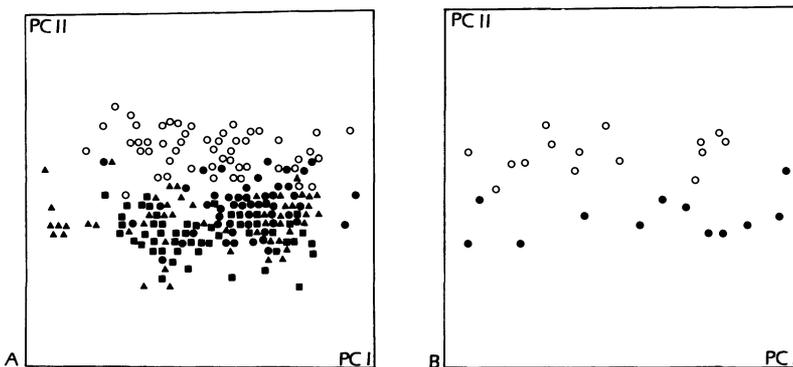


Fig. 4. Scatter plot results of PCA: A) PCI vs PCII, all four species of *Allodontichthys*, all sizes (open circles = *A. hubbsi*, solid circles = *A. zonistius*, triangles = *A. tamazulae*, squares = *A. polylepis*); B) PCI vs PCII, *A. polylepis*, adults only (open circles = males, solid circles = females).

TABLE 4. ALLOMETRIC COEFFICIENTS FOR EACH SPECIES OF *Allodontichthys*, SEPARATED BY SEX.

Variable	<i>A. tamazulae</i>		<i>A. zonistius</i>		<i>A. hubbsi</i>		<i>A. polylepis</i>	
	M	F	M	F	M	F	M	F
1-2	.84	.84	.82	.78	.79	.81	.81	.85
1-10	.82	.83	.85	.85	.83	.85	.87	.90
9-10	1.03	1.17	1.11	1.21	1.06	1.11	1.04	1.21
2-9	1.03	1.09	1.09	1.13	1.10	1.13	1.09	1.12
2-10	.97	.91	.94	.89	.93	.92	.98	.94
1-9	.93	1.02	.99	1.04	.96	1.00	.96	1.06
2-3	.97	1.08	.95	1.10	1.02	1.03	.99	1.13
3-8	1.17	1.11	1.14	.99	1.16	1.17	1.16	1.01
8-9	1.10	1.13	.86	1.00	1.01	1.05	1.05	1.15
2-8	1.05	1.12	1.06	1.12	1.10	1.11	1.09	1.17
3-9	1.08	1.05	.99	.94	1.05	1.09	1.05	.94
3-4	1.04	.98	1.01	.88	1.00	.92	.97	.95
4-7	1.03	1.01	1.00	.96	1.09	1.13	1.00	.97
7-8	1.00	.90	1.03	.87	.77	.62	1.03	.81
3-7	1.10	1.06	1.10	1.00	1.05	1.04	1.05	.96
4-8	1.04	.99	.99	.87	1.00	.95	1.05	.94
4-5	.94	.92	1.04	1.14	.93	.91	.92	.94
5-6	.99	.94	1.00	.97	1.06	1.08	.95	.91
6-7	.90	.89	.93	1.00	.98	.96	.95	.98
5-7	.95	.92	.95	.99	.99	.96	.93	.95
4-6	.94	.93	1.04	1.10	.98	.98	.97	.97

To investigate the nature of sexual-dimorphic shape in the genus, only adults whose sex could be determined were used. PCA were performed on measurements for all four species pooled and for each species separately. Table 3 and Figure 4B show the results for *A. polylepis*; the other analyses produced similar results. The males have further advanced pelvic, anal, and dorsal fins than females. The anal- and dorsal-fin bases are longer in males, and males have wider bodies around the level of the dorsal fin. Table 1 shows that fin lengths are longer in males also.

In a within-group analysis, PCI distributes individuals based on size, yet is not merely a size factor. Its unequal loadings reflect shape that is correlated with size, i.e., allometry. I chose to compare allometric coefficients among these four species, to detect differences in patterns of relative growth. Allometric coefficients are calculated by rescaling the elements of the first eigenvector of a within-group PCA (drawn from a covariance matrix of log-transformed measurements) to have a mean of one, by dividing each element by the square root of the number of variables (Jolicoeur, 1963). These can be interpreted as growth coefficients: segments showing positive allometry, with allometric coefficients greater than one, grow relatively faster

than average, thus contributing more heavily to the size component. Similar interpretations follow for segments showing isometry (allometric coefficient = one) and negative allometry (less than one). Since these are being interpreted to represent relative rates of growth, it is imperative that a full size-range of individuals be included in the analysis.

Allometric coefficients for each of the four species, separated by sex, are presented in Table 4. Several aspects about these deserve comment. First, the four species are generally consistent with each other when they deviate from isometry. Negative allometry is expressed in the head region and caudal peduncle, and the segments crossing the mid-region of the body and anchoring the fins show positive allometry (Fig. 5).

Secondly, the sexual-dimorphic shape differences noted above can be accounted for by differences in relative growth. Segments (9, 10), (2, 9), (1, 9), (2, 3), (8, 9), and (2, 8) are more positively allometric in females than in males, reflecting the more anterior position of the dorsal, pelvic, and anal fins in mature males. Similarly, segments (3, 4), (7, 8), (3, 7), and (4, 8) are more positively allometric in males than in females, reflecting the longer dorsal- and anal fin-base lengths in males.

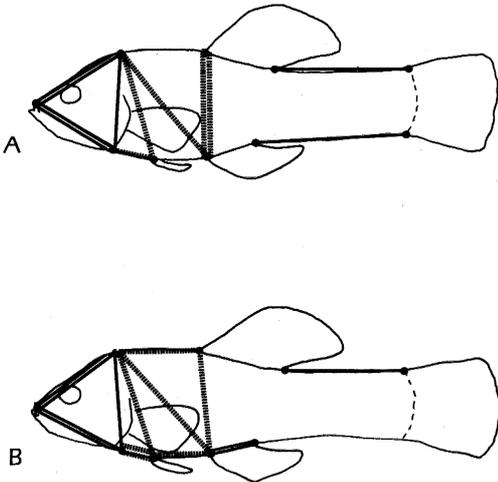


Fig. 5. Depiction of allometries of measurement variables for species of *Allodontichthys*: A) Males; B) Females. Solid lines depict negative allometry; a single solid line represents an allometric coefficient between .85 and .95, a double solid line for allometric coefficients less than .85. Broken lines depict positive allometry; a single broken line represents an allometric coefficient between 1.05 and 1.15, a double broken line for allometric coefficients greater than 1.15. Segments with allometric coefficients between .95 and 1.05 are considered to be relatively isometric and are not depicted on these figures.

Thirdly, *A. zonistius* has slightly higher coefficients for segments (4, 5) and (4, 6), and lower coefficients for (3, 9) than the other three species. This difference in growth patterns, suggesting a more anteriorly placed dorsal fin in *A. zonistius*, was not detected in the pooled PCA.

Finally, a seemingly paradoxical situation arises when comparing *A. hubbsi* to its congeners. The pooled PCA found *A. hubbsi* to have a relatively longer anal-fin base than the other species. The allometric coefficients for this character (7, 8) are smallest in *A. hubbsi*, implying that it grows slower than overall size. This paradox is resolved, however, when the result of the PCA incorporating only young individuals of all four species pooled is recalled. The young *A. hubbsi* already had a larger anal-fin base than did the young of the other species. Therefore, while the anal-fin base of *A. hubbsi* grows slower than it does in the other three species, it starts out bigger.

MATERIAL EXAMINED

Numbers in parentheses indicate the number of specimens examined for meristic data, not the total number in each lot. *Allodontichthys zonistius* (all from Colima, Mexico): UMMZ 189593 (20), Rio de la Comala,

at second bridge south of Colima, 1970; UMMZ 97316 (1), paratype, Colima, 1913; UMMZ 143201 (3), Colima River, .3 km from Colima RR station, 1939; UMMZ 212332 (2), Rio Cobocho, tributary to Rio Salado, west fork, Hwy 54 near Cobono, 1981.

Allodontichthys tamazulae (all from Jalisco, Mexico): UMMZ 192254 (2), tributary to Rio Tuxpan, 4.5 km west of Soyatlan de Afuera, 1969; UMMZ 138688 (1), Rio Tuxpan at Tuxpan, 1941; UMMZ 172163 (2), tributary to Rio Tamazula, .8 km by hwy east of La Garita, 1955; UMMZ 202611 (1), Rio Tamazula ca. 1.6 km east of La Garita, 1978; UMMZ 172159 (20), Rio San Rafael at San Rafael bridge, 1955; UMMZ 190892 (5), Rio Tamazula just below Hwy 110 bridge, 1968; UMMZ 172152 (8), tributary to Rio Naranjo, 8 km by hwy north of Pihuamo, 1955; UMMZ 189602 (20), Rio Terrero about 1.6 km north of 21st de Noviembre, 1970; UMMZ 202621 (5), Rio Tuxpan, ca. 1.6 km north of Atenquique, 1978.

Allodontichthys hubbsi (all from Jalisco, Mexico): UMMZ 191682 (20), Rio Terrero, .8 km west of 21st de Noviembre, 1971; UMMZ 172153 (14), paratypes, tributary to Rio Tuxpan 8 km by hwy north of Pihuamo, on Colima-Jiquilpan hwy, 1955; UMMZ 172165 (2), paratypes, tributary to Rio Tamazula, .8 km by hwy east of La Garita, 1955.

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LITERATURE CITED

- FINK, W. L. 1987. Video digitizer: a system for systematic biologists. *Curator* 30:63-72.
- FITZSIMONS, J. M. 1981. Sensory head pores and canals in goodeid fishes. *Occ. Pap. Mus. Zool. Univ. Michigan* 60:1-10.
- GOSLINE, W. A. 1949. The sensory canals of the head in some cyprinodont fishes, with particular reference to the genus *Fundulus*. *Occ. Pap. Mus. Zool. Univ. Mich.* 519:1-17.
- HUBBS, C. L., AND C. L. TURNER. 1939. Studies of the fishes of the Order Cyprinodontes. XVI. A revision of the Goodeidae. *Misc. Publ. Mus. Zool. Univ. Mich.* 42:1-80.
- HUMPHRIES, J. M., F. L. BOOKSTEIN, B. CHERNOFF, G. R. SMITH, R. L. ELDER AND S. G. POSS. 1981. Multivariate discrimination by shape in relation to size. *Syst. Zool.* 30:291-308.
- JOLICOEUR, P. 1963. The multivariate generalization of the allometry equation. *Biometrics* 19:497-499.
- LEVITON, A. E., R. H. GIBBS, JR., E. HEAL AND C. E. DAWSON. 1985. Standards in ichthyology and herpetology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985:802-832.
- MILLER, R. R. 1948. The cyprinodont fishes of the Death Valley system of eastern California and southwestern Nevada. *Misc. Pap. Mus. Zool. Univ. Mich.* 68:1-155.
- . 1986. Composition and derivation of the

- freshwater fish fauna of Mexico. *An. Esc. Nac. Cienc. Biol. Mex.* 30:121–153.
- , AND T. UYENO. 1980. *Allodontichthys hubbsi*, a new species of goodeid fish from southwestern Mexico. *Occ. Pap. Mus. Zool. Univ. Mich.* 692:1–13.
- , AND M. L. SMITH. 1986. Origin and geography of the fish fauna of Central Mexico, p. 391–415. *In: The zoogeography of North American freshwater fishes.* C. R. Hocutt and E. O. Wiley (eds.). Wiley-Interscience, New York, New York.
- SMITH, M. L., AND R. R. MILLER. 1987. *Allotoca goslinei*, a new species of goodeid fish from Jalisco, Mexico. *Copeia* 1987:610–616.
- TURNER, C. L. 1946. A contribution to the taxonomy and zoogeography of the goodeid fishes. *Occ. Pap. Mus. Zool. Univ. Mich.* 495:1–13.
- UYENO, T., R. R. MILLER AND J. M. FITZSIMONS. 1983. Karyology of the cyprinodontoid fishes of the Mexican family Goodeidae. *Copeia* 1983:497–510.

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Copeia, 1988(2), pp. 441–449

Description of a Genus and Three Deep Water Species of Fishes (Teleostei: Cichlidae) from Lake Malawi, Africa

JAY R. STAUFFER, JR. AND KENNETH R. MCKAYE

A genus and three new species of fishes are described from Lake Malawi. The genus is characterized by a small mental prominence at the symphysis of the dentaries; body marked with 6–8 black vertical bars; and enlargement of the lateral line tubules.

CICHLID fishes present an outstanding case of explosive radiation in extant vertebrates. The rift valley lakes of Africa contain an extremely diverse fish fauna due primarily to the speciation of endemic haplochromine cichlids (Regan, 1921; Trewavas, 1935; Greenwood, 1979). The genera *Docimodus* Boulenger (Eccles and Lewis, 1976), *Lethrinops* Regan (Eccles and Lewis, 1977, 1978, 1979), *Labidochromis* Trewavas (Lewis, 1982) and a group of species of *Petrotilapia* Trewavas (Marsh, 1983) which inhabit Lake Malawi have recently been revised. However, the phylogenetic interrelationships and generic status of most of the endemic cichlids in Lake Malawi are unknown (Stiassny, 1981) Regan (1921) although stating that the Lake Malawi (Nyassa) “species are a natural group” placed a large number of Lake Malawi species into the genus *Haplochromis*. Recently, Greenwood (1979) restricted the genus *Hap-*

lochromis to five species of cichlids occurring in lakes Victoria, Edward, George, and Kivu. This revision is not completely accepted, as some individuals (Barel, 1984; Hoogerhoud, 1984) prefer to maintain the nomenclature prior to 1979 for the Lake Victoria cichlid flock. No disagreement, however has been expressed concerning the removal of the Lake Malawi cichlids from the genus *Haplochromis*.

Greenwood (1979) suggested that the temporary formal name *Cyrtocara* be used for “*Haplochromis*” species of Lake Malawi, but in a later publication he referred to these forms under “*Haplochromis*” (Greenwood, 1983:228). However, he did not imply that any of these species have a true phyletic relationship to the type species, *Cyrtocara moori* Boulenger. We have used *Cyrtocara* for earlier descriptions of Lake Malawi cichlids (McKaye and McKenzie, 1982; Stauffer and McKaye, 1985) and will refer to

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