

## Two new species of cichlid fishes, *Cichlasoma sajica* and *C. diquis*, from southeastern Costa Rica

by

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(Received for publication July 2, 1973)

**ABSTRACT:** Two new endemic forms are added to the growing list of species indigenous to the tropical wet rainforest region of the Pacific versant of Costa Rica. The new species are described from extensive material collected from throughout their respective ranges. In addition to meristic and morphometric data, the colors of live specimens, sexual dimorphism, and ecological aspects are discussed.

Both new species appear to represent Pacific slope cognates of Trans-American geminate pairs: *Cichlasoma sajica* and the Atlantic slope *C. septemfasciatum*, and *C. diquis* and the principally Atlantic slope *C. alfari*. It is postulated that these and other geminate pairs with similar distributions arose from common ancestors on the Tertiary Talamancan Island, and that during the Pliocene the members of each species pair were isolated from each other by the emerging intercontinental land bridge between the Americas.

Until recent years one of the ichthyologically least explored areas of Central America was the wet rainforest region of southeastern Costa Rica. As a result of collections made in the last decade, five new species of freshwater fishes have been described (1, 4). The strange sexual dimorphism of a sixth form was described, but the species was not formally named (2). All these species are apparently endemic to the region.

In spite of the relative faunal diversity of the area, and the exceptional radiation of *Cichlasoma* in Central America, few cichlids have been reported from southern Costa Rica. The present paper brings the total of the region to six species: one species of *Aequidens* and five species of *Cichlasoma*, i.e., *Amphilophus* species group—*Cichlasoma altifrons* (Kner and Steindachner), *C. lyonsi* Gosse, *C. diquis*, new species; *Archocentrus* species group—*C. sajica*, new species; *Theraps* species group—*C. sieboldii* (Kner and Steindachner).

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## MATERIAL AND METHODS

All body measurements refer to standard length (SL) in millimeters (mm). All proportional measurements are expressed as times in SL or times in head length. Body proportions as thousandths of SL appear in Table 1. The last two dorsal and anal rays are counted as one only when their bases are in contact; when the base of the last ray is not touching the penultimate ray, each ray is counted separately.

The type material is listed by drainage basins in the following manner: catalog number, locality with elevation in meters (m) in parentheses, date, number of specimens in parentheses and their size range in millimeters (mm). Abbreviations are spelled out when used for the first time. Distances are expressed as kilometers (km) by road or air kilometers (airkm). A "quebrada" is a small river or stream.

The type specimens are deposited at the Natural History Museum of Los Angeles County (LACM), Museo de Zoología, Universidad de Costa Rica (UCR), and the United States National Museum (USNM).

*Cichlasoma sajica*, n. sp.

(Fig. 1)

**HOLOTYPE:** LACM 33902-1, a male, 70.8 mm, Costa Rica, Puntarenas Province, tributary (20 m) of Río Sierpe 2 km S of Palmar Sur at Interamerican Highway (IH), original collection number CR64-3, 4 January 1964, collected by W. A. Bussing.

**PARATYPES:** Collections UCR 300-5, 380-8 and 393-11 of the Río Térraba drainage were made in San José Province; all other collections are from Puntarenas Province.

**RIO SIERPE DRAINAGE:** LACM 4853: Same data as holotype (5) 36-67 mm. UCR 114-12: Same locality as holotype, 6 January 1967 (25) 11-79 mm. UCR 179-1: Same locality as holotype, 14 April 1967 (4) 43-67 mm. LACM 2760: Tributary (20 m) of Río Sierpe 10.3 km SE of Palmar Sur at IH, 6 August 1961 (1) 55 mm. UCR 112-16: Tributary (20 m) of Río Sierpe 1 km SE of Río Salamá Nuevo at IH, 5 January 1967 (60) 11-90 mm. USNM 194247: Same locality as UCR 112-16, 21 January 1963 (5) 44-66 mm.

**RIO TERRABA DRAINAGE:** LACM 4830: Branch of Río Térraba (20 m) 4 km NW of Palmar Norte on road to Puerto Cortés, 4 January 1964 (61) 12-74 mm. LACM 2928: Río Sonador? (570 m) 6.5 km NW of Volcán on old IH, 27 December 1961 (3) 28-46 mm. UCR 393-11: Río Pedregoso (660 m) 3 km SW of San Isidro de El General on Dominical road, 3 February 1970 (5) 39-45 mm. UCR 300-5: Tributary (680 m) of Río Pacuar behind town slaughterhouse at San Isidro de El General, 28 December 1968 (17) 26-58 mm. UCR 380-8: Same locality as UCR 300-5, 8 November 1969 (1) 55 mm.

**RIO ESQUINAS DRAINAGE:** UCR 111-19: Quebrada 36 (80 m) 12 km W of Pueblo Río Claro at IH, 5 January 1967 (89) 24-70 mm. LACM 33904-1: Same data as UCR 111-19 (20) 22-68 mm. USNM 211619: Same data as UCR 111-19

(20) 24-67 mm. UCR 757-6: Quebrada Angelina (60 m) 0.5 km NW of Villa Briceño at IH, 1 March 1973 (2) 49-61 mm.

INDEPENDENT DRAINAGES, PARRITA-QUEPOS AREA: UCR 304-9: Tributary (15 m) of Río Jicote 0.5 km S of Loma on Puriscal-Parrita road, 16 January 1969 (10) 32-49 mm. UCR 309-1: Drainage canal (20 m) tributary of Río Palo Seco 4 km E of Parrita on Parrita-Quepos road, 17 January 1969 (10) 29-75 mm. UCR 311-4: Quebrada Bonita (10 m) S of Damas 9 km NW of Quepos, 18 January 1969 (53) 27-90 mm. LACM 33905-1: Same data as UCR 311-4 (10) 30-84 mm. USNM 211618: Same data as UCR 311-4 (10) 34-86 mm.

RÍO RINCON DRAINAGE: UCR 69-7: Flooded gravel pit in Río Riyito (20 m) near Charcos 2 airkm S of Rincón airfield, 10 August 1966 (353) 10-78 mm. LACM 33903-1: Same data as UCR 69-7 (20) 12-73 mm. USNM 211617: Same data as UCR 69-7 (20) 13-78 mm. UCR 163-3: Same locality as UCR 69-7, 2 August 1967 (4) 22-66 mm. UCR 164-7: Same locality as UCR 69-7, 7 August 1967 (57) 11-73 mm. UCR 165-3: Same locality as UCR 69-7, 9 August 1967 (8) 53-88 mm. UCR 172-3: Río Riyito (10 m) ca. 5 airkm S of Rincón airfield, 28 February 1967 (3) 15-27 mm. UCR 173-6: Quebrada Aguabuena (30 m) 1 km upstream from Tropical Science Center near Rincón airfield, 28 February 1967 (22) 17-73 mm. UCR 251-7: Same locality as UCR 173-6, 5 March 1968 (3) 41-70 mm. UCR 250-3: Quebrada Banegas (10 m) 0.8 km upstream from Pacific Road 3 airkm SW of Rincón, 1 March 1968 (29) 12-73 mm.

INDEPENDENT DRAINAGES, OSA PENINSULA: UCR 166-3: Stream (10 m) S of Estero Grande on Pacific Road between Rincón and Playa Blanca, 10 August 1967 (30) 36-76 mm. UCR 175-3: Quebrada Tortuga at coastal road ca. 8 km SW of Bahía Drake, 18 March 1967 (2) 30-60 mm.

DIAGNOSIS: A small *Cichlasoma*, forming part of the *Cichlasoma nigrofasciatum* complex. Thus, the new form presents general characteristics which situate it in the *Archocentrus* section or species group of *Cichlasoma*, but exceeds the ranges of meristic variation indicated for the group by REGAN (8). The new species is distinguished by the following combination of characters: 1) Dorsal spines 16-18, dorsal soft rays 9-11; anal spines 6-7, anal soft rays 7-9. 2) Six or seven dark vertical bars on body; third bar (opposite tip of pectoral fin) most prominent at all ages; caudal spot faint or absent. 3) Mature males with small spots on last dorsal and anal soft rays and caudal fin. 4) Mature females without fin spotting, but with intense black margin of dorsal and anal fins.

The intraspecific variation of this species and three other closely related species of the *Archocentrus* species group will be treated in a forthcoming publication.

DESCRIPTION: Body deep, greatest depth (at origin of pelvic fins) in SL 1.8-2.2 times. Body outline nearly oval, but slightly deeper anteriorly. Predorsal profile including snout, evenly convex in adults, but nearly straight in some juveniles. Ventral profile not as rounded as dorsal profile. Mouth subterminal. Caudal peduncle depth 6.1-6.7 times in SL; caudal peduncle

TABLE 1

Meristics and proportions in thousandths of standard length of holotypes and twenty-five paratypes each of *Cichlasoma sajica*, n. sp. and *Cichlasoma diquis*, n. sp.

	<i>Cichlasoma sajica</i>			<i>Cichlasoma diquis</i>		
	Holotype	Paratypes*	$\bar{x}$	Holotype	Paratypes**	$\bar{x}$
Dorsal spines	16	16-18	16.9	16	15-17	16.1
Dorsal rays	11	9-11	10.2	11	10-13	11.6
Anal spines	7	6-7	6.9	6	5-7	6.6
Anal rays	8	7-9	8.0	9	8-9	8.8
Pectoral rays	15	14-16	15.1	15	14-16	15.1
Pelvic rays	I,5	I,5	I,5	I,5	I,5	I,5
Caudal rays	15	15	15	16	15-16	16.0
Total gill rakers	9/10	7-10	8.7	14/14	11-14	12.5
Pores upper lat. line	18/20	18-20	19.3	19/20	17-21	19.3
Pores lower lat. line	9/9	7-10	8.9	10/10	9-12	10.5
Longitudinal scales	27/27	27-28	27.6	29/29	28-30	28.6
Scales above lat. line	4/4	3-4	4.0	5/5	4-5	4.8
Scales below lat. line	10/10	9-11	10.0	12/12	11-12	11.4
Scales caud. peduncle	17	17-18	17.3	—	—	—
Standard length (mm)	70.8	48.0-75.8	58.4	116.3	80.9-133.0	96.4
Head length	356	343-371	357	391	373-413	394
Orbit diameter	96	92-112	102	86	82-105	93
Snout length	115	121-151	135	191	174-207	188
Upper jaw length	105	94-109	101	134	124-149	134
Bony interorbital	137	105-134	117	120	107-126	110
Greatest depth	544	456-555	512	437	373-459	420
Suborbital distance	106	68-90	77	121	100-124	114
Peduncle depth	162	150-165	158	147	136-157	148
Peduncle length	133	127-153	137	138	133-153	143
Predorsal distance	431	392-424	411	437	413-453	434
Precanal distance	641	619-679	645	694	654-701	674
Prepectoral distance	347	356-386	369	388	371-399	387
Prepelvic distance	407	390-427	407	435	414-458	422
Length pectoral fin	325	245-297	278	279	256-313	301
Length pelvic fin	458	320-413	354	273	254-342	297
Length dorsal fin base	657	587-675	636	577	528-603	571
Length anal fin base	322	270-350	310	248	219-287	249
Length mid-caudal rays	374	303-348	322	288	279-345	309
Length 6th dorsal spine	117	105-135	117	89	79-116	94
Length last dorsal spine	178	139-177	159	—	111-172	136

\*25 specimens from UCR 69-1, 111-19, 112-16, 300-5, 311-14.

\*\*25 specimens from UCR 40-3, 42-8, 101-9, 104-16, 111-18, 112-18, 114-11, 299-3, 300-4, 306-7, 519-1, 756-21, LACM 2713, 4819.

length from end of anal fin base to middle of caudal base 6.6-8.2 times in SL.

Head length including opercular membrane 2.7-2.9 times in SL. Eyes of moderate size; horizontal orbit diameter 3.2-3.8 times in head length. Inter-orbital space convex, least width of bony interorbital 2.6-3.3 times in head length. Least width of suborbital from posterior tip of maxillary to nearest point on fleshy margin of orbits 3.4-5.3 times in head length. Snout length greater than orbit diameter, 2.3-3.0 times in head length.

Mouth small. Upper jaw moderately protractile, premaxillary spines on vertical from anterior margin of eye. Maxillary not reaching vertical with anterior margin of eye; length of upper jaw, from snout tip to postero-ventral end of maxillary 3.3-3.8 times in head length. Fold of lower lip interrupted by wide frenum at midline. Teeth forming bands (wider medially) in both jaws. Teeth conical, those of outer row larger and becoming smaller laterally. Teeth of inner row projecting slightly above fleshy gums, teeth of outer row slightly longer. Teeth of inner row and lateral teeth of outer row, wide-based and compressed antero-posteriorly. Medial teeth of outer row compressed in young, but nearly round in cross section, and blunted, in large adults. All jaw teeth with brown tips in adults. Each upper pharyngeal bone with convex surface bearing oval patch of curved retrorse teeth; anterior teeth largest and round in cross section, posterior teeth progressively smaller and laterally compressed. Lower pharyngeal plate triangular with apex directed anteriorly and tooth-bearing surface concave; teeth antrorse, small anteriorly and large posteriorly. Many smaller pharyngeal teeth with shoulder or incipient second cusp on inside of curved surface. Thus, the pharyngeal mill is an efficient shredding apparatus with large teeth opposing small teeth and the upper teeth directed posteriorly and the lower teeth anteriorly.

Gill rakers of first arch short, pointed and slightly longer than width of base in young; gill rakers of large specimens shorter, truncate and some with lateral ramifications. One or two rakers on upper limb, angle of two limbs of gill arch indistinct. Total gill rakers 7-10, usually 9. Sensory pores between tip of chin and angle of preopercle 7 (4 on mandible, 3 on ventral margin of preopercle) on 15 specimens; one specimen with 2 pores on one mandible and 3 on other mandible.

Upper lateral line commencing just above upper margin of gill opening, following same curve as dorsal profile, and terminating below first soft dorsal fin rays; pored scales 18-20, usually 19. Lower lateral line beginning three scale rows below end of upper lateral line, and continuing to end of hypural complex; pored scales 7-10, usually 9; two additional pored scales on mid-caudal fin rays not included in count. Scales in longitudinal series from upper margin of gill opening to end of hypural complex 27-28, usually 28. Transverse scale rows between origin of dorsal fin and lateral line 3-4, usually 4. Transverse scale rows between origin of anal fin and lateral line 9-11, usually 10. Scale rows around caudal peduncle 17-18, usually 17.

Two branches of the acoustico-lateralis system are found on the caudal

the end of the dorsal fin base and the end of the anal fin base. The seventh bar is centered on the caudal peduncle or lies slightly closer to the caudal fin base; this bar is very faint or absent on some individuals. A blotch wholly on the caudal fin base is distinct on some individuals and absent from others; this blotch is usually centered on the fin base and rarely extends from dorsal to ventral margins. The blotch was not included in the vertical bar count.

Anterior to the first vertical bar of some males, are one or two indistinct short bars inclined toward the head. The anteriormost bar is most evident dorsally at the nape and fades out before reaching the upper margin of the gill opening. The second short bar is most pronounced below the dorsal fin origin and fades out posterior to the gill opening or may fuse with the first vertical bar. On some preserved material an indistinct horizontal band lies perpendicular to the third bar and extends anteriorly to the upper margin of the gill opening.

The head of males is a uniform dark brown on many fish, but on others the opercle is darker and the lower lip and throat paler.

The median fins of males are dusky. A diffuse continuation of the third vertical bar occurs on the interradiation membranes between dorsal spines 10-12 or 11-13. Small dark spots occur on the interradiation membrane of the last few soft rays of the dorsal and anal fins. Similar spots are most prominent on the proximal half of the caudal fin. Male specimens collected at San Isidro de El General lack spotting on the median fins. The pectoral fins are clear and the pelvic fins are dusky to black.

Preserved females differ from males only in the coloration of the median fins. The dorsal and anal fins of females are primarily clear subdistally with a black distal border and with some brown pigment near the base. The black border is especially prominent on the spinous portion of these fins, but in some specimens also extends onto the margin of the soft dorsal fin. The basal portion of the dorsal and anal fins, which is covered by small scales, is dark brown. The interradiation membranes of the remaining portion of these fins are pale dusky or clear, and contrast with the dark pigmentation of the fin elements. A few clear spots appear on the dusky membrane of the last soft dorsal and anal rays of some females, but the minute black spotting found in males is absent. The caudal fin rays are dark and the interradiation membrane dusky on the basal third of the fin, but clear distally. Although a few dark spots appear near the base of the caudal fin of some females, the fin is never evenly spotted as in males.

Immature specimens are brown and usually have a more evident vertical bar pattern than adults. The prominent third bar often continues to the tips of the dorsal spines under which base it lies. The median fins are dusky, but show some dark spotting on the soft dorsal and anal rays of males 33 mm long.

**COLORATION IN LIFE:** The colors of a mature pair of freshly collected specimens from the Río Rincón Drainage are essentially the same as colors

noted on a live breeding pair collected in the Río Sierpe Drainage.

The ground color of the male is brown above and a pale lavender-brown on the ventral half. The ventral opercular region is dusky blue. Both the spinous and soft dorsal fins are narrowly margined with red. The dorsal fin elements are reddish; the interradial membrane is iridescent pale blue. The anal fin is similar, but lacks the red margin. Both soft dorsal and anal fins bear maroon spots posteriorly. The proximal third of the caudal fin is brown, but the distal portion bears small maroon spots. The pectoral fins are clear yellow. The pelvic fins are dusky, with the first soft (filamentous) ray very dark or black. The iris is brown, but blue and gold iridescent areas are usually evident.

The female has a dark brown body with some flecks of gold iridescence on the dorsal half. When she is guarding eggs or young the posterior half of the body becomes straw-colored. The lower opercular region, as in the males, is dusky blue. The spinous dorsal and anal fins, and often the first few soft rays of these fins, are margined in jet black. The rather wide black margin contrasts with the remainder of the dorsal and anal fins, which are bright iridescent yellow-orange. The proximal third of the caudal fin is dusky; the posterior two-thirds of the fin are bright iridescent yellow-orange. The pectoral fins are pale yellow and the pelvic fins dusky blue with a black filamentous soft ray. Parts of the iris are bright blue, other areas are brown.

**SEXUAL DIMORPHISM:** In addition to the sexual dichromatism of mature fishes, external sexual differences are restricted to the slightly longer pelvic filament of males, differences in form of the urogenital papillae, and difference in maximum length of the sexes. The male urogenital papilla is conical with a pointed tip. The ventral surface of the papilla is slightly rugose; the opening is terminal. The female papilla has a wide spongy termination. A broad opening occurs on the ventral surface of the papilla. The largest specimens of any given locality were males. An exceptionally large female attains 70 mm, whereas many of the males collected were larger than 80 mm. The largest specimens collected were males 90 mm long.

**ETYMOLOGY:** The specific name, *sajica*, is an acronym utilizing the initial two letters of the given name and paternal and maternal surnames of Salvador Jiménez Canossa, Director of the Library of Congress of Costa Rica. The name is treated as an arbitrary combination of letters, i.e., as an indeclinable noun. Sr. Jiménez, a friend and experienced field collector, accompanied me on most of my early collecting trips in Costa Rica, and through his enthusiasm and curiosity of nature, contributed greatly to their success. I propose the common name "False Convict Cichlid" for the species.

**ECOLOGY:** *Cichlasoma sajica* is abundant in small and moderate-sized streams, especially near shore over gravel or soft substrates. It was not seen in rapid water nor collected in streams larger than a few meters wide.

Its food consists largely of plant matter, based on the stomach and upper intestinal contents of twelve specimens from different localities. At some localities food consisted mainly of filamentous algae and a few small seeds. In other collections small seeds contributed the bulk of the ingested material. Unidentifiable plant matter probably consisted of triturated seeds. Only two of the twelve specimens contained animal matter: aquatic insect fragments and a small fish.

Collections made during different months were inspected cursorily for females with the most distended bellies. Ripe individuals were found in collections made during the dry season from December to February. The only samples taken during the rainy season (in April and August) revealed no ripe females, but young taken in August were estimated to vary in age from one to three months. These inconclusive data suggest that breeding occurs in both wet and dry seasons, but may be periodic rather than continuous.

The large amber-colored eggs of *C. sajica* were found on the underside of a flat rock in Quebrada Aguabuena on the Osa Peninsula. In an aquarium an adult pair spawned on the inside of an overturned flower pot. The spawning occurred in May, but the parents lost the brood to other cichlids. A second spawning occurred on November 1 and was saved by transferring the eggs and parents to another tank. Both parents took turns guarding the eggs, but the female was more aggressive and active in caring for the fry.

**GEOGRAPHIC DISTRIBUTION:** *Cichlasoma sajica* has been collected only in southern Costa Rica on the Pacific versant, from just south of Punta Mala (Punta Judas) to the Río Esquinas basin which flows into the upper Golfo Dulce. The species is the only *Cichlasoma* reported from the Osa Peninsula. The species has not been taken in the Río Tárcoles Drainage to the north nor the Río Coto watershed in extreme southern Costa Rica, next to the Panamá border.

*Cichlasoma diquis*, n. sp.

(Fig. 2)

*Cichlasoma alfari*, Bussing (in part) (not Meek, 1907), 1967, *Rev. Biol. Trop.*, 14: 231 (intra- and interspecific variation).

**HOLOTYPE:** LACM 33911-1, a male, 116.3 mm, Costa Rica, Puntarenas Province, tributary (20 m) of Río Sierpe 2 km S of Palmar Sur at IH, original collection number UCR 114-11, 6 January 1967, collected by W. A. Bussing and O. Blanco B.

**PARATYPES:** Collections LACM 4838 and LACM 4740 of the Río Térraba Drainage and paratypes from all other drainages were collected in Puntarenas Province. All other collections from the Río Térraba Drainage were made in San José Province in the vicinity of San Isidro de El General.

**RÍO SIERPE DRAINAGE:** UCR 114-11: Same data as holotype (13) 39-133 mm.



USNM 211622: Same data as holotype (10) 45-75 mm. LACM 2759: Tributary (20 m) of Río Sierpe 10.3 km SE of Palmar Sur at IH, 6 August 1961 (1) 109 mm. UCR 112-18: Tributary (20 m) of Río Sierpe 1 km SE of Venecia and 200 m SE of Río Salamá Nuevo at IH, 5 January 1967 (3) 48-87 mm.

Río TÉRRABA DRAINAGE: LACM 4838: Branch of Río Terraba (20 m) 4 km NW of Palmar Norte on road to Puerto Cortés, 4 January 1964 (2) 49-59 mm. LACM 4740: Río Convento (540 m) 32.8 km SE of San Isidro de El General at IH, 25 July 1963 (6) 40-89 mm. UCR 519-1: Tributary (540 m) of Río Peje, 13 km S of San Isidro de El General, 1 km N of IH, 25 November 1971 (37) 34-85 mm. LACM 2942: Río Peje (560 m) 11 km S of San Isidro de El General at IH, 16 July 1961 (3) 20-37 mm. LACM 2713: Same locality as LACM 2942, 27 December 1961 (11) 25-110 mm. LACM 2954: Same locality as LACM 2942, 28 December 1961 (2) 29-53 mm. LACM 2960: Same locality as LACM 2942, 11, 12 July 1962 (35) 20-47 mm. UCR 41-2: Same locality as LACM 2942, 29 July 1966 (2) 38-49 mm. UCR 42-8: Quebrada Paja de Agua (610 m) 8 km S of San Isidro de El General on N side of IH, 29 July 1966 (5) 26-89 mm. UCR 40-3: Río Pedregoso (700 m) 3 km W of San Isidro de El General in Finca Villa Nueva, 19-21 July 1966 (5) 26-94 mm. UCR 298-2: Swamp (680 m) on Dominical road 0.5 km S of airfield at San Isidro de El General, 26 December 1968 (8) 48-80 mm. UCR 299-3: Swamp (680 m) on Dominical road 1 km S of airfield at San Isidro de El General, 28 December 1968 (8) 24-102 mm. UCR 300-4: Tributary (680 m) of Río Pacuar behind town slaughterhouse at San Isidro de El General, 28 December 1968 (32) 16-114 mm. USNM 211623: Same data as UCR 300-4 (10) 25-77 mm. UCR 380-3: Same locality as UCR 300-4, 8 November 1969 (5) 31-70 mm.

Río ESQUINAS DRAINAGE: UCR 111-18: Quebrada 36 (80 m) 12 km W of Pueblo Río Claro at IH, 5 January 1967 (21) 31-93 mm.

INDEPENDENT DRAINAGES, PARRITA AREA: UCR 304-8: Tributary (15 m) of Río Jicote 0.5 km S of Loma on Puriscal-Parrita road, 16 January 1969 (1) 57 mm. UCR 305-2: Tributary of Quebrada Visita on Loma-Esterillos road, 16 January 1969 (1) 51 mm. UCR 306-7: Tributary of Quebrada Visita ca. 4 km E of Esterillos on Loma-Esterillos road, 16 January 1969 (2) 34-83 mm.

Río COTO DRAINAGE: LACM 4864: Stream (20 m) 7.5 km S of IH on road to Golfito, 5 January 1964 (2) 44-67 mm. UCR 110-7: Stream 5.4 km S of IH on road to Golfito, 4 January 1967 (3) 39-41 mm. LACM 4770: Río Caracol (20 m) 8.8 km NW of Villa Neily on IH, 7 January 1964 (7) 40-74 mm. UCR 756-21: Same locality as LACM 4770, 27 February 1973 (7) 52-111 mm. LACM 4819: Quebrada San Antonio (20 m) 14.6 km E of Golfito on Golfito road, 6 January 1964 (7) 27-100 mm. UCR 101-9: Río Nuevo (20 m) 12 km E of Pueblo Río Claro at IH, 2 January 1967 (8) 27-82 mm. UCR 104-16: Tributary (40 m) of Río Corredores 0.5 km E of Villa Neily junction at IH, 3 January 1967 (19) 29-88 mm. USNM 211339: Same data as UCR 104-16 (10) 33-65 mm. UCR 103-7: Quebrada La Palma 3 km W of Paso Canoas at IH, 3 January 1966 (2) 54-63 mm.

COMPARATIVE MATERIAL OF *Ciclasoma alfari*: Only collections of *C. alfari* from the Pacific versant, which were not included in BUSSING (1), are included here.

Río GRANDE DE TÁRCOLES DRAINAGE: LACM 9244-1: San José Province, Río María Aguilar (1150 m) on S side of San José next to Colegio Seminario, 12 August 1961 (24) 18-37 mm. UCR 243-2: San José Prov., tributary (900 m) of Río Virilla near Santa Ana 13 km W of San José on Highway 7, 14 April 1968 (4) 52-54 mm.

UCR 144-2: San José Prov., Río Pacaca (780 m) at Highway 7 bridge on N side of Villa Colón, 14 April 1968 (34) 13-117 mm. UCR 85-2: Alajuela Prov., Río Alajuela (650 m) 2 km E of Santa Rosa at bridge on Santa Rosa-El Coyol road, 10 September 1966 (9) 70-116 mm.

RÍO BEBEDERO DRAINAGE: UCR 149-1: Guanacaste Prov., Río Higuerón (50 m) 10 km S of Cañas at IH, 10 July 1967 (31) 33-112 mm. UCR 765-3: Guanacaste Prov., Río Sandillal (55 m) 2.5 km NW of Cañas at IH, 29, 30 April 1973 (8) 25-40 mm.

**DIAGNOSIS:** This moderate-sized species is most similar to members of the *Amphilophus* species group of *Cichlasoma* as defined by REGAN (8). The new form is distinguished from its congeners of this species group by the following combination of characteristics: 1) Dorsal spines 15-17, dorsal soft rays 10-13; anal spines 5-7, anal soft rays 8-9. 2) Fold of lower lip broadly interrupted at symphysis. 3) Posterior margin of caudal fin rounded. 4) Black blotch in axil of pectoral fin; dorsal fin with red distal margin and pale blue subdistal margin; black blotches on spinous dorsal of females. 5) Vertical bar pattern on body irregular; a small blotch on flanks and upper base of caudal fin; longitudinal band, if present, not continuous.

**DESCRIPTION:** Body slender to moderately deep, varying with geographic range. Greatest depth (at origin of pelvic fins) in SL 2.2-2.7 times. Dorsal profile of head slightly convex or straight from tip of snouth to nape; more strongly convex just anterior to origin of dorsal fin. Ventral profile of head a continuation of the gently rounded ventrum. Mouth subterminal. Caudal peduncle depth 6.5-7.4 times in SL; caudal peduncle length from end of anal fin base to middle of caudal base 6.6-7.5 times in SL.

Head length including opercular membrane 2.4-2.7 times in SL. Eyes of moderate size; horizontal orbit diameter 3.8-4.7 times in head length. Interorbital space convex, least width of bony interorbital 3.1-3.8 in head length. Least width of suborbital from posterior tip of maxillary to nearest point on fleshy margin of orbits 3.1-3.9 times in head length. Snout length much greater than orbit diameter, 2.0-2.2 times in head length.

Mouth large. Upper jaw greatly protractile, premaxillary spines not reaching a vertical from anterior margin of eye. Maxillary not reaching vertical with anterior margin of eye; length of upper jaw, from snout tip to postero-ventral end of maxillary 2.7-3.3 times in head length. Fold of lower lip interrupted by wide frenum at midline. Jaw teeth conical, slightly recurved and brown-tipped in adults; round in cross section with no tendency to become compressed with age. Each jaw with one enlarged outer tooth row and 3-4 inner rows. Lower jaw with medial six teeth set slightly anterior to smaller lateral teeth of outer row; three regular inner rows of smaller teeth. Medial teeth of outer row of upper jaw enlarged, but not set anteriorly as in lower jaw; remaining teeth of outer row decreasing in size laterally; three or four inner rows medially of much smaller teeth, one row laterally. Each upper pharyngeal bone with convex surface bearing teeth of diverse forms; two

anterior rows of antero-posteriorly compressed teeth with sharp tips directed laterally; of remaining teeth, median ones massive and round in cross section, lateral teeth laterally compressed with sharp tips directed posteriorly. Lower pharyngeal plate triangular with apex directed anteriorly and tooth-bearing surface concave; medio-posterior teeth massive and round in cross section; teeth on lateral and anterior portion of bone smaller, laterally compressed and with sharp tips directed anteriorly. Many smaller pharyngeal teeth with shoulder or incipient second cusp on inside of curved surface.

Gill rakers of upper limb of first arch long and slender, those of lower limb short, truncate and usually bilobed. Three or four rakers on upper limb and 8-10 rakers on lower limb including angle. Total gill rakers 11-14, usually 12. Sensory pores between tip of chin and angle of preopercle 7 (4 on mandible, 3 on ventral margin of preopercle) on 20 specimens.

Upper lateral line beginning just above upper margin of gill opening, following same general curve as dorsal profile, and terminating below first soft dorsal fin rays; pored scales 17-21, usually 20. Lower lateral line beginning three scale rows below end of upper lateral line, and continuing to end of hypural complex; pored scales 9-12, usually 10; 1-3 additional pored scales, usually 2, on mid-caudal fin rays not included in previous count. Scales in longitudinal series from upper margin of gill opening to end of hypural complex 28-30, usually 28. Transverse scale rows between origin of dorsal fin and lateral line 4-5, usually 5. Transverse scale rows between origin of anal fin and lateral line 11-12, usually 11.

The number of pored scales of the caudal branches of the acoustico-lateralis system is highly variable. The holotype and some other large specimens have no pored caudal scales. On smaller individuals, 1-6 pored scales are found between the eleventh and twelfth or twelfth and thirteenth principal rays; 1-6 pored scales also occur between principal rays 5 and 6, 6 and 7, and 7 and 8. The pored caudal scales do not form a continuous series with the trunk lateral lines.

Origin of dorsal fin approximately over posterior margin of opercle, fin usually with XVI, 13 rays, range (based on 204 specimens) XV-XVII, 10-13 rays. Distance from tip of snout to origin of dorsal fin (predorsal distance) 2.2-2.4 times in SL. Length of dorsal fin base 1.7-1.9 times in SL. Dorsal fin spines progressively longer posteriorly; length of sixth dorsal spine 8.6-12.6 times in SL, length of last dorsal spine 5.8-9.0 times in SL. Soft dorsal fin of large individuals of both sexes sometimes produced into a filament reaching to posterior third of caudal fin.

Anal fin usually with VI, 9, range based on 204 specimens V-VII, 8-9 rays. Preanal distance 1.4-1.5 times in SL. Length of anal fin base 3.5-4.2 times in SL.

Pectoral fin rays 14-16, usually 15. First (dorsal) two and last (ventral) two rays unbranched; first ray short and closely affixed to second ray; all other rays unbranched. Distance from tip of snout to dorsal margin of pectoral

fin base (prepectoral distance) 2.5-2.7 times in SL. Distal margin of pectoral fin rounded, not quite reaching to vertical from anal fin origin; length from dorsal margin of base to tip of appressed fin 3.2-3.9 times in SL.

Pelvic fin rays I, 5 in 26 specimens. Distance from tip of snout to insertion of pelvic fin (prepelvic distance) 2.2-2.4 times in SL. Pelvic fin tips of adults of both sexes, produced into filaments which reach first or second anal fin spine. Length from pelvic insertion to tip of produced ray 2.9-3.9 times in SL.

Principal caudal rays (number of branched rays plus two) 15 in one paratype, 16 in 25 other specimens. Caudal fin rounded; length of middle caudal rays 2.9-3.6 times in SL.

**COLOR OF SPECIMENS IN ALCOHOL:** The variation of the color pattern can be noted on three male specimens from the Palmar Norte, Golfito and Villa Neily areas (1) and Parrita area (Fig. 2A). The ground color of males is pale yellow and slightly paler ventrally. The upper sides are crossed by six or seven irregular dark vertical bars. These bars are frequently bifurcated dorsally or ventrally, or almost in their entirety; on some large individuals an irregular blotch pattern nearly obscures any semblance of a vertical bar pattern. Below the midline, the bar pattern fades out; the venter is unmarked.

A small blotch, equal to the pupil diameter, occurs on the dorsal half of the caudal fin base. An irregular blotch, about eye diameter, lies on the dorsal half of the body just posterior to the tip of the pectoral fin. A dark blotch on the dorsal margin of the opercle forms part of a discontinuous longitudinal band extending between the eye and lateral blotch. The dorsal half of the pectoral fin base and the entire pectoral axil is dark brown. The head is brown dorsally, fading to pale tan below.

The median fins are dusky; the anal is darkest especially distally. Small clear spots occur on the interradial membranes between the last few dorsal and anal soft rays; the distal margin of the dorsal fin is clear. Similar clear spots cover the interradial membranes of the caudal fin. The pectoral fins are clear and the pelvic fins, especially the filamentous first soft ray, dusky brown or dark gray.

Preserved females are very similar to males, but have a darker vertical bar pattern which contrasts sharply with the pale tan ground color (Fig. 2B). The dark blotch at the base of, and in the axil of the pectoral fin is very prominent. The second, third and sometimes fourth vertical bars may extend as diffuse markings onto the middle of the spinous dorsal fin. On other specimens the spinous dorsal marking is faint or consists of a long dark band uncorrelated with the bar pattern of the flanks.

Immature specimens are characterized by a well-defined vertical bar pattern and a prominent lateral blotch. The spot in the pectoral axil, and the unpigmented pelvic fins are typical of very small individuals.

**COLORATION IN LIFE:** The following notes were based on a live male

80 mm long collected in the Palmar Sur area. Dorsum olive brown. Irregular vertical bars dark brown, contrasting with straw-colored interspaces. A brown lateral blotch on flanks. Median fins dusky. Small pale blue spots on soft dorsal rays and caudal fin. A 1 mm wide red margin along entire dorsal fin; immediately below this distal stripe, a slightly wider pale blue stripe. Anal fin dark brown throughout. Pelvic fins with a dark filamentous leading ray; other rays pale dusky. Pectoral fins pale yellow. Iris of eye copper-colored.

**SEXUAL DIMORPHISM:** The differences between sexes are not great. The morphometric differences shown in Figure 2 are not sexual differences, but attributable to intraspecific variation. The more pronounced vertical bar pattern and pectoral and dorsal fin blotch of females was already mentioned. The blotch on the dorsal fin and ventral opening of the urogenital papilla of the female is a reliable way to sex mature specimens. The male urogenital papilla is conical with a pointed tip on undeveloped fish. Ripe males have expanded papillae with rounded tips and large terminal openings. The female papilla is dorso-ventrally flattened with a rounded spongy termination. A broad opening occurs on the ventral surface of the papilla.

**INTRASPECIFIC VARIATION:** Numerous fish species from the Río General, a tributary of the Río Térraba, reveal the effects of headwater isolation. Fishes from this region have slimmer bodies and differ in other ways from lower Río Térraba populations. Specimens of *C. diquis* from the Térraba headwaters have slimmer bodies, longer heads and snouts and larger lips than individuals throughout the rest of its range (Fig. 2). Despite these striking morphometric differences between the Río General and Río Térraba populations, meristic differences are slight or absent (Table 2).

**COMPARISON WITH *Cichlasoma alfari*:** BUSSING (1) considered specimens of *C. alfari* collected in the headwaters of the Río Tárcoles, a Pacific drainage, as intermediate to the Atlantic and other known Pacific populations. Additional material of *C. alfari* and *C. diquis* from the Pacific versant and historical data now reveal that the Tárcoles population was introduced by man and does not represent an intermediate population, but that two similar, but distinct, species are involved.

Long-time residents of the Central Valley of Costa Rica, which is drained by the Río Tárcoles, report that during their childhood no "mojarras" (Cichlidae) occurred in the vicinity of San José. It is pertinent that in 1912 MEEK (7) collected no cichlids from the Central Valley, and reported only *Cichlasoma sieboldii* and *C. spilurum* (probably an erroneous identification of *C. nigrofasciatum* which he did not report from Costa Rica) from the lower reaches of the Río Tárcoles Basin.

I therefore conclude that the Central Valley population of *C. alfari* was introduced to the Tárcoles Basin by human agents sometime after 1912. MEEK (7), however, did report *C. lehrinus* (= *C. alfari*) from the Río Higueción

TABLE 2

Variation in number of dorsal fin elements and anal fin spines in *Cichlasoma diquis*, n. sp. and *C. alfari*.  
All localities are in Costa Rica except the Nicaraguan series from Río Prinzapolka

	Dorsal Spines						Dorsal Rays					Anal Spines				Total		
	15	16	17	18	19	$\bar{x}$	9	10	11	12	13	$\bar{x}$	5	6	7		8	$\bar{x}$
<i>C. diquis</i>																		
Pacific Slope																		
Esterillos		4				16.0			2	2		11.5		4			6.0	4
Río General	2	96	2			16.0			40	60		11.6		24	76		6.8	100
" Térraba	1	48	1			16.0		1	23	25	1	11.5		11	39		6.8	50
" Coto		37	13			16.3			25	25		11.5	2	48			6.0	50
TOTAL	3	185	16			16.1		1	90	112	1	11.6	2	87	115		6.6	204
<i>C. alfari</i>																		
Atlantic Slope																		
Río Prinzapolka			6	34		17.9		19	20	1		10.6			31	9	7.2	40
" San Carlos			23	16	1	17.5	1	9	29	1		10.8		1	32	7	7.2	40
" Sarapiquí			26	14		17.4		10	27	3		10.8			37	3	7.1	40
" Reventazón			17	23		17.6	2	14	21	3		10.6		10	28	2	6.8	40
" Madre de Dios			10	20		17.7		7	20	3		10.9		2	26	2	7.0	30
Pacific Slope																		
Río Bebedero			36	4		17.1		3	32	5		11.1			22	18	7.5	40
" Tárcoles			25	33	2	17.6	1	30	26	3		10.5		7	49	4	7.0	60
TOTAL			143	144	3	17.5	4	92	175	19		10.7		20	225	45	7.1	290

on the Pacific slope of northwestern Costa Rica. Recent collections confirm the existence of *C. alfari* in the Río Higuieron and other tributaries of the Río Bebedero Drainage, although its distribution is very spotty. Numerous species of principally Atlantic slope distribution occur in this region and have presumably reached the Pacific versant by way of headwater stream capture (3). The Pacific slope populations of *C. alfari* resemble fairly closely populations from the Atlantic side of Costa Rica, and an analysis of diagnostic meristic differences bears this out and separates the species from *C. diquis* (Table 2). *C. alfari* is now known on the Atlantic slope of Central America from eastern Honduras to western Panamá (5, 6).

ETYMOLOGY: The specific name, "diquís", signifies "Large Water" or "Big River" in the language of the Borucas, an Indian tribe indigenous to southern Costa Rica. Archaeologists have applied the term "Diquís Region" to the entire region of southeastern Costa Rica. The specific name is treated as a noun in the genitive singular. I propose the common name "Diquís Cichlid" for the species.

ECOLOGY: *Cichlasoma diquis* is abundant in small and moderate-sized streams, especially in areas where the current is not swift. The species is largely insectivorous, but also ingests large quantities of silt and detritus. The stomach and upper intestinal contents of twelve specimens from different localities were examined. At all localities food consisted of from 30-70 % aquatic insects; one specimen also contained fragments of terrestrial insects. The remainder of the ingested matter consisted of detritus and fine silt. One individual had ingested several small seeds.

Internal examination of the few large specimens collected revealed no ripe individuals. Mature specimens of both sexes were all larger than 80 mm. The largest specimens from a given locality were males; a male 133 mm long from the type locality was the largest individual collected.

GEOGRAPHIC DISTRIBUTION: The new species was collected only in southern Costa Rica on the Pacific versant, from just south of Punta Mala (Punta Judas) to the Río Coto Drainage in extreme southeastern Costa Rica. The species is not known from the Río Tárcoles to the north, nor in Panamá.

## REMARKS

Four, or perhaps all five, of the species of *Cichlasoma* from southeastern Costa Rica have similar cognate forms on the Atlantic versant of the San Juan Fish Province. These species pairs (Pacific geminate form first) are: *Cichlasoma diquis* and *C. alfari*; *C. lyonsi* and *C. citrinellum*; *C. sajica* and *C. septemfasciatum*\*, and *C. sieboldii* and *C. tuba*. *Cichlasoma altifrons* may be represented on the Atlantic versant by *C. calobrense* (3). BUSSING (3) suggested that these Trans-American geminate species pairs were derived from common

\* Erroneously considered a synonym of *C. spilurum* (Günther) by Meek (7).

ancestors which inhabited the Talamancan Island during Middle Tertiary times. The ancestral forms differentiated on the Talamancan Island from previously widespread species. Subsequently, as the Talamancan Cordillera became incorporated into the emerging Isthmian Link in the Late Pliocene, the geminate pairs were isolated from each other on the lowlands of opposing slopes.

### ACKNOWLEDGMENTS

I am grateful to Manuel Chavarría A. for his thorough review and assistance in preparation of the manuscript; to Sergio Salas D. for furnishing a detailed color description and sketch of a pair of live specimens of *C. sajica* from Rincón; to Stanley H. Weitzman (USNM) and Robert J. Lavenberg and Jerry W. Neumann (LACM) for information regarding specimens in their care; and to Oscar Blanco B., Myrna I. López de Bussing, Karl Karlson, Carlos Mata R., Roy W. McDiarmid, Sergio Salas D. and Norman J. Scott, Jr. for obtaining specimens for this description.

Work was carried out at the Escuela de Biología, Universidad de Costa Rica.

### RESUMEN

Se agrega dos especies adicionales a la lista creciente de formas indígenas del bosque tropical húmedo de la vertiente del Pacífico de Costa Rica. Se describe estas especies con base en numerosos ejemplares colectados a través de su distribución geográfica y, además de los datos merísticos y morfológicos, se comenta sobre la coloración de ejemplares vivos, el dimorfismo sexual y aspectos ecológicos.

Las dos especies nuevas aparentemente representan especies de formas gemelas transamericanas correspondientes a la vertiente del Pacífico. Las especies de la vertiente del Pacífico son *Cichlasoma sajica* y *C. diquis* y sus congéneres gemelos son *C. septemfasciatum* y *C. alfari* de la vertiente atlántica. Se postula que estos pares gemelos, de distribución similar, provienen de una ascendencia común en la Isla de Talamanca del Terciario, que quedaron aislados al formarse la barrera intercontinental entre las Américas durante el Plioceno.

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Fig. 1. *Ciclasoma sajica*, n. sp. A, Holotype, LACM 33902-1, a male 70.8 mm, from a tributary of Río Sierpe, Costa Rica; B, Paratype, a female 60.5 mm, UCR 173-6, from Quebrada Aguabuena, Osa Peninsula, Costa Rica; C, juvenile, uncataloged specimen, from a tributary of Río Salamá Nuevo, Costa Rica.

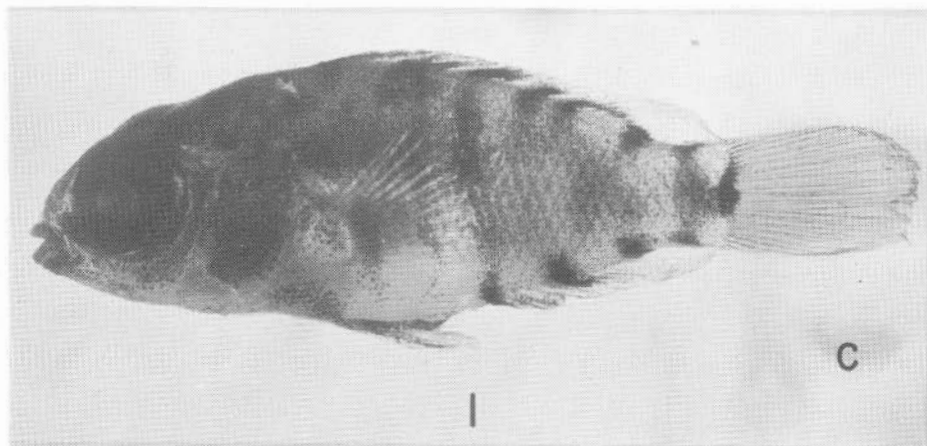
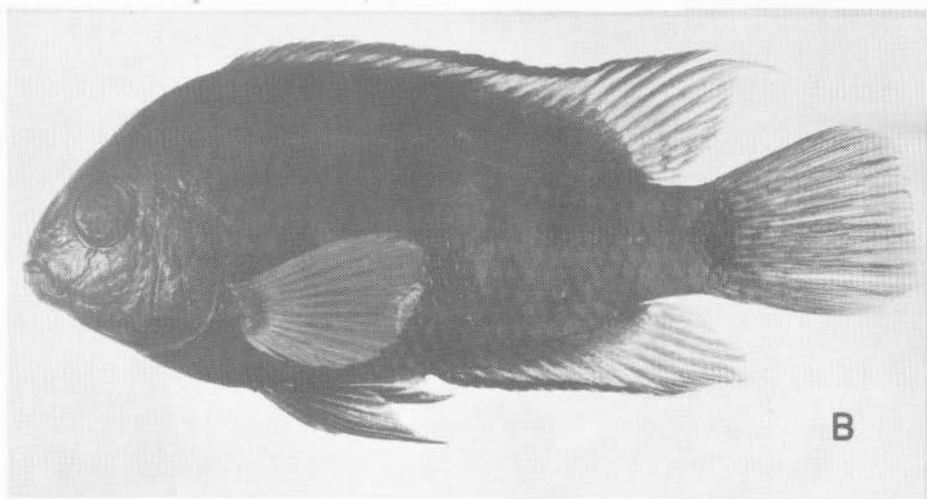
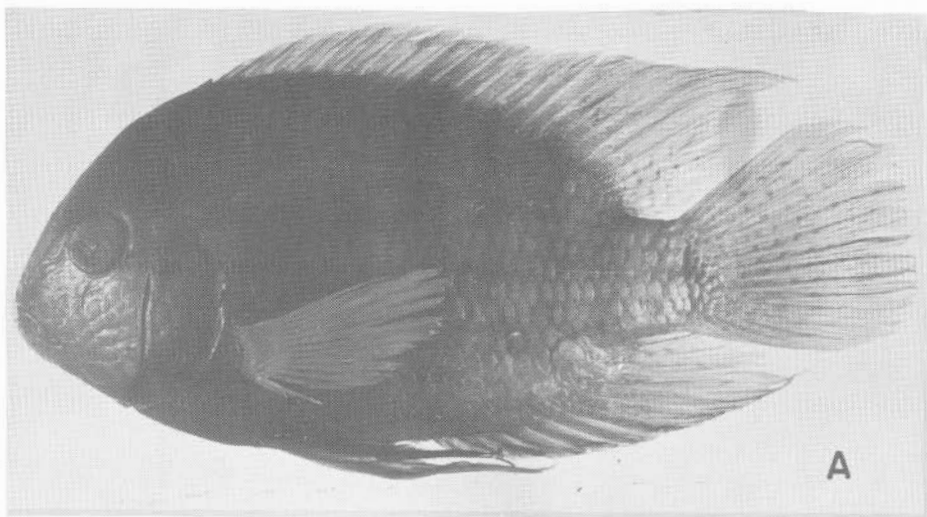
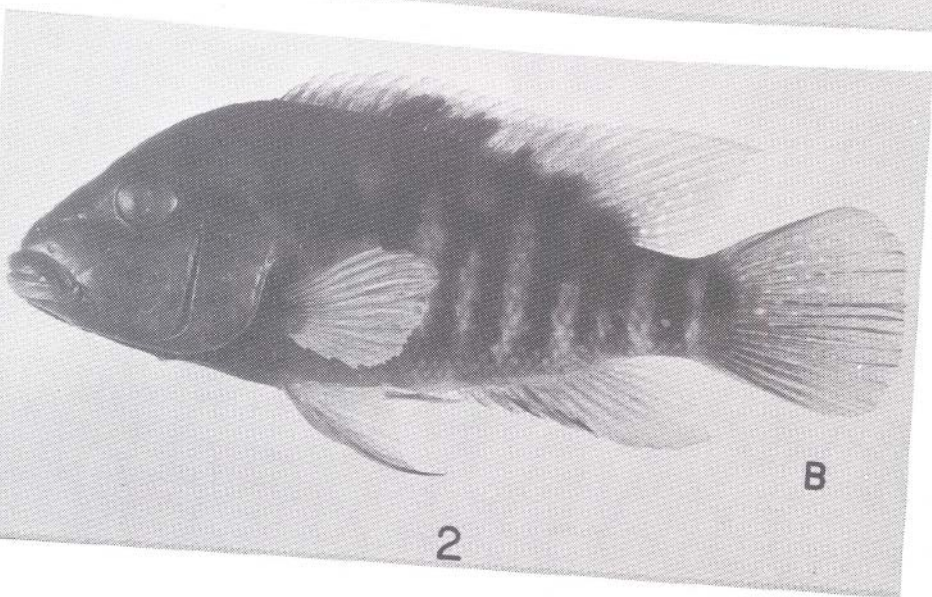
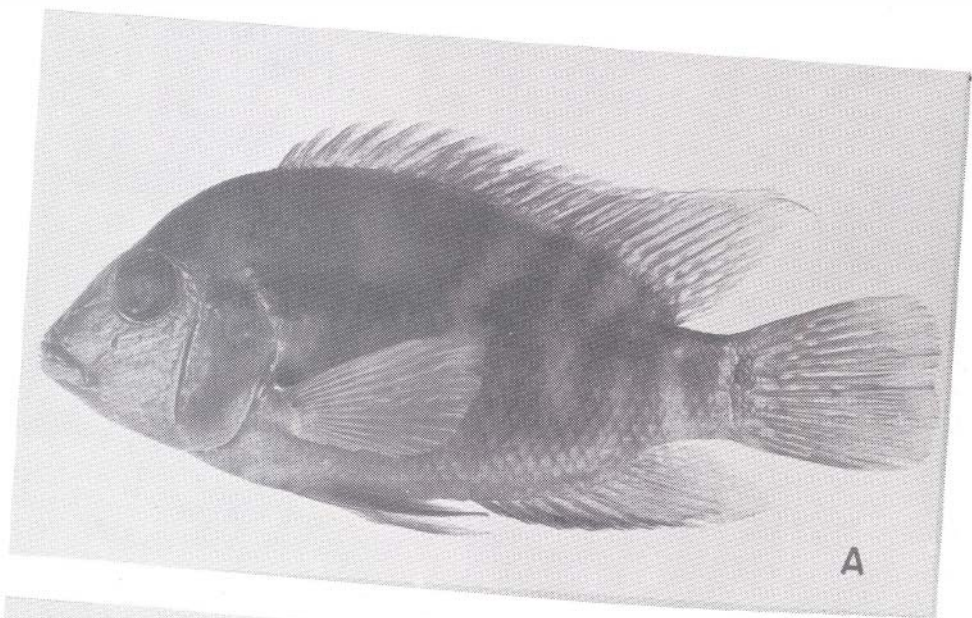


Fig. 2. *Cichlasoma diquis*, n. sp. A, Paratype, a male 83.6 mm, UCR 306-7, from near Esterillos, Costa Rica; B, Paratype, a female 90.2 mm, UCR 42-8, from San Isidro de El General, Costa Rica.



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