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A new species of *Astyanax* (Characiformes, Characidae) from Uruguay river basin in Argentina, with remarks on hook presence in Characidae

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A new species of *Astyanax* (Characiformes, Characidae) from Uruguay river basin in Argentina, with remarks on hook presence in Characidae. - In the present paper the new species *Astyanax ojiara* sp. n. is described, from the headwaters of Yabotí river, an affluent of Uruguay river in the province of Misiones, Argentinean northeast. A combination of characters differentiates the new species from other congeners: one heptacuspid maxillary teeth; teeth of inner premaxillary row gently expanded distally; 7-9 dentary teeth decreasing in size anteroposteriorly; males with hooks in all fins; large males with pelvic axillary scale bearing 1 to 8 hooks; 36-38 perforated scales in lateral line; 20-23 branched anal-fin rays. Number of scales in the lateral line and branched anal-fin rays, humeral spot, and low body of *Astyanax ojiara* sp. n. resemble those of *A. eigenmanniorum*, but maxillary, premaxillary and dentary teeth differ in both species. The disposition of the dentary teeth is also similar in *A. taeniatus* and *A. giton* but *A. ojiara* sp. n. has one heptacuspid maxillary tooth.

Key-words: Characiformes - Characidae - *Astyanax* - new species - Uruguay river.

INTRODUCTION

In the last years, the genus *Astyanax* was not revised and an accurate definition of the genus is still pendant. Eigenmann (1921, 1927) analised the genus and, subsequently, many authors followed his results. Géry (1977) provided an arrangement of the species in groups, and identification keys. Recently, Zanata (1997) erected a new genus - *Jupiaba* - for many species previously known as *Astyanax* or *Deuterodon*. *Jupiaba* is defined by the presence of a diagnostic pelvic bone, with unique disposition of muscles. The taxonomic status of some species of the genus *Astyanax* is not completely clear and the interrelationships of the species remain unresolved. A detailed revision of the remaining nominal species of *Astyanax* is necessary.

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In the río de la Plata basin, about twenty nominal species of *Astyanax* have been recorded, although the records of some species are doubtful. In the southwest of the Brazilian shield, the main course of the río Uruguay flows from East to West, turning to the southwest and ending in the río de la Plata. Some affluents of the river originate from the Sierra de Misiones, which reach about 800 m a.s.l., and presently constitute an effective barrier between waters of the Uruguay and Paraná rivers, in northeastern Argentina. The arroyo Yabotí comes from the highest area of Sierra de Misiones; in one of its headwaters, the arroyo Benítez, a new species of *Astyanax* was collected in the vicinity of the city of San Pedro. The description of the new species is presented in this paper.

MATERIAL AND METHODS

The specimens examined in this study were cleared and counterstained (C&S) following Taylor & Van Dyke (1985). Measurements are straight distances taken with calliper to nearest 0.1 mm. Material is deposited in the Field Museum of Natural History, Chicago (FMNH); Muséum d'histoire naturelle de Genève, Genève (MHNG); Facultad de Ciencias Naturales y Museo de La Plata, La Plata (MLP); Museu de Zoologia da Universidade de São Paulo, São Paulo (MZUSP).

Comparative material (SL in mm). *Astyanax eigenmanniorum* (Cope, 1876): MLP 5202, 5 ex., 56.5-68.5, Argentina, Córdoba, río Primero frente a Capilla de los Remedios; MLP 9160, 6 ex., 36.8-80.2, Argentina, Buenos Aires, Los Talas. Cleared and stained material: Personal collection of MA. *Astyanax abramis* (Jenyns, 1842): 2 ex., 74.5-92.0, Argentina, Buenos Aires, río de la Plata en Punta Lara; 2 ex., 80.6-98.8, Argentina, Misiones, río Piray-Miní. *Astyanax alburnus* (Hensel, 1870): 5 ex., 40.5-47.2 , Uruguay, río Yaguarón. *Astyanax alleni* (Eigenmann and McAtee, 1907): 2 ex., 62.4-72.9, Argentina, Corrientes, río Riachuelo; 1 ex., 66.0, same collecting data. *Astyanax* cf. *asuncionensis* Géry, 1972: 2 ex., 28.0-37.6, Argentina, Santa Fe, Isla Los Sapos; 2 ex., 80.4-92.7, Argentina, Misiones, río Uruguay en San Isidro. *Astyanax eigenmanniorum*: 2 ex., 17.7-33.0, Argentina, Buenos Aires, desembocadura del río Colorado; 2 ex., 28.0-30.5, Argentina, Buenos Aires, Laguna de Gómez; 1 ex., 60.3, Argentina, Buenos Aires, río de la Plata; 4 ex., 51.5-82.1, Argentina, Misiones, arroyo Piray-Miní; 1 ex., 45.0, Brasil, Rio Grande do Sul, Viamão, açude Charolês; *Astyanax* cf. *fasciatus* (Cuvier, 1819): 2 ex., 91.0-106.5, Argentina, Misiones, río Uruguay en San Isidro. *Astyanax ojiara* sp. n.: 3 females, 46.2-63.0; 7 males, 37.8-58.0, Argentina, Misiones, arroyo Benítez.

TAXONOMY

Astyanax ojiara sp. n. Figs 1-13, table 1

Holotype (Fig. 1). MLP 9470, male, 50.5 mm SL, Argentina, province of Misiones, arroyo Benítez, headwaters of río Yaboty, an affluent of río Uruguay, coll. J. O. García, May 1983.

Paratypes. (Collecting data as holotype). MLP 9471, 2 males, 38.0-45.0 mm. MLP 9472, 12 females, 39.8-72.0 mm. MHNG 2605.67, 10 males (measured); MHNG 2606.35, 3 females, 44.0-53.5 mm, (not measured). FMNH 98319, 5 ex. MZUSP 40255, 5 ex.

Diagnosis

The species is distinguished by a combination of characters: one maxillary teeth with seven small cusps; teeth of inner premaxillary row gently expanded distally; 7-9 dentary teeth decreasing in size anteroposteriorly; large males with hooks in all fins; large males with 1 to 8 hooks in the pelvic axillary scale; 36-38 perforated scales in the lateral series; and iv-v,20-23 anal-fin rays. Also, presence of humeral spot vertically elongated, a second faint humeral spot, caudal spot continued on middle caudal rays, and low body depth help to differentiate the new species.

Description

Morphometrics of holotype and 24 paratypes are presented in table 1. *Astyanax* with low body (Fig. 1), maximum body depth at dorsal-fin origin. Dorsal profile of body slightly convex from snout to posterior tip of supraoccipital process, angled behind supraoccipital, strongly marked in medium sized and large females. Dorsal profile of body gently curved from this point to origin of dorsal fin; in large females, that portion almost straight; slanted ventrally from dorsal-fin origin to caudal peduncle. Dorsal profile of caudal peduncle straight; ventral profile slightly convex or straight. Ventral profile of body slightly curved from tip of snout to pelvic-fin origin, straight between this point and anal-fin origin, and slanted dorsally to caudal peduncle. Body rounded between pectoral and pelvic fins. Body laterally compressed between pelvic and anal fins.

Dorsal-fin origin nearer tip of snout than base of caudal-fin rays, equally distant in some small specimens. Pelvic-fin origin anterior to vertical through dorsal fin-origin. Adipose fin anterior to bases of last branched anal-fin rays. Tip of pectoral fin falling near, sometimes surpassing, pelvic-fin origin; in large females, tip of pectoral fin far from that origin. Tip of pelvic fin reaching anal-fin origin in males; in females, pelvic-fin tip far from that origin, even in many small specimens.

Dorsal fin iii, 9; posterior margin of dorsal fin slightly rounded, first branched dorsal-fin ray longest. In males, all dorsal-fin rays, excluded last one and unbranched rays, with slender hooks, directed outward, most of them curved ventrally, more abundant on posterior branch of each ray (Fig. 2), usually, one pair on each segment. Few hooks developed on ray tips of small specimens.

Anal-fin iv-v, 20-23 (holotype 21). Posterior margin almost straight in males; in females, first five branched rays produced forming a small lobe. Anal fin of all males bearing hooks directed posteriorly and outward, slightly curved dorsally. Large specimens with hooks on last branched anal-fin ray and also on largest unbranched ray. Hooks placed on all branches of the ray (Fig. 3), sometimes two or three pairs on each segment.

Caudal fin bearing 10-12 dorsal and 9-10 ventral procurrent rays; one unbranched and 9 branched principal rays in upper lobe; 8 branched and 1 unbranched principal rays in lower lobe. Usually, caudal lobes similar in size; sometimes, lower one slightly longer. Few hooks occurring on distal tips of middle caudal-fin rays in males (Fig. 4). In some specimens, few hooks scattered on all fin rays, included principal unbranched one. Hooks directed outward, most of them on lower lobe curved dorsally

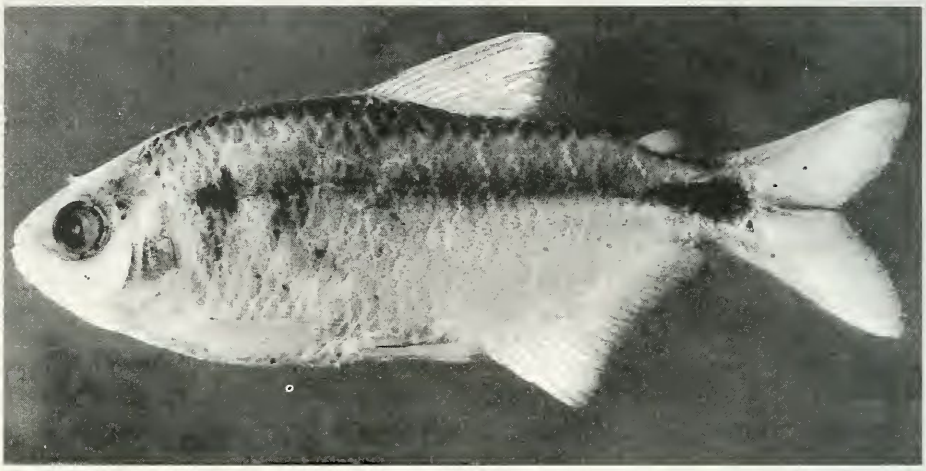


FIG. 1

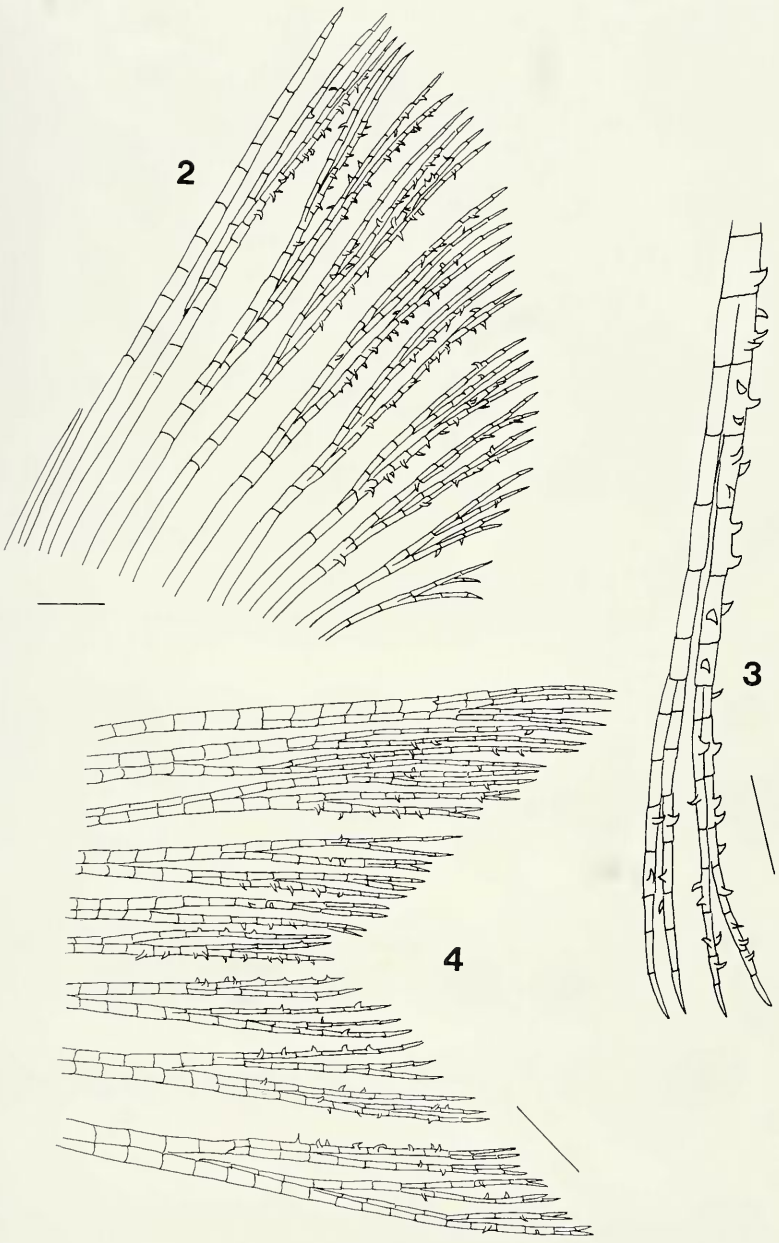
Astyanax ojiara new species, holotype, MLP 9470, male, SL 50.5 mm, Argentina, province of Misiones, arroyo Benítez, headwaters of río Yaboty, an affluent of río Uruguay.

and those ones of upper lobe curved ventrally. Some small specimens with 2 or 3 pairs of hooks only; one 43.0 mm SL male without hooks.

Pectoral-fin i, 10-13 (holotype i, 12), rays bearing hooks of different size in males. In medium sized and large specimens hooks developed on first unbranched ray and until 9 branched rays. Sometimes more than one pair of hooks on each segment, some of them directed dorsally and other ones ventrally, most of them directed inward (Fig. 5). Very few hooks developed in small specimens.

Pelvic fin i, 7; hooks developed on branched rays, occasionally on first unbranched ray also in large specimens (Fig. 6). One or two pairs of hooks on each segment, in different branches of ray, most of them directed inward, slightly curved anteriorly. Usually, one ray with scarce hooks in small specimens.

Head length moderate, mouth terminal, horizontal; snout short. Lower jaw slightly longer. Premaxilla with short ascending process, bearing two series of teeth. Usually, 3 pentacuspid or tricuspid teeth in outer series, sometimes two or four teeth, central cusp larger. Inner series of premaxillary teeth consisting of 5 teeth, gently expanded distally, slightly compressed at distal tips (Fig. 8). Symphysial tooth narrower and deeper, with 4 or 6 cusps. Second tooth widest, with 7 cusps. Third and fourth teeth with 6-7 cusps. Fifth tooth smaller, with 5 cusps. In all teeth, central cusp slightly larger than remaining ones. Maxilla short, scarcely lobed posteriorly, almost reaching or scarcely surpassing vertical through anterior orbital margin. One compressed maxillary tooth, with seven small cusps (Fig. 9). Few specimens (about 8 %) with two maxillary teeth, one of them heptacuspid. Dentary bearing 7 to 9 (usually 8) teeth with broad bases, decreasing in size anteroposteriorly. Symphysial tooth narrower, with 5-6 cusps. Second tooth widest. Second, third and fourth teeth with 5-7 cusps. Fifth tooth with 3-5



FIGS 2-4

Astyanax ojiara, left view. 2: dorsal fin, SL 44.5 mm, scale= 1 mm; 3: detail of hooks on third branched anal-fin ray, SL 39.6 mm, scale= 0.5 mm; 4: detail of hooks on middle caudal-fin rays, SL 39.6 mm, scale= 1 mm.

cusps, sixth and seventh teeth with 1 to 3 cusps; eighth tooth - and nineth one when present - always conic (Fig. 10).

Eye small, interorbital wide. Six infraorbitals well developed; third infraorbital almost contacting sensory tube of preopercle. Anterior fontanelle triangular, widening posteriorly; posterior fontanel long, extending onto supraoccipital process base.

Scales cycloid, crenate. Lateral series with 36-38 perforated scales (holotype with 37, one specimen with 39). Lateral line running on lower half of caudal peduncle, ending in a long tube without lamina, between caudal rays. Five scales between dorsal-fin origin and lateral line; 5 between lateral line and ventral-fin origin. Thirteen or fourteen scales around caudal peduncle. Eleven or twelve scales forming a regular row between supraoccipital process and dorsal-fin origin; sometimes, 14 scales in an irregular row. Ten to twelve (until 14) rectangular scales placed on anal-fin base, covering all unbranched and twelve branched anal-fin rays. Scales placed on basal fifth of caudal lobes. A narrow axillary scale present dorsal to pelvic-fin insertion, oval, as long as one third of pelvic fin sometimes. Axillary scale bearing two hooks in its posterior inner area in medium and large males; although, a high number of hooks developed (8 in largest male, 56 mm SL, Figs 11-13). Young males with a ridge in that area of scale.

In ten cleared and stained specimens, first arch bearing 17-19 gill-rakers: 2 on hypobranchial, 8 on ceratobranchial, 1 on cartilage, and 6 to 8 on epibranchial. Vertebral counts including Weberian apparatus and CU1+PU1 as one element: 32 (1 sp.), 33 (2 sp.), and 34 (7 sp.).

Coloration of alcohol preserved specimens: Background light brown, dorsal region of flanks and head darker. A humeral spot well developed, dorsoventrally expanded, at level of pectoral-fin origin. A second lateral spot faint and smaller, usually rounded. A dark lateral band with different intensity in coloration and width crossing flanks. A deep and very narrow line of chromatophores runnig from humeral spot to base of middle caudal-fin rays. Most specimens with dark chromatophores on inner opercular surface forming a spot.

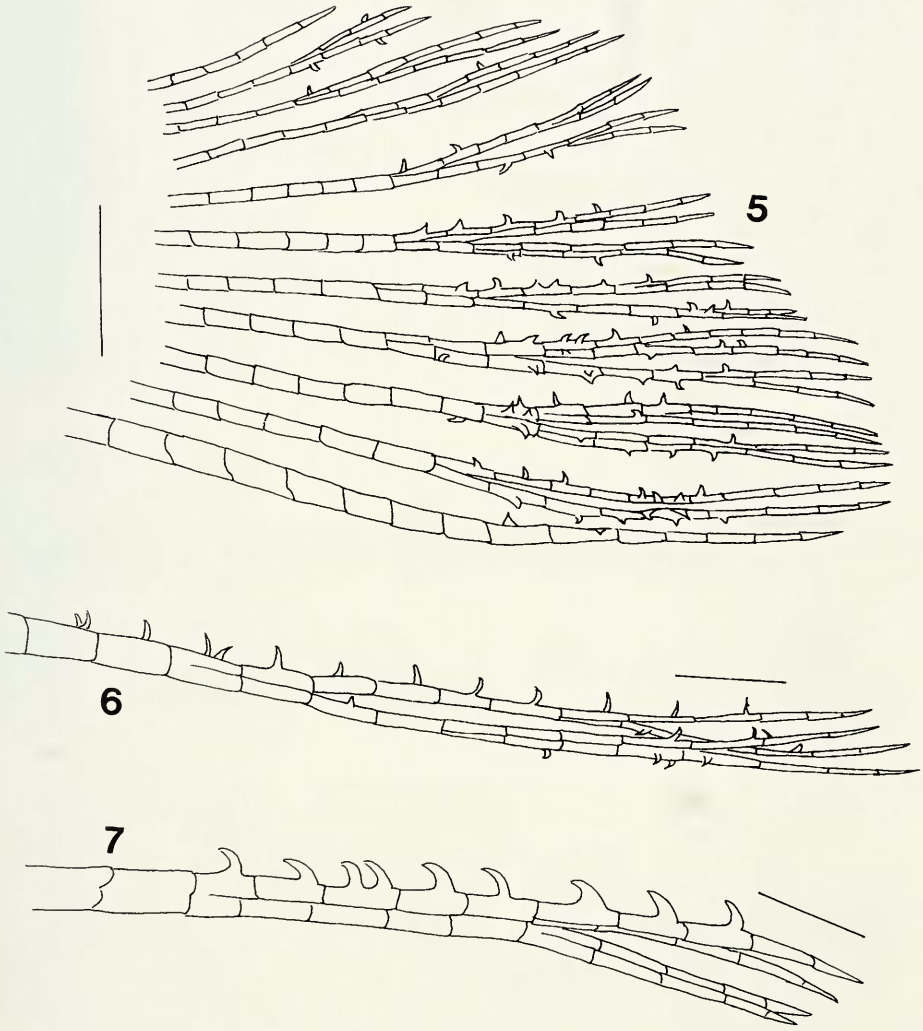
Dark chromatophores on distal margin of anal fin, forming a band; two or three first dorsal rays with black chromatophores; middle caudal-fin rays black, also tips of caudal-fin rays with dark chromatophores; pectoral and pelvic fins hyaline.

Etymology

The specific epithet is the name of a spirit, protector of the fresh waters, in the tupí-guaraní language.

DISCUSSION

Eigenmann (1921, 1927) separated the species of the genus *Astyanax* into three subgenera that were maintained by many authors. *Astyanax ojiara* has low body depth and a complete series of scales in the predorsal area. Following Géry (1977), *A. ojiara* is placed in the group with 32-41 scales in the lateral line. Among those species, the number of anal-fin rays of *A. ojiara* agrees with that of *A. fasciatus* group. Like Géry (1977) pointed out, the other group is defined by the presence of 17-24 anal-fin rays,



FIGS 5-7

Astyanax ojiara, dorsal view, SL 45.0 mm. 5: left pectoral fin, scale= 1 mm; 6: detail of hooks on second branched pelvic-fin ray, scale= 0.5 mm. 7: *A. eigenmanniorum*, dorsal view, SL 45.0 mm, detail of the same ray, scale= 0.5 mm.

except *A. eigenmanniorum*. The number of perforated scales in the lateral line and the number of anal-fin rays of *A. ojiara* ressemble those of *A. eigenmanniorum*. Nonetheless, the number and shape of teeth greatly differ. *Astyanax eigenmanniorum* has 4-5 teeth in the outer series of premaxilla and 5 teeth in the inner one, with the central cusp notably larger; the maxillary tooth has 3 to 5 cusps (Azpelicueta, 1979); all those teeth always have broad bases. The dentary bears 4 large teeth, a median one, and a series with 5 to 7 very small teeth. In comparison, the maxilla of *A. eigenmanniorum* is narrow and long, always reaching the anterior third of the eye; the premaxilla has a longer dorsal process. *Astyanax eigenmanniorum*, as described by Cope (1876), has pectoral fins that reach ventral-fin origin, a character always present in the Brazilian specimens examined; the length of pelvic fins and the preanal distance have similar values that those of males of *A. ojiara*. The pelvic-fin hooks of *A. eigenmanniorum* are strong and regularly placed (Figs 6, 7); the anal-fin hooks develop on the first ten rays whereas they are smaller, more numerous and are present on many anal-fin rays of *A. ojiara*. In *A. eigenmanniorum*, the eye, the postorbital length, and the interorbital distance are larger.

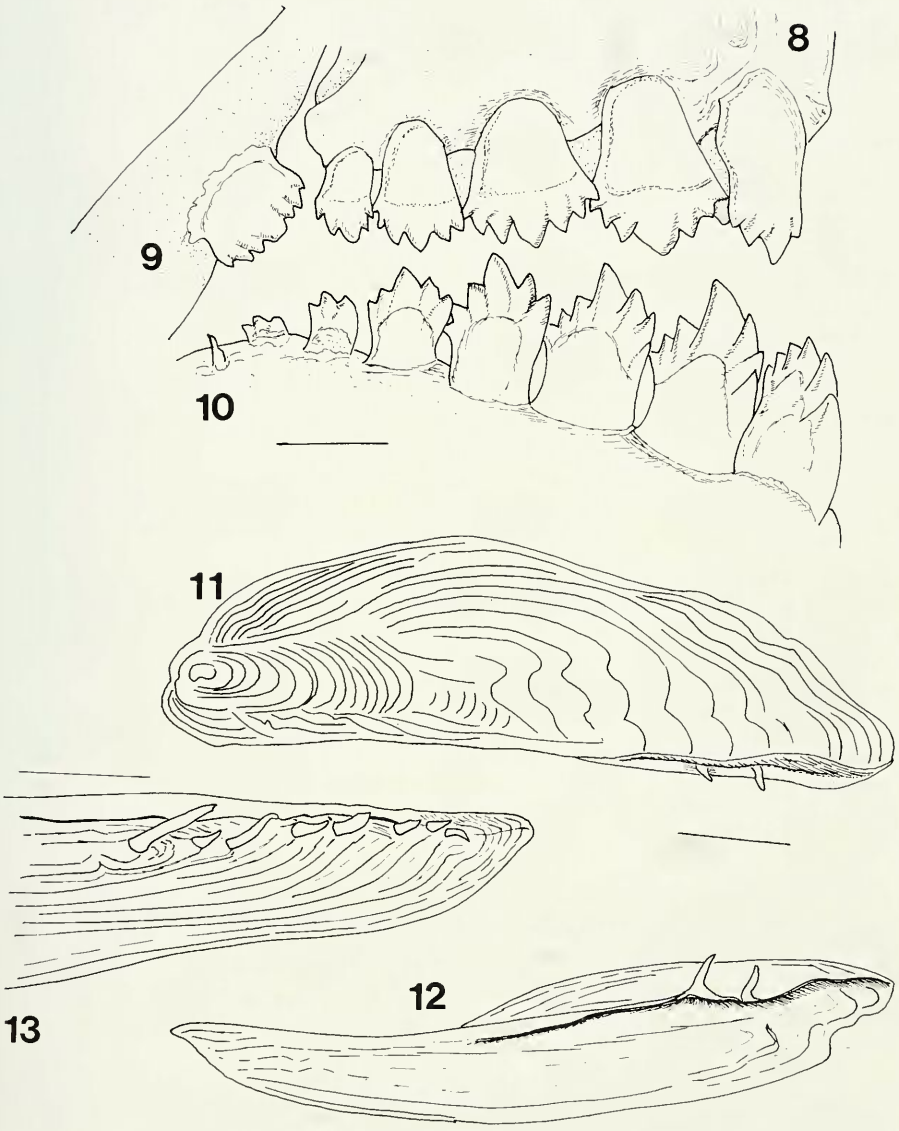
From other species of the *A. eigenmanniorum* group, *A. ojiara* is distinguished by one maxillary heptacuspid tooth, and the hooks developed in all fins of males. *Astyanax taeniatus* (Jenyns, 1842) and *A. giton* Eigenmann, 1908 have dentary teeth decreasing in size anteroposteriorly. Lucena & Lucena (1992) discussed the presence of that feature as a character that evolved in different species of the genera *Deuterodon* and *Astyanax*.

Different measurement relations in both sexes of *A. ojiara* are the length of pelvic fin, the distances between last branched anal-fin ray-hypural joint, snout tip-anal-fin origin, and origins of pelvic and anal fins (Table 1). Two thirds of the sample examined were males.

Presence of hooks in Characidae

Sexual dimorphism appears in many characids; hooks develop in different fins of males, excluding the genus *Cheirodon* in which female pelvic fins bear hooks (Malabarba, 1998, fig. 16). One of the attributes of secondary sexual characteristics is its appearance during breeding season, followed by regression. Nonetheless, the specimens of *A. ojiara* examined were collected in May -the end of fall in southern hemisphere-, and neither males nor females were mature. Therefore, hooks are always present in the new species; this fact has been observed in the genera *Cheirodon* and *Hyphessobrycon* as well.

In several subfamilies of Characidae such as Iguanodectinae, Stethaprioninae, Glandulocaudinae or Cheirodontinae and in different lineages within the family, males usually show hooks on anal and pelvic fins, but sometimes they occur on caudal or dorsal fins. Within the Cheirodontinae, some species as *Serrapinus calliurus* bears hooks in anal fin while many other ones have hooks on anal and pelvic fins. Among them, *C. piscicnlus*, *C. terrabae*, *C. dialeptnrus*, *C. affinis*, *C. gorgonae* (Fink & Weitzman, 1974), *C. ortegai* (Vari & Géry, 1980), and *C. interruptus* (pers. obs.), *Serrapinus kriegi* and *S. microdon* (Uj, 1987; pers. obs.); and *Heterocheirodon yatay*



FIGS 8-13

FIGS 8-10: *Astyanax ojiara*, lingual view of left teeth, SL 48.0 mm, scale= 0.5 mm. 8: inner row of premaxillary teeth, with tips gently expanded distally; 9: maxillary tooth with seven small cusps; 10: eight dentary teeth, decreasing in size anteroposteriorly. FIGS 11-13. *Astyanax ojiara*, left pectoral axillary scale of males, SL 42.0 mm; 11: lateroventral view, scale= 0.5 mm; 12: profile of the same scale; 13: inner view, detail of one cleared and stained specimen with 8 hooks, SL 56.0 mm, scale= 0.5 mm.

(Casciotta *et al.*, 1992). Hooks are not common in the caudal fin, but, Fink & Weitzman (1974) described and illustrated hooks not only on the caudal fin of *Saccoderma hastata* but also on that fin of *Cheirodon dialepturus*.

In glandulocaudine species, with notable sexual dimorphism, hooks may occur on caudal fin, as in *Xenurobrycon macropus* (Mahnert & Géry, 1984; Weitzman & Fink, 1985), *X. pteropus*, *Scophaerocharax octopodus*, *Corynopoma risei*, *Gephyrocharax atricaudatus* (Weitzman & Fink, 1985), *Mimagoniates microlepis* and *M. reocharis* (Menezes & Weitzman, 1990), *Ptychocharax rhyacophila* (Weitzman *et al.*, 1994) *Tyttocharax cochui* (Weitzman & Ortega, 1995). The presence of hooks in anal and pelvic fins is usual among glandulocuadine fishes; the position, size and shape of the hooks vary in different species. Mahnert & Géry (1984) mentioned the occurrence of hooks on the pectoral fin only in one specimen of *X. macropus*.

Many other species of characins have been described with hooks; some of them have hooks on anal fins as *Hyphessobrycon diancistrus* (Weitzman, 1977a) and *H. procerus* (Mahnert & Géry, 1987) or hooks may be present on pelvic fins as in *Paracheirodon axelrodi* (Weitzman & Fink, 1983). In most of the species, hooks develop on anal and pelvic fins: *Hyphessobrycon guarani* (Mahnert & Géry, 1987), *H. arianne* (Uj & Géry, 1989), *H. epicharis* (Weitzman & Palmer, 1997), *H. wajat* (Almirón & Casciotta, 1999), *Rachoviscus gracilipes* and *R. crassipes* (Weitzman & Gonçalves da Cruz, 1981), *Piabarcus annalis* and *P. torrenticola*, *Creagrutus paraguayensis* (Mahnert & Géry, 1988), some Trans-Andean species of *Creagrutus* as *C. cancanus*, *C. maracaiboensis*, *C. paralacus* or *C. affinis* (Harold & Vari, 1994), *Hemigrammus mahnerti* (Uj & Géry, 1989), *Bryconamericus iheringi* (pers. obs.).

Well developed hooks occur also on anal or pelvic fins of other characiform species such as *Brycon microlepis* (Géry & Mahnert, 1992), the miniature *Priocharax ariel* (Weitzman & Vari, 1987), *Toracocharax stellatus* (pers. obs.) as well as in some species of different genera of the Stethaprioninae such as *Poptella*, *Stethaprion*, *Brachychalcinus* and *Orthospinus* (Reis, 1989).

In the genus *Jupiaba*, *J. meunieri* or *J. maroniensis* (Gery *et al.*, 1996, as *Astyanax*) show hooks on the anal fin. Within *Astyanax*, hooks on anal and pelvic fins have been reported in *Astyanax maculisquamis* (Garutti & Britski, 1997), *A. alburnus* (Malabarba, 1983 as *A. hasemani*), *A. kullanderi* (Costa, 1995), *A. unitaeniatus* (Garutti, 1998), *A. eigenmanniorum*, *A.* cf. *fasciatus*, *A.* cf. *asuncionensis* or *A. alleni* (pers. obs.). None of those species have caudal fin hooks.

Extremely scarce is the information about the presence of hooks on dorsal fin; Weitzman (1977b) found hooks on that fin in two species of *Hyphessobrycon* only, the Amazonian *H. socolofi* and *H. erythrostigma* which bears very few hooks.

The hooks of the pelvic axillary scale appear in medium sized males of *A. ojiara* and their number varies in different specimens, although one or two hooks are present usually (Figs 11, 12). One cleared and stained specimen has eight hooks (Fig. 13) on that scale. No other characids have been described with hooks on all fins or on pelvic axillary scale.

TABLE 1

Morphometrics of holotype, 12 females and 12 males (paratypes) of *Astyanax ojiara*. Minimum, maximum and mean in parenthesis. DLAR-HJ= distance between last anal-fin ray and hypural joint.

	Holotype	females	males
Standard length	50.5	39.8-72.0	38.0-53.5
% of standard length			
Predorsal distance	51.4	51.8-56.9 (44.8)	50.5-53.1 (51.3)
Preventral distance	49.3	48.7-51.6 (50.4)	47.7-51.3 (48.8)
Preanal distance	64.0	65.8-70.4 (67.7)	61.3-65.9 (63.4)
Body depth	35.0	35.5-40.0 (38.1)	34.0-37.9 (36.5)
Dorsal-fin base	13.4	13.8-17.2 (15.4)	12.8-15.9 (13.3)
Anal-fin base	32.4	27.6-33.4 (30.5)	30.0-34.6 (32.2)
Pectoral-fin length	23.3	20.3-24.6 (21.7)	22.1-24.5 (23.2)
Pelvic-fin length	19.6	14.8-18.3 (16.5)	17.9-21.5 (19.0)
Distance between pectoral and pelvic fin origins	22.5	20.4-25.7 (23.2)	21.8-24.6 (23.4)
Distance between pelvic and anal fin origins	19.2	19.6-22.8 (21.3)	16.1-20.0 (18.2)
Head length	27.7	27.3-29.5 (28.1)	26.5-29.7 (27.8)
% of DLAR-HJ			
Peduncle depth	90.7	90.0-110.0 (99.0)	74.6-90.7 (83.0)
% of head length			
DLAR-HJ	46.4	38.8-46.4 (42.3)	46.8-56.8 (50.2)
Snout length	28.5	24.5-30.9 (27.7)	27.8-30.5 (29.2)
Eye	35.7	29.1-37.2 (28.1)	32.3-35.9 (34.3)
Postorbital length	57.1	50.0-54.8 (52.4)	53.4-57.2 (55.8)
Interorbital length	32.8	31.0-34.6 (33.0)	31.0-35.6 (32.5)
Maxillary length	22.8	21.1-24.5 (22.8)	37.1-40.6 (38.8)

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