



Astyanax pardensis (Ostariophysi: Characiformes: Characidae), New Species from Das Contas and Pardo Rivers Basins, Bahia, Brazil

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Abstract

Astyanax pardensis sp. n. was described for the basins of the Contas and Pardo rivers. This species belongs to the complex of species related to *A. fasciatus*, differing from *A. brevimanus*, *A. costaricensis*, *A. cuvieri*, *A. fulgens*, *A. jequitinhonhae*, *A. mexicanus*, *A. oerstedii*, *A. panamensis*, *A. rutilus* and *A. viejita* for number of precaudal vertebrae (16 vs. ≥ 17). Differs from *A. fasciatus* and all other species *A. fasciatus* complex by shape in zig-and-zag of first portion of longitudinal band. It is also distinguished from *A. jequitinhonhae* for shape of the mandible (rounded vs. acuminate).

Keywords: New Species; *Astyanax Fasciatus* Complex; Das Contas; Pardo Basins

Introduction

Astyanax was defined by Baird, et al. [1] based on the description of *A. argentatus*. The definition for this genus is as follows: "Adipose fin present. Abdominal line not serrated. A double row of teeth on the upper and a single row on the lower jaw, and flattened with several conical spines or processes upon their edge. Neither canine nor palatine teeth. Dorsal fin above the ventral fin. Scales large". Species included in *Astyanax* in Baird, et al. [1] are a significant component of Ichthyofauna in the tropical and subtropical waters of South and Central America [2-27], in the Nearctic and Neotropical zones. They are commonly known as lambaris, piabas or tambiús in Brazil. They are distributed from the southern United States to Argentina [3,19,27-52], with a maximum standard length of around 150.00 mm. These species are the most abundant components in several Ichthyofauna surveys [7,9]. They can be found in several environments, such as headwaters and main river courses, near mangrove areas and even in rivers inside caves, in trogrove forms, with absence of pigments and eye reduction [41,43]. They have gregarious habits and an omnivorous diet, composed

of small arthropods (insects, arachnids, microcrustaceans), algae and plants. Many species have commercial value, being used in sport fishing and in the feeding of several fishivorous species of high commercial value [9,29,30]. *Astyanax* is one of the main representatives of the Characidae family, containing about 150 valid species [21] and it is very likely that many species will occur still to be described by the few broad taxonomic studies involving their species. This ignorance of *Astyanax* diversity becomes an example of the advances that need to be made in order to know the Neotropical Ichthyofauna, emphasizing the need for more basic research in systematics as previously suggested by Bohlke, et al. [5].

It is important to note that the first species, today in *Astyanax*, were described in *Tetragonopterus*, Cuvier, 1816, being transferred by Eigenmann, et al. [14] and Fowler, et al. [23] to *Astyanax*. Even with the description of *A. argentatus* Baird & Girard, the genus type specimen and this passage of several species to *Astyanax*, subsequent authors still described species in *Tetragonopterus* description of species for Central America; Steindachner, et al. [46] description of *T. rutilus jequitinhonhae* for the river Jequitinhonha, currently

valid as *A. jequitinhonhae*; Regan, et al. [42] description of *T. macrophthalmus*, currently valid as *A. macrophthalmus*, and review of the other *Astyanax* species of Central America, at that time equally allocated in *Tetragonopterus*).

Eigenmann, et al. [19,20] was the first author to gather all available taxonomic information on *Astyanax*, through his extensive review. This author, in several papers described several species for South America [15,17,18]. For Central America, Meek's studies [37-39] stood out in describing new species. These publications even presented synopses on previously described species or some regional revisions, contributing to a greater scope of these data.

Despite the importance of Eigenmann's review for systematic studies of the genus, there are still many gaps in knowledge about the diversity and morphology of species, which are very similar morphologically to each other and generally difficult to recognize.

Thus, Garutti, et al. [25] in his free teaching thesis presented a review of the *Astyanax* species with Brazilian humeral oval stain, Melo, et al. [12] reviewed the species found in Serra dos Órgãos and surroundings, Ruiz, et al. [44] reviewed the species with similar stain belonging to the subgroup *A. orthodus* Eigenmann, 1907, and Oliveira, et al. [39] reviewed the species related to *A. scabripinnis*. Besides the great morphological similarity, the taxonomic difficulties are also due to other factors: very generalized and not very informative old original descriptions, the precarious state of this material-type and the difficulties of access to these specimens by institutions, generally foreign, where they are fallen, which do not send them for comparative studies in South America. In addition, there are no studies that prove the monophyllum of the genus [53].

In order to complement the current knowledge in *Astyanax*, this article has been developed. Among these various species of *Astyanax*, one has been noted in several river basins of Central and South America, called *A. fasciatus*, abundant in its environments [10,16,19,24,28].

This species is popularly known as lambari-do-rabovelho, et al. [28]. Abundant material identified by this binomial is found in many national and foreign ichthyological collections. These identifications follow the concept of *A. fasciatus* adopted by Eigenmann, et al. [19], broad, covering a synonymic list of 11 nominal species with model localities in several rivers of the Neotropical Region.

Eigenmann, et al. [19] recognizes five subspecies in addition to the nominal form: *A. f. heterurus* Eigenmann, et al. [19], *A. f. parahybae* Eigenmann, et al. [15], *A. f. jequitinhonhae* (Steindachner, 1877), *A. f. macrophthalmus*

and *A. f. aeneus*. In his key to *Astyanax* Eigenmann, et al. [19] presents the following diagnostic characters for *A. fasciatus*: regular predorsal area, third infraorbital not completely covering the face, vertically elongated humeral spot, 25 or more rays on the anal fin, peduncle spot extending to the end of the median caudal rays, equidistant dorsal fin in relation to the snout and caudal fin, one or two, rarely three teeth in the jaw. Géry, et al. [27] basically follows this definition of *A. fasciatus*. Thus, due to these attributes of Eigenmann, et al. [19] and the great morphological similarity, many species can be called *A. fasciatus*. Garruti, et al. [26], when commenting on the presence of *Astyanax* species in the upper Paraná, suggest that *A. fasciatus* is a complex of forms very close to each other. Melo, et al. [12], in a systematic regional review of the genus *Astyanax*, recognizes two species that could be incorrectly identified as *A. fasciatus*, which supports the idea that *A. fasciatus sensu* Eigenmann is a complex of species.

The characters traditionally used in the diagnosis of *A. fasciatus* generally belong to superficial morphology (number of scales and rays, shape of teeth etc.) and may represent homoplasms or simplesiomorphies [53,54], which suggests that further studies of *Astyanax*'s anatomy should be performed. On the other hand, as Weitzman, et al. [53] have pointed out, groups like *Astyanax* have little morphological divergence useful for cladistic analysis among their species, but these are characters that allow mortgaging monophyletic groups on a generic level.

Recently some studies [12,34,45] have ventured to recognize as valid species some of the subspecies of *A. fasciatus* proposed in Eigenmann, et al. [19], but without defining what *A. fasciatus* is. These works are in general regional revisions that are based on the fact that a species described for Brazilian Rivers in Cuvier [10], is a species possibly restricted to the São Francisco River, from where its type material was collected [11,19] and on the premise that no freshwater fish species can have such a wide distribution throughout Central and South America, since there are geographical barriers that would prevent the exchange and genetic control of this species [34]. Thus, under the binomial *A. fasciatus* there must actually be many cryptic species [4], many not formally described. This article describes one of these species, found in the basins of the Das Contas and Pardo rivers, in Bahia, Brazil.

Material and Methods

The material examined is deposited in the institutions: BMNH – Natural History Museum, Londres; MCZ – Museum of Comparative Zoology, Harvard University, Ichthyology Department, Cambridge, Massachusetts; MNHN – Muséum National d'Historire Naturelle, Paris; MARD – Museo Argentino Riva Davia; MLP – Museo de La Plata, Instituto de

Limnologia, La Plata; MNRJ – Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro; MZUSP – Museu de Zoologia da Universidade de São Paulo, São Paulo; NMW - Naturhistorisches Museum of Wien, Viena; ZMUC - Zoology Museum of University of Copenhagen, Copenhagen; ZMB – Zoology Museum of Berlin, Berlin; ZMH – Museu de Zoologia de Hamburgo.

The obtaining of meristic and morphometric data was done with the help of a digital pachymeter under stereomicroscope, following Fink, et al. [22]. Additional measurements include (1) the distance between the dorsal fin and the adipose fin, (2) the anal fin and the distal end of its longest ray and (3) the distance between the dorsal fin and the distal end of its longest ray. The osteological analysis was done in diaphanized and stained specimens following Taylor, et al. [47]. Counting of vertebrae, free superneurals and pro-current rays were obtained from diaphanized and stained specimens as well as radiographed specimens. The total count of vertebrae includes the vertebrae incorporated in the Weber apparatus and the ossification of the flow complex PU1 + U1 *sensu* Vari, et al. [48] counted as a single vertebra. The vertebrae are divided into precaudals and caudal, and the precaudal vertebrae are located anterior to the first hemal spine.

The osteological nomenclature follows Weitzman, et al. [49] with the modifications proposed in Vari, et al. [48], being translated according to Castro, et al. [9]. Specimens were dissected according to Weitzman [51].

The description of the new species is preceded by a brief synonymic list in which are presented original description, type locality, possible synonyms and bibliographical citations of them.

Results

Taxonomy

***Astyanax pardensis* sp. n. Salgado, 2021** (Figure 1).

- **LSID:** urn: lsid: zoobank.org:pub: 64CA100D-E287-47A8-AEFF-995D03493956
- **Type locality:** Panelinha river, tributary of the Panelão river, Pardo river drainage, Camacan, Bahia, Brazil, 15°22'24"S 39°29'59"W (Figure 2).
- **Holotype:** MNRJ 22928 (51.3 mm SL), Panelinha river, tributary of the Panelão river, Pardo river drainage, Camacan, Bahia, Brazil, 15°22'24"S 39°29'59"W, PA Backup, AT Aranda, FAG Melo, FP Silva, RS Lima, GR Moyer, 22 Aug. 2001. **Paratypes.** MNRJ 22921 (9 specimens; 26.7-62.5 mm SL), small stream crossing the road (flow from South to North), between Aurelino Leal and Taboquinhas, Itacaré, Bahia, 14°22'11"S 39°14'54"

W, PA Backup, AT Aranda, FAG Melo, FP Silva, RS Lima, GR Moyer, Aug. 21, 2001. MNRJ22928 (12 specimens, 23.1-55.2 mm SL), Panelinha river, tributary of Panelão river, Pardo river drainage, Camacan, Bahia, Brazil, 15°22'24"S 39°29'59"W, PA Backup, AT Aranda, FAG Melo, FP Silva, RS Lima, GR Moyer, 22 Aug. 2001.



Figure 1: MNRJ 22928, *Astyanax pardensis* sp. n. Salgado, 2021, 51.3 mm SL, holotype, male, Panelinha river, tributary of the Panelão river, Pardo river basin, Camacan, Bahia, Brazil, 15°22'24"S 39°29'59"W. Bar = 10 mm.



Figure 2: Type locality of *Astyanax pardensis* sp. n. Salgado, 2021. Panelinha river, tributary of the Panelão river, Pardo river drainage, Camacan, Bahia, Brazil, 15°22'24"S 39°29'59"W (arrow).

- **Diagnosis:** *Astyanax pardensis* sp. n. belongs to the *A. fasciatus* complex. Within this grouping, it differs from *A. brevimanus* (Boucort, 1868), *A. costaricensis* Meek, 1914, *A. cuvieri* (Luetken, 1875), *A. fulgens* (Boucort, 1868), *A. jequitinhonhae* (Steindachner, 1877), *A. mexicanus* (De Filippi, 1853), *A. oerstedii* (Kröyer, 1874), *A. panamensis* (Günther 1864), *A. rutilus* (Jenyns, 1842) and *A. viejita* (Cuvier & Valenciennes, 1849) by the number of them. precaudal vertebrae (16 vs. ≥ 17). Differs from *A. fasciatus*

and all other species *A. fasciatus* complex by shape in zig-and-zag of first portion of longitudinal band (Figure 1). It is also distinguished from *A. jequitinhonhae* by the shape of the mandible (rounded vs. acuminate) (Figures 3 & 4).

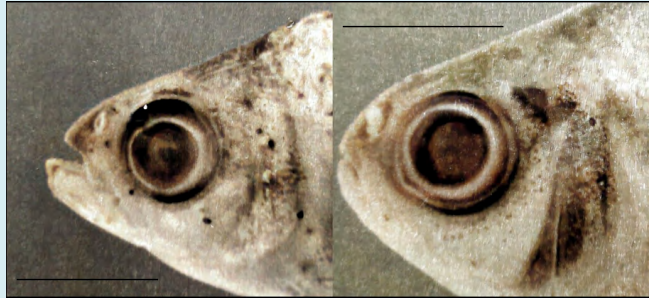


Figure 3: MNRJ 22505, *Astyanax jequitinhonhae* (Steindachner, 1877), 60.0 mm SL and MNRJ 22928, *Astyanax pardensis* sp. n. Salgado, 2021, 51.3 mm SL – head profiles. Bars = 10 mm.

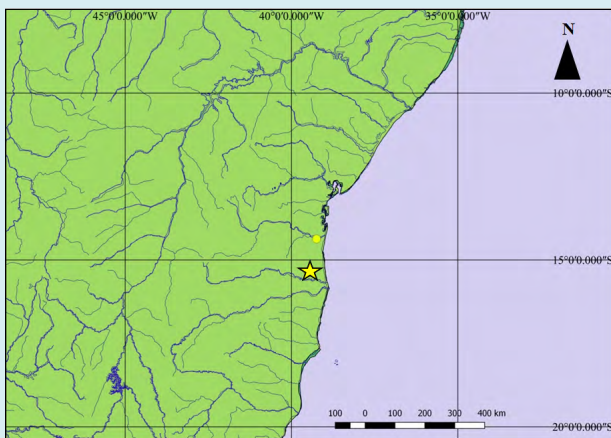


Figure 4: Sampled locations of *Astyanax pardensis* sp. n. Salgado, 2021. Locality type: star; other locations: circles.

- **Description:** Morphometric data presented in the Table 1. Body moderately elongated and laterally compressed. Greater height of the body at the origin of the dorsal fin. Dorsal profile of the convex body from the tip of the snout to the base of the first dorsal fin ray, straight along the base of the dorsal fin, with slight convexity between the base of the last dorsal fin ray and the origin of the

adipose fin. Ventral profile of the body convex between the tip of the muzzle and the origin of the pelvic fin, slightly straight between the origin of the pelvic fin to the anus and; straight along the base of the anal fin; caudal peduncle concave in the ventral and dorsal profiles.

Convex snout, first infra-orbital expanded over a small portion of the jaw. Premaxilla with two rows of teeth; outer row with three to five, usually four teeth with five cusps smaller than those in the inner series; inner row with five teeth with five to seven cusps. Maxilla with one or two teeth, usually one, on its anterior margin; teeth with five cusps. Dental with four or five anteromedial teeth larger than the others, usually with five cusps; fifth tooth usually with three cusps; other tiny unicuspid teeth in number from five to eight.

Dorsal fin ii, 9 (mean = 9, n = 13) branched rays. First ray unbranched approximately half the length of the second ray. Dorsal fin origin nearly midway along the body. Origin of adipose fin slightly posterior to insertion of anal fin rays. Pectoral fin i, 11-13 (mean = 11.8, n = 13) rays, distal edge of longer rays reaching or extending beyond origin of pelvic fin. Pelvic fins i, 7 rays; Origin of pelvic fin anterior to origin of origin of dorsal fin. Distal edge of longer rays reaches origin of anal fin. Pelvic fins with retrorso and ventromedial hooks on unbranched ray and on all branched rays and sexually mature males. Anal fin iii-vi, 20-25 (mean = 22.5, n = 13) radii. Origin of anal fin almost ventral to origin of dorsal fin in mid-length of body. Anal fin rays in males with small backward hooks, present in the largest unbranched ray and along almost the entire anal fin in well-developed males. Usually one pair of hooks per bone segment of the rays

Cycloid scales of the same size all over the body; complete lateral line, with 34 to 37 (mean = 35.2, n = 13) scales perforated by the lateral-sensory canal; curved ventrally, 5 to 7 (mean = 5.8, n = 13) rows of horizontal scales above the line and 5 to 6 (mean = 5.8, n = 13) below the line. Predorsal series with 10 to 13 (mean = 10.5, n = 13) regular scales. Scale sheath along the base of the anal fin formed by 7 to 11 scales extending to the base of the 11th branched radius. Around the caudal peduncle 14 to 16 (mean = 14.8, n = 13) scales. Vertebrae 33 to 35 (mean 34, n = 2), precaudal vertebrae 16, caudal vertebrae 17 to 19.

Characters	N	Range	M±SD
Standard length (mm)	13	35.8-71.2	51.8±9.5
Head length (mm)	13	10.3-19.1	13.9±2.4
Percentages related to standard length			
Body depth (males)	13	25.8-41.6	37.2±5.0
Body depth (female)	13	36.9-44.2	40.8±2.3

Head length	13	25.3-30.0	27.4±1.3
Caudal peduncle depth	13	12.3-14.2	13.1±0.6
Predorsal distance	13	50.8-56.9	53.5±1.6
Preanal distance	13	62.7-72.9	67.1±2.5
Prepelvic distance	13	47.4-53.2	49.4±1.5
Prepectoral distance	13	25.8-30.4	28.3±1.5
Dorsal-caudal distance	13	51.2-58.2	54.0±1.7
Dorsal-adiposa distance	13	36.9-41.7	39.2±1.5
Anal-fin base length	13	27.8-32.7	30.8±1.2
Anal-fin depth (males)	13	18.7-21.2	20.0±0.8
Anal-fin depth (females)	13	20.3-28.7	22.3±2.7
Dorsal-fin depth (males)	13	27.4-31.6	29.8±0.7
Dorsal-fin depth (females)	13	28.1-32.4	29.4±1.4
Dorsal-fin length	13	13.6-15.4	14.3±0.6
Pectoral-fin length	13	22.3-27.3	24.6±0.9
Pelvic-fin length (males)	13	17.9-20.8	19.2±1.0
Pelvic-fin length (females)	13	16.0-20.8	18.8±1.4
Caudal peduncle length	13	8.8-11.1	10.0±0.7
Eye-dorsal distance	13	38.5-44.0	40.3±1.7
Percentages related to head length			
Snout length	13	18.2-23.3	21.1±1.6
Orbital diameter	13	43.7-50.5	47.6±2.2
Interorbital width	13	31.3-37.0	34.2±1.7
Superior maxilla length	13	41.2-45.0	42.9±1.0

Table 1 : Morphometric data of *Astyanax pardensis* sp. n. Salgado, 2021 (N = number of specimens, M = mean, SD = standard deviation).

- **Sexual Dimorphism:** Adult male specimens are recognized by the presence of hooks on the anal and pelvic fins. Males and females differ in the relative length of the pelvic fin (Table 1) and slightly concave from the anal fin in females and almost straight in males. Females also reach larger body sizes and heights (Table 1).
- **Colorful in Alcohol:** Brown predominant color. Dark wide lateral band, crossing three rows of scales extending to the medial caudal rays, with a narrowing at the caudal peduncle. Stain of the caudal peduncle in a slightly lozenge shape. Caudal, anal, pectoral and pelvic fins predominantly hyaline. Brown pigments in the anal, dorsal and caudal fins are more concentrated in its distal portion. Greater concentration of chromatophores in the dorsal region of the body. Dark brown pigmented scales. Stain extending dorsally to the second row of scale above the lateral line and ventrally to the second row below the line. Maximum width of the spot above the line crosses three scales.
- **Etymology:** The specific epithet *pardensis* is a reference to the Pardo river basin, Camacan, Bahia, Brazil, where the holotype was collected.
- **Geographic distribution:** *Astyanax pardensis* occurs in the Das Contas and Pardo river basins (Figure 4).

Discussion

Traditionally, several specimens presenting a characteristic silver longitudinal strip from several basins in eastern Brazil are identified as *A. fasciatus* [13]. This researcher, however, restricted the distribution of this species to the São Francisco river basin, based on osteological characters, which corroborated several previous cytogenetic studies [33]. Several new species, related to *A. fasciatus*, were identified in the remaining areas of the original distribution of *A. fasciatus* [13]. Despite the results of this researcher, this species continued to be listed in the coastal basins of

Bahia, in several listings of local ichthyofauna [35]. However, several other articles, corroborating Melo, et al. [13], indicated the presence of unknown species related to the *A. fasciatus* complex [36,55] for these basins, indicating the scarce knowledge of the taxonomy of *Astyanax* in the Bahia coastal basins, already noticed in Melo, et al. [13]. *Astyanax pardensis* is the first of these species belonging to this complex, formally described for the Das Contas and Pardo river basins, and the third described in *Astyanax*.

This article increases the knowledge of the *Astyanax* taxonomy for the coastal basins of Bahia, adding to the 10 other descriptions of new species for these drainages, being six species for the Paraguaçu river basin, *A. burgerai* and *A. vermilion*, from small isolated coast basins, *A. jacobinae* Zanata, et al. [54] from the Itapicuru river basin and *A. pelecus* Bertaco, et al. [3] from the Pardo river. This way, the number of known Bahia coastal species increase to 12 species (Appendix).

In terms of Biogeography, the Das Contas and Pardo river basins show similarities with other 16 basins from Northeastern Mata Atlântica freshwater ecoregion (more specifically with Cachoeira, Almada, Una, Pardo, and Jequitinhonha rivers basins). Two species are shared exclusively by these five basins [6] indicating a possible common history of these drainages.

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Conflict Of Interest

None

Availability of Data and Materials

All materials in this paper were deposited in the museums listing in the article.

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