

A NEW SPECIES OF *BIVIBRANCHIA*
(PISCES: CHARACIFORMES) FROM THE
AMAZON RIVER BASIN

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Abstract. — *Bivibranchia notata* is described as new from the lower Rio Tapajós, Brazil. The species is distinguished from *B. protractila* Eigenmann, *B. velox* (Eigenmann and Myers), and *B. bimaculata* Vari by a variety of meristic and morphometric characters. The possession of a distinct midlateral body spot centered posterior of the vertical through the insertion of the posteriormost dorsal fin rays further distinguishes *B. notata* from *B. bimaculata* in which the spot is located more anteriorly, and from *B. velox* which has a plain body. A key is provided to the species of *Bivibranchia*.

Bivibranchia velox is reported from the lower Rio Xingu, the first citation of the species from the main portion of the Amazon basin. The distribution of *B. protractila* in the Amazon and variation in the pigmentation of the species in that river system is discussed.

The genus *Bivibranchia* Eigenmann (1912:258) is a small group of unusual hemiodontid characiforms readily distinguished externally by their highly protractile upper jaws; a system unique within the Characiformes and only approximated, although to a much lesser degree, in *Argonectes* the sister group to *Bivibranchia* (Roberts 1974:432). The alterations of the jaws and suspensorium permitting such pronounced jaw protractility along with various modifications of the branchial arches were discussed by Roberts (1974). More recently Vari (1985) has described a number of other apomorphous alterations of the anteriormost full pleural ribs, their associated vertebrae, parapophyses, and intercostal ligaments that distinguish *Bivibranchia* (including *Atomaster* Eigenmann and Myers, 1927) within the Hemiodontidae, and indeed within the entire Characiformes. That author also described a unique hypertrophy of the portions of the glossopharyngeal and vagus (ninth and tenth cranial) nerves innervating the branchial arches. Associated with the pronounced expansion of these nerves is a dramatic increase in the degree of development of the vagal lobe of the medulla oblongata, and the presence of a series of elaborate folds on the lateral surface of the enlarged vagal lobes. These modifications are all unique to *Bivibranchia* among examined characiforms and congruent with the hypothesis of the monophyly of the genus. In that same paper Vari described a new hemiodontid, *Bivibranchia bimaculata*, which was the third characiform species with a markedly protractile mouth. Recent collecting activities in the Amazon River basin have revealed the existence of a new *Bivibranchia* species described herein, and provide additional data on the variation in pigmentation of *B. protractila*, and on the geographic distribution of that species and *B. velox* within that drainage system.

Methods and materials. — Counts of total vertebrae were taken from radiographs and cleared and stained specimens, and include the four vertebrae of the Weberian

apparatus, with the fused $PU_1 + U_1$ of the caudal skeleton counted as a single element. Numbers in parentheses after a vertebral count are the number of specimens with that particular count. In counts of the pelvic and median rays, unbranched rays are indicated by Roman numerals and branched rays by Arabic numerals. The ranges for meristic counts are based on the holotype and paratypes, with the value for the holotype indicated in square brackets.

Specimens examined for this study are deposited in the following institutions: Museu de Zoologia da Universidade de São Paulo, MZUSP; and National Museum of Natural History, Smithsonian Institution, USNM.

Key to the species of *Bivibranchia*, Eigenmann

- 1. 81 to 90 pored lateral line scales to hypural joint. Scales of adults with distinct ctenni *B. velox* (Eigenmann and Myers)
- 49 to 73 pored lateral line scales to hypural joint. Scales of adults cycloid 2
- 2. 63 to 73 pored lateral line scales to hypural joint. 11 or 12 scale rows in transverse series from lateral line to origin of rayed dorsal fin. *B. notata*, new species
- 49 to 55 pored lateral line scales to hypural joint. 7½ to 9½ scale rows in transverse series from lateral line to origin of rayed dorsal fin. 3
- 3. Distinct large, dark midlateral spot on body centered along or slightly posterior of vertical through insertion of posteriormost dorsal-fin ray. Smaller spot of dark pigmentation typically present on midlateral surface of caudal peduncle. 8 branched anal-fin rays. Pelvic fin length 0.18–0.20 of SL. *B. bimaculata* Vari
- Body plain or with faint or discrete midlateral spot on body. When midlateral pigmentation patch present, centered distinctly posterior of vertical through insertion of posteriormost dorsal-fin ray. 7 branched anal-fin rays. Pelvic fin length 0.14–0.17 of SL. *B. protractila* Eigenmann

Bivibranchia notata, new species
Fig. 1, Table 1

Holotype. —MZUSP 28657, 68.3 mm standard length (SL), coll. Michael Goulding, 25 Nov 1983, Rio Tapajós, beach at Alter do Chão, Pará, Brazil (approx. 2°31'S, 54°57'W).

Paratypes. —1 specimen, taken with holotype, USNM 268049, 66.6 mm SL. 6 specimens: MZUSP 23712, 3 specimens, 26.5–30.7 mm SL; USNM 268562, 3 specimens 28.4–35.1 mm SL, coll. Expedição Permanente de Amazônia, under direction of Paulo E. Vanzolini, 25 Nov 1970, pool in Rio Tapajós at Barreirinha near São Luís, Pará, Brazil (approx. 4°26'S, 56°14'W).

Diagnosis. —*Bivibranchia notata* shares with the other species of the genus numerous derived modifications of the upper jaw, suspensorium, branchial arches, anterior ribs and vertebral column that distinguish *Bivibranchia* within the Hemiodontidae (see Vari 1985). The limited available material of the new species has prevented the dissections necessary to confirm the presence of the hypertrophy of the glossopharyngeal and vagus nerves described by Vari as synapomorphous

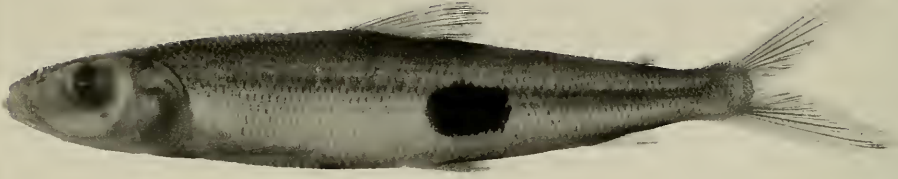


Fig. 1. *Bivibranchia notata*, new species, holotype, MZUSP 28657, 68.3 mm SL; Rio Tapajós, Alter do Chão, Pará, Brazil.

for other *Bivibranchia* species. Neither was it possible to determine whether this species has the hypertrophy of the vagal lobes of the medulla oblongata, and the elaboration of the surface of those lobes that are common to its congeners. *Bivibranchia notata* does, however, have the distinctive vertical expansion of the epibranchials and ceratobranchials, and the elaboration of the soft tissues overlying these elements that are characteristic of *Bivibranchia*. If the cranial nerve and medulla oblongata hypertrophies of other *Bivibranchia* species are indeed correlated with the unique soft tissue and osteological modifications of the branchial apparatus, then we would expect that *B. notata* shares the neurological apomorphies for the genus. Similarly, it is assumed that the hard tissue modifications of the third and fourth full pleural ribs and associated vertebrae obvious in the radiographs of *B. notata* are paralleled by the system of intercostal ligaments typical for *Bivibranchia* (see Vari 1985 for a fuller description of the system).

The presence on the midlateral body surface of *Bivibranchia notata* of a large spot of dark pigmentation centered distinctly posterior of the vertical through the insertion of the posteriormost dorsal-fin ray separates that species from *B. velox* which has a plain body and from *B. bimaculata* in which the midlateral body spot is approximately centered along the vertical through the insertion of the posteriormost dorsal-fin ray. The 63 to 73 pored lateral line scales to the hypural joint distinguish *Bivibranchia notata* from *B. bimaculata* which has 49 to 55 scales in that series, *B. protractila* which has 50 to 54 scales, and *B. velox* which has 81 to 90 scales (originally listed by Eigenmann and Myers 1927 as having 89 to 98 scales, a count including 8 or 9 scales on the caudal fin base beyond the hypural joint). The 11 or 12 scale rows above the lateral line in a transverse series to the origin of the rayed dorsal fin further differentiates *B. notata* from *B. bimaculata* and *B. protractila* which have $8\frac{1}{2}$ – $9\frac{1}{2}$ and $7\frac{1}{2}$ – $8\frac{1}{2}$ scale rows respectively in that series.

Description. — Morphometrics of the holotype and paratypes are given in Table 1. Body slender, slightly compressed laterally. Greatest body depth at origin of rayed dorsal fin. Dorsal profile of body gently curved from tip of snout to origin of rayed dorsal fin; slightly posteroventrally slanted along base of fin, nearly straight from insertion of posteriormost dorsal-fin ray to caudal peduncle. Slight median keel immediately anterior of origin of rayed dorsal fin. Ventral profile of

body smoothly convex from tip of lower jaw to caudal peduncle. Ventral surface of body transversely flattened anteriorly.

Head obtusely pointed in profile, interorbital region flattened. Fronto-parietal fontanel evidently extending from rear of ethmoid to supraoccipital; anterior portion narrower transversely than posterior section. Parietals completely separated, frontals in contact only at epiphyseal bar. Upper jaw longer than lower jaw even when not protracted. Nostrils approximate, anterior opening smaller, round; posterior crescent shaped, partially closed by flap of skin separating nostrils. Eye relatively large. Large, horizontally ovoid "adipose eyelid" (a thick transparent connective tissue layer) extending from anterior of vertical drawn through border of anterior nostril posteriorly over orbit onto anterior portion of opercle. Adipose eyelid thicker anteriorly, with ovoid, vertically elongate opening overlying pupil.

Lower jaw edentulous, rounded in ventral view, anterior margin fleshy. Upper jaw highly protractile, maxilla extending under anterior portion of infraorbital series. Upper jaw with single series of functional teeth. All teeth tricuspidate, 9 or 10 teeth on each side of upper jaw; teeth becoming progressively larger medially. Gill arches highly modified, with vertically expanded epibranchials and ceratobranchials. Surfaces of these expanded gill-arch elements with series of fleshy ridges aligned nearly perpendicular to longitudinal axis of bones. Gill rakers extending along surfaces of expanded ceratobranchials and epibranchials; each raker associated with fleshy ridge. Gill membranes narrowly attached medially to urohyal.

Scales cycloid, firm. Pored lateral line scales between supracleithrum and hypural joint 63 to 73 [73]; 5 to 7 pored lateral line scales extending beyond hypural joint onto base of caudal fin; canals in lateral line scales straight. Scales in transverse series from lateral line to origin of rayed dorsal fin 11 or 12 [11]. Scales below lateral line in transverse series to origin of anal fin 7 or 8 [7]. Body squamation extending onto base of caudal-fin rays. Axillary process of pelvic fin formed by single enlarged scale.

Vertebrae 39 (2).

Rayed dorsal fin obtusely pointed, first and second branched rays longest, subequal. Dorsal-fin rays ii,9. Adipose dorsal fin of moderate size, unscaled. Anal fin obtusely pointed, first and second branched rays longest, subequal; anterior branched rays approximately one and one-half times length of posteriormost rays. Anal-fin rays ii,7. Pectoral fin pointed, reaching slightly over one-half distance to vertical through insertion of pelvic fin. Pectoral-fin rays 16 to 18. Dorsalmost ray of pectoral fin corresponding in position to groove along side of body formed by connective tissue ridge extending posteriorly from posterior margin of cleithrum. Pelvic-fin pointed, extending slightly over one-half distance to anus. Pelvic-fin rays i,8 or i,9 [i,9] (typically i,9).

Coloration in preservative. —Overall coloration of adult specimens fixed in formalin and preserved in ethanol light tan. Head darker on dorsal portions with uniform scattering of small dark chromatophores on upper lip, section of snout anterior and dorsal of adipose eyelid, and across interorbital region and dorsal portions of head. Dorsally situated field of scattered chromatophores extending posteroventrally onto opercle, becoming progressively less dense ventrally; with few, widely scattered chromatophores on opercle ventral of horizontal through lower border of eye. Overall coloration of body darker dorsally; each body scale,

other than on ventral portions of body, with corresponding, posteriorly concave, crescent-shaped series of chromatophores. Overall chromatophore field on body increasing in density dorsally, masking crescentic chromatophore series of individual scales. Distinct dark, slightly horizontally ovoid spot with somewhat irregular margins on midlateral surface of body. Spot commencing at scale 28 to 30 of lateral line and extending 12 scales horizontally and 5 scales dorsally. Pigmentation of spot consisting of chromatophores both medial to scales and in epithelial layers overlying scales. Spot centered distinctly posterior of vertical through insertion of posteriormost dorsal-fin ray. Deep lying dusky band extending along midlateral surface of body from posterior margin of midlateral spot to caudal peduncle. Caudal fin dusky, particularly on ventral lobe; rays outlined by series of chromatophores. Rayed dorsal fin dusky. Adipose dorsal, anal, pectoral and pelvic fins with scattered chromatophores.

Overall coloration of juveniles (26.2–35.1 mm SL) fixed in formalin and preserved in alcohol tannish brown. Distribution of chromatophores generally as in adults, but chromatophore fields of juveniles less dense. Midlateral body spot relatively smaller than in adults, extending only 5 scales horizontally and 3 scales vertically. No indication of dusky band between midlateral body spot and caudal peduncle. Median rayed fins with scattered chromatophores. Adipose dorsal fin and paired fins hyaline.

Etymology.—The specific name, *notata*, from the Latin for mark, refers to the prominent spot on the midlateral surface of the body.

Ecology.—*Bivibranchia notata* was captured in the Rio Tapajós along the river margin in a mixed school with *B. protractila*. Specimens of the latter species from the same locality have faint dusky patches on the midlateral surface of the body which correspond in position to the very dark spot present in *B. notata*.

Remarks.—The specimens that are the basis for the species description fall into two distinct size classes, with the holotype (MZUSP 28657) and the paratype from the holotypic locality (USNM 268049) being twice the average standard length of the six paratypes from Barreirinha (MZUSP 23712 and USNM 268562). The specimens of both size classes agree well in meristics but the larger individuals from Alter do Chão differ from those captured at Barreirinha in the relative greatest body depth, distance from origin of dorsal fin to hypural joint, head length, snout length and interorbital width (see Table 1). These differences are presumably a function of the different size classes being compared.

Vari (1985) synonymized *Atomaster* Eigenmann and Myers (1927) in *Bivibranchia* Eigenmann (1912) as a consequence of the large number of synapomorphies uniting these two taxa and the few differences in squamation separating them. One of the two characters noted by Eigenmann and Myers (1927:565) as distinguishing *Atomaster* from *Bivibranchia* was the distinct difference in scale size (=number of scales in a longitudinal series) in the two genera. *Bivibranchia notata* with a lateral line scale count of 63 to 73 is intermediate in that feature between the 49 to 55 scales of *B. protractila* Eigenmann and *B. bimaculata* Vari on the one hand, and the 81 to 90 scales of *Atomaster* (= *Bivibranchia*) *velox* Eigenmann and Myers on the other. The intermediate position of the new species with respect to this character eliminates the trenchant differences in scale counts between the nominal genera, and lends further support to the synonymization of *Atomaster*.

Table 1.—Morphometrics of *Bivibranchia notata*, new species. Standard length is expressed in mm; measurements 1 to 10 are proportions of standard length; 11 to 15 proportions of head length.

	Holotype	Paratypes (7)		
		USNM 268049	USNM 268562 + MZUSP 23712	Average
Standard length	68.3	66.6	26.2–35.1	34.7
1. Greatest body depth	0.20	0.20	0.18	0.183
2. Snout to dorsal-fin origin	0.48	0.48	0.47–0.54	0.508
3. Snout to anal-fin origin	0.84	0.84	0.79–0.84	0.824
4. Snout to pelvic-fin origin	0.56	0.57	0.54–0.60	0.572
5. Snout to anus	0.77	0.77	0.75–0.78	0.762
6. Origin of rayed dorsal fin to hypural joint	0.53	0.54	0.48–0.51	0.502
7. Least depth of caudal peduncle	0.08	0.08	0.08	0.080
8. Pectoral-fin length	0.17	0.18	0.18–0.20	0.190
9. Pelvic-fin length	0.14	0.15	0.13–0.15	0.142
10. Head length	0.27	0.28	0.31–0.34	0.314
11. Snout length	0.31	0.28	0.36–0.37	0.346
12. Orbital diameter	0.28	0.29	0.26–0.29	0.282
13. Postorbital head length	0.37	0.37	0.35–0.40	0.376
14. Interorbital width	0.33	0.32	0.26–0.30	0.294
15. Gape width	0.12	0.13	0.11–0.13	0.124

Comments on other Amazonian Bivibranchia species.—The original description of *Bivibranchia velox* (Eigenmann and Myers, 1927) was based on a series of specimens collected by Dr. Carl Ternetz in the middle and upper portions of the Rio Tocantins system, whose mouth lies outside the main Amazon basin. Vari (1985) recently cited the species as an element of the lower section of the Rio Tocantins. In the course of this study, a series of juvenile specimens of *B. velox* were found intermingled with a large series of juvenile *B. protractila* from Belo Monte on the Rio Xingu (see “Comparative Material Examined”). This represents the first record of *B. velox* from the main portion of the Rio Amazonas basin. The Xingu specimens agree with the original description of *B. velox* (Eigenmann and Myers, 1927) other than in possessing cycloid scales rather than the ctenoid scales typical of *B. velox*. This difference in scale form may be a function of the different sizes of the involved specimens (Eigenmann and Myers’ specimens 104+ mm (SL?), Rio Xingu specimens, 30–56 mm SL).

Bivibranchia protractila was originally described by Eigenmann (1912) from the Essequibo River of Guyana. Steindachner (1917:16) subsequently listed the species from Boa Vista, Conceição, Serra Grande and the Rio Parima in the Amazon basin. Eigenmann and Myers (1927), in turn, extended the known range of the species to the upper Río Orinoco, the Rio Negro, the upper Rio Tocantins and the region of Santarem. Material collected by one of us (MG) has shown that *B. protractila* is also a component of the ichthyofauna of the Rio Xingu, the lower portions of the Rio Tapajós, and is present in the Rio Machado, a tributary of the middle Rio Madeira (see Fig. 2 and “Comparative Material Examined”).

The examined specimens of *Bivibranchia protractila* from the Essequibo River of Guyana lack any pronounced pigmentation patterns. Amazonian material of the species, alternatively, range from straw colored, plain bodied individuals



Fig. 2. Map of northern South America showing the distribution of Amazonian *Bivibranchia* specimens cited in this paper: *Bivibranchia notata*, new species, localities 1 (MZUSP 28657 holotype and USNM 268049 paratype), and 2 (USNM 268562 and MZUSP 23712 paratypes); *Bivibranchia velox* (Eigenmann and Myers), locality 3; *Bivibranchia protractila* Eigenmann, localities 1, and 3 to 7. Localities: 1, Alter do Chão; 2, Barreirinha near São Luís, and Itaituba; 3, Belo Monte; 4, Tucuruí; 5, Rio Marauia; 6, Bem Querer; 7, Rio Machado. See "Comparative Material Examined" and listing of holotype and paratypes for further locality and collection data.

similar to those from the Essequibo system, to specimens with distinct midlateral markings. In its most developed condition the latter pigmentation pattern consists of two patches of chromatophores with irregular borders. The larger, anterior spot occurs on the midlateral surface of the body and is centered distinctly posterior of the vertical through the insertion of the posteriormost dorsal-fin ray. A second smaller elongate pigmentation patch is located on the caudal peduncle and extends posteriorly onto those scales covering the base of the middle rays of the caudal fin. Within a single sample of *B. protractila* from the Rio Tapajós at Itaituba (USNM 268048) there is found a continuum from plain bodied specimens, through individuals with faint midlateral marks, to those specimens with distinct pigmentation patches. Faint markings in comparable positions are evident on specimens captured in the Rio Negro and Rio Tocantins systems, but no pigmentation patches were obvious in individuals from the Rio Xingu. The factors contributing to this pigmentary variability within and between populations of this species are unknown.

Comparative material examined.—In addition to the specimens listed below, the specimens cited in Vari (1985) were also examined for this study. All of the following material was collected in Brazil by M. Goulding unless otherwise noted.

Bivibranchia velox (Eigenmann and Myers): 50 specimens, MZUSP 28656, Pará, Rio Xingu, Belo Monte; 58 specimens, USNM 268490, data as for preceding.

Bivibranchia protractila Eigenmann: Pará: 9 specimens, USNM 268086, Rio Tocantins, Tucuruí, coll. M. Jégu; 17 specimens, USNM 268489; Rio Tapajós,

Alter do Chão (taken with holotype of *B. notata*); 16 specimens, USNM 268048, Rio Tapajós, Itaituba; 5 specimens, USNM 268047, Rio Xingu, Belo Monte; 100 specimens, USNM 268055, data as for preceding. Amazonas: 10 specimens, USNM 268050, Rio Marauia at confluence with Rio Negro; 13 specimens, USNM 268051, Rio Marauia, cachoeira do Bicho-Acu. Roraima: 55 specimens, USNM 268052, Rio Branco, cachoeira do Bem Querer. Rondonia: 22 specimens, USNM 268054, Rio Machado, Paracauba; 12 specimens, USNM 268053, Rio Machado, Jauari.

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