

Evaluating the use of the anterior ceratohyal morphology to diagnose *Laetacara* KULLANDER, 1986, with comments on other cichlid genera (Cichlidae: Cichlasomatini)

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Abstract

The morphology of the anterior ceratohyal is herein analyzed in all the species of *Laetacara* currently known, and in some species of the tribes Cichlasomatini and Heroini, evaluating the use of this structure morphology to diagnose *Laetacara* as well as a key character to the classification of the tribe Cichlasomatini. It was concluded that the morphology of the anterior ceratohyal is not useful to diagnose species of *Laetacara* by being quite polymorphic among species of the genus. We can also conclude that the traditional use of this bone morphology in the taxonomy of the tribe Cichlasomatini at present stage of knowledge seems not to be appropriate due to the polymorphism occurring in the species analyzed herein, and until a similar work is done for the whole tribe.

Key words

Anatomy, Cichlinae, Comparative Morphology, Hyoid Arch, Ichthyology, Osteology, Taxonomy.

Introduction

Osteology has been an important source of character states for taxonomic studies of the Teleostei. Several cichlid genera have osteological character states as diagnostic features, as well as, osteological characters are widely used in the classification of Cichlidae (see KULLANDER, 1986, 1998; KULLANDER & NIJSSEN, 1989). Despite of using osteological diagnostic features, exhaustive studies about description, morphology and variation of osteological structures are scarce among cichlids.

The morphology of the anterior ceratohyal has been considered to provide diagnostic characters in taxonomical studies of the tribe Cichlasomatini (see KULLANDER, 1986; and KULLANDER & NIJSSEN, 1989). Three morphological patterns of the anterior ceratohyal have been described as taxonomically informative for cichlids according to KULLANDER (1986) and KULLANDER & NIJSSEN

(1989): (1) dorsal margin with a lean or slightly concave surface (Figs. 1A, D, and F; Figs. 4A, B, C and D; and STAECK & SCHINDLER, 2007, fig. 6); (2) dorsal margin with a deep notch, not margined by laminar ledges (Fig. 1C; Fig. 2E; Fig. 3B; KULLANDER, 1986, fig. 149; KULLANDER & NIJSSEN, 1989, fig. 108; and OTTONI *et al.*, 2009, fig. 4); and (3) dorsal margin with deep notch, margined by laminar ledges (Figs. 1B and G; Figs. 2A and F; Fig. 3D; Fig. 4G; KULLANDER, 1986, figs. 108 and 145; and KULLANDER & NIJSSEN, 1989, fig. 89). According to KULLANDER (1986) and KULLANDER & NIJSSEN (1989) the pattern 2 uniquely occurs in *Laetacara* KULLANDER, 1986 and *Cleithracara* KULLANDER & NIJSSEN, 1989 among all the cichlids; pattern 3 occurs only in *Andinoacara* MUSILOVÁ, ŘÍČAN & NOVÁK, *Bujurquina* KULLANDER, 1986, *Krobia* KULLANDER & NIJSSEN, 1989, and *Tahuantinsuyoa* KULLANDER, 1986

among all cichlids; and pattern 1 is a general character state occurring in the remaining cichlid genera.

KULLANDER (1986) considered the pattern 2 as being one of the “synapomorphies” of *Laetacara*, based only on the examination of *L. flavilabris* (COPE, 1870), *L. curviceps* (AHL, 1924), and a putative new species (KULLANDER, 1986). CASCIOITA (1998) and STAECK & SCHINDLER (2007) did not confirm the presence of this character state in *L. fulvipinnis* STAECK & SCHINDLER, 2007 and in some populations of *L. dorsigera* (HECKEL, 1840) from Argentina. More recently, OTTONI & COSTA (2009) confirmed the occurrence of a depression on dorsal margin of the anterior ceratohyal in *L. araguaiae* OTTONI & COSTA, 2008 and *L. dorsigera*. OTTONI *et al.* (2009) confirmed this depression occurring in at least one side (hyoid) of each specimen of *L. curviceps*, and OTTONI *et al.* (2012) recorded it occurring in *L. flamannellus* OTTONI, BRAGANÇA, AMORIM & GAMA, 2012, and *L. thayeri* (STEINDACHNER, 1875).

Although these studies report controversial records about the use of the anterior ceratohyal morphology as generic diagnostic feature, this structure was never exhaustively analyzed for species of *Laetacara*. The objective of this paper is to provide a comprehensive analysis of variation of the morphology of the anterior ceratohyal among species of *Laetacara*, in order of assessing its validity as a diagnostic character state of *Laetacara*.

Material and Methods

Osteological studies were made on cleared and counter-stained (C&S) specimens prepared according to TAYLOR & VAN DYKE (1985); the osteological nomenclature follows COSTA (2006). The medial view of the hyoids was preferably illustrated, because it is clear to observe this character in this view. Scale bar = 1 mm.

The three morphological patterns of the dorsal margin of the anterior ceratohyal are herein minutely re-characterized to facilitate the comprehension of the three distinguish patterns.

Material is deposited in the following institutions: IEPA – Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá, Macapá; MNRJ – Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro; MZUSP – Museu de Zoologia, Universidade de São Paulo, São Paulo; and UFRJ – Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro.

Material examined

Acaronia nassa (HECKEL, 1840): Brazil: Amazonas state: UFRJ 4360, 1, 59.1 mm SL; Parananema lake, Amazonas river basin, Parintins municipality; C. Figueiredo and C. Codeço, 11 Sep. 1996.

“*Aequidens*” *hoehnei* (RIBEIRO, 1918): Brazil: Mato Grosso state: UFRJ 9404, 5, 27.9 – 46.3 mm SL; flooded area form a tributary

of the das Mortes river, Araguaia river basin; F. Ottoni and P. Bragança, 06 Apr 2013.

Australoheros autrani OTTONI & COSTA, 2008: Brazil: Rio de Janeiro state: UFRJ 6115, 1 (paratype), 44.9 mm SL; Aldeia Velha river, 23 km from Silva Jardim, W. Costa, 10 Jul. 1993. UFRJ 6133, 1 (paratype), 52.3 mm SL; tributary of the São João river; W. Costa, 10 Jul. 1991.

Bujurquina vittata (HECKEL, 1840): Brazil: Mato Grosso state: UFRJ 8868, 3, 42.5–63.7 mm SL; flooded area form the Cuiabá river, Estância do SESC Pantanal, Cuiabá; W. Costa, A. Barbosa and F. Autran, 09 Jun 1999.

Cichlasoma araguaense KULLANDER, 1983: Brazil: Mato Grosso state: UFRJ 8759, 1, 54.8 mm SL; buriti palm on BR-154, 94 km south of Nova Xavantina; F. Ottoni and P. Bragança, 25 Apr. 2012. Tocantins state: UFRJ 5074, 1, 50.8 mm SL; Araguaia rive Araguaia river. D. Almeida, G. Brasil and R. D’Arrigo, Feb. 2009. Goiás state: UFRJ 8759, 1, 59.2 mm SL; buriti palm Go- 142, north of Montividiu do Norte; F. Ottoni and P. Bragança, 02 May 2012.

Cleithracara maronii (STEINDACHNER, 1881): Brazil: Amapá state: IEPA 2338, 6 (1 C&S 36,1 mm SL), 30,7–46,8 mm SL; Parna Montanhas do Tumucumaque, Mapaoni river, Jari river basin; C. Souza-Gama, 10 Jan. 2005.

Kribia guianensis (REGAN, 1905): Brazil: Amapá state: UFRJ 8870, 3, 52.0–60.8 mm SL; road BR-210 between Cupixi river and Porto Grande near Felicissimo ranch, Porto Grande; P. Bragança and E. Henschel, 27 Jul 2012.

Laetacara araguaiae OTTONI & COSTA, 2008: Brazil: Goiás state: UFRJ 7552, 4 (paratypes), 24.3–34.2 mm SL; buriti palm 21 km south from São Miguel do Araguaia; W. Costa *et al.*, 28 Jul. 1993. UFRJ 1585, 2, 29.4–30.7 mm SL; buriti palm 15 km east of Aruanã; W. Costa *et al.*, 29 Aug. 1993. UFRJ 8345, 5, 26.4–36.8 mm SL; tributary of rio Claro, BR-364 between Aparecida do Rio Doce and Cachoeira Alta, 11, 5 km from Aparecida do Rio Doce, 18°24’46.8” S 51°05’48.6” W, alt. 546 m; W. Costa *et al.*, 20 Sep. 2011. UFRJ 8337, 7, 29.8–36.4 mm SL; flooded area of the Verde river on the street GO-184, Serranópolis, 18°22’29.3” S 52°00’58.9” W, alt. 527 m; W. Costa *et al.*, 17 Sep. 2011. UFRJ 8368, 3, 24.9–27.4 mm SL; buriti palm area in the street between Cristianópolis and Piracanjuba, 17°19’13.8” S 48°58’04.71” W, alt. 710 m; W. Costa *et al.*, 14 Sep. 2011. UFRJ 8369, 1, 31.0 mm SL; buriti palm area of the Paranaíba drainage, Piracanjuba municipality, 17°19’11.5” S 48°58’41.78” W, alt. 723 m; W. Costa *et al.*, 14 Sep. 2011. Tocantins state: UFRJ 5078, 1, 23.9 mm SL; Javaés river, near Projeto Quelônios, near Cangaçu; D. Almeida, R. D’Arrigo and G. Brasil, Feb. 1999. UFRJ 8712, 4, 25.6–33.1 mm SL; flooded area of the Tocantins river in the street TO-050, between Porto Nacional and Silvanópolis, Porto Nacional municipality, 10°51’27.7” S 48°21’19.2” W, alt. 240 m; P. Bragança and F. Ottoni, 02 May 2012. UFRJ 8716, 4, 22.0–31.9 mm SL; flooded area in the street TO-409, between São Miguel do Tocantins and Sítio Novo, about 3 km of Sítio Novo, 05°35’15.1” S 47°36’52.7” W, alt. 192 m; F. Ottoni and P. Bragança, 30 Apr. 2012. Mato Grosso state: UFRJ 7659, 7, 20.0–28.5 mm SL; stream 13 km west of the Rio das Mortes in the street between Água Boa and Cocalinho; W. Costa, C. Bove, R. Cunha and C. Muratori, 20 Nov. 1993. UFRJ 6094, 1, 36.9 mm SL; buriti palm área 15 km from Aparecida do Taboado; W. Costa *et al.*, 18 Sep. 1994. UFRJ 8367, 4, 26.0–31.5 mm SL; tributary of the Aporé, street Cassilândia-Itajá, 19°22’29.3” S 52°00’58.9” W, alt. 527 m; Costa *et al.*, 15 Sep. 2011. UFRJ 9722, 3, 21.2–34.9 mm SL; Left side of the Xingú river in the MT-322; W. Costa *et al.*, 18 Feb. 1993. UFRJ 9409, 6, 27.3–29.0 mm SL; flooded area of the Teles Pires river in the BR-153, about 82 km north from Sinop, Tapajós river basin, Itaúba municipality, 11°06’39.05” S 55°18’16.96” W, alt. 277; F. Ottoni and P. Bragança, 10 Apr. 2013.

Laetacara curviceps (AHL, 1924): Brazil: Amazonas state: UFRJ 7522, 4, 25.2–29.5 mm SL; Parananema lake, Amazonas river basin, Parintins; C. Figueiredo & C. Codeço, 11 Sep. 1996. Pará state:

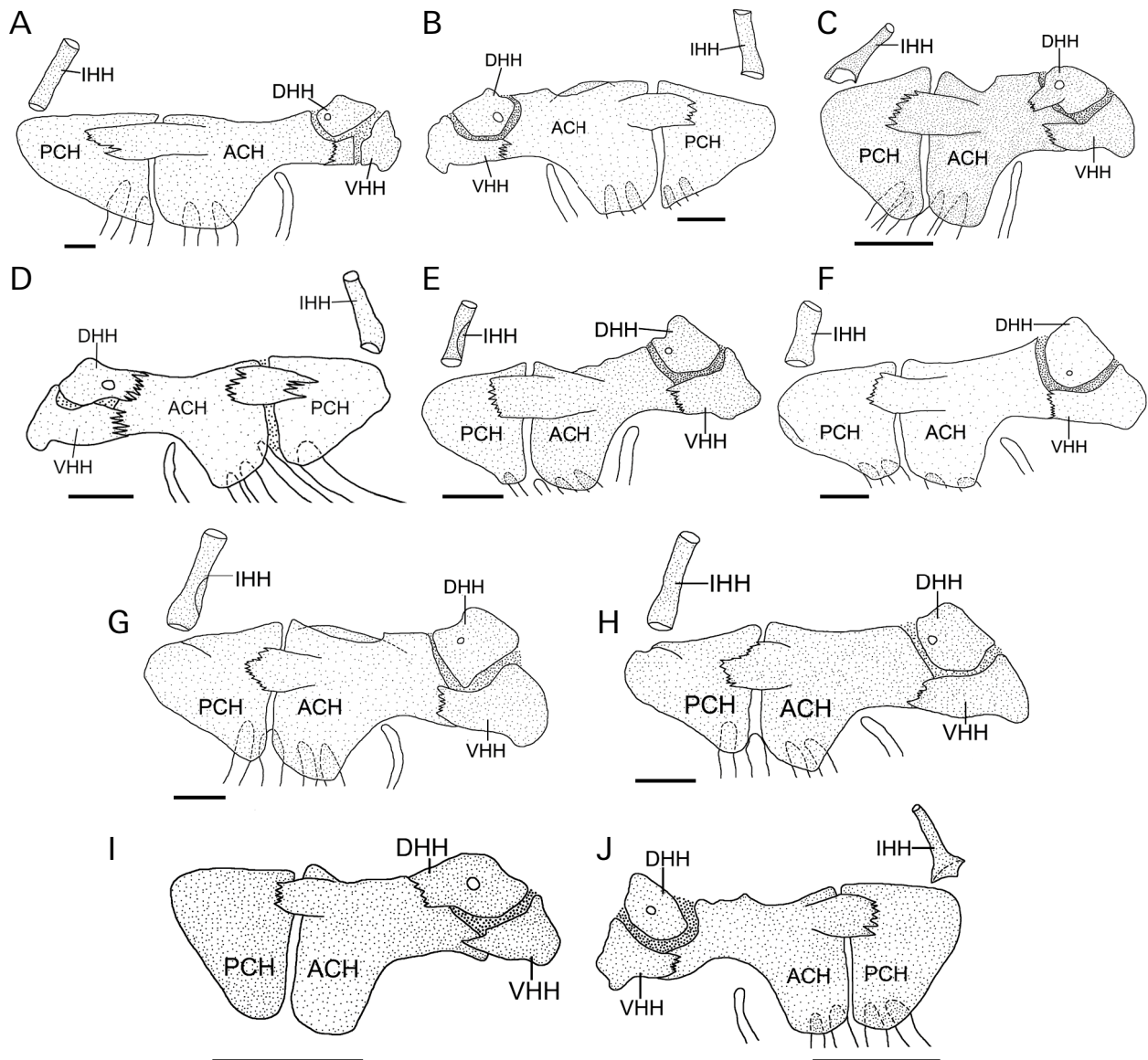


Fig. 1. Hyoid arch of species of the Cichlasomatini. (A) medial view of left hyoid of *Acaronia nassa* (UFRJ 4360); (B) medial view of right hyoid of *Bujurquina vittata* (UFRJ 8868); (C) medial view of left hyoid of *Cleithracara maronii* (IEPA 2338); (D) medial view of right side of “*Aequidens*” *hoehnei* (UFRJ 9404); (E) medial view of left hyoid of *Cichlasoma araguaense* (UFRJ 5074); (F) medial view of left hyoid of *Cichlasoma araguaense* (UFRJ 8759); (G) medial view of left hyoid of *Krobia guianensis* (UFRJ 8870); (H) medial view of left hyoid of *Krobia guianensis* (UFRJ 8870); (I) medial view of left hyoid of *Nannacara aureocephalus* (UFRJ 8869); and (J) medial view of right hyoid of *Nannacara aureocephalus* (UFRJ 8869).

ACH – anterior ceratohyal; DHH – dorsal hypophyal; IHH – interhyal; PCH – posterior ceratohyal; VHH – ventral hypophyal.

UFRJ 8058, 2, 24.8–38.1 mm SL; Utinga lake, Belém municipality; D. O. Castro, 12 Oct 2010.

Laetacara dorsigera (HECKEL, 1840): Brazil: Mato Grosso state: UFRJ 9410, 2, 26.0–28.3 mm SL; Flooded area of Bento Gomes river in the street MT-060, Poconé municipality, 16°0′0.53″S 56°28′50.21″W; F. Ottoni and P. Bragança, 05 Apr. 2013. UFRJ 7521, 4, 23.3–36.9 mm SL; temporary pool near Casal Vasco, Guaporé river basin; Costa *et. al.*, 29 Apr. 1996.

Laetacara flamannellus OTTONI, BRAGANÇA, AMORIM & GAMA, 2012: Brazil: Amapá state: UFRJ 8057, 3 (paratypes), 26.7–37.8 mm SL; Curiaú lake, following the road AP-70 to Santo Antônio da Pedreira, Macapá municipality, 0°0′54″ N 51°2′26″ W; P. Bragança & P.F. Amorim, 10 Jan 2011. UFRJ 8056, 2 (paratypes), 21.4–29.1 mm

SL; flooded area at the road BR-156, in direction to Oiapoque, 4 km before Tartarugal, Tartarugalzinho municipality, 1°21′45″ N 50°55′34″ W; P. Bragança & P.F. Amorim, 16 Jan 2011.

Laetacara flavilabris (COPE, 1870): Brazil: Amazonas state: MZUSP 42669, 6 (1 C&S), 32.2–55.9 mm SL; Fonte Boa; Expedição Permanente da Amazônia, 25 Oct. 1968. Peru: MZUSP 26094, 11 (3 C&S), 29.8–61.3 mm SL; Ucayali, Ivita, Pucallpa, Provincia Coronel Portillo; H. Ortega, 17 Feb. 1976.

Laetacara fulvipinnis STAECK & SCHINDLER, 2007: Brazil: Brazil: Amazonas state: UFRJ 9076, 1, 42.7 mm SL; Igarapé do Cajarázinho, tributary of the rio Caurés, in the community of Balaio, Barcelos municipality, 01°06′17.2″ S 062°58′42.3″ W; F. Ottoni, P. Bragança and P. Amorim, 17 Nov. 2012. UFRJ 9075, 1, 44.9 mm

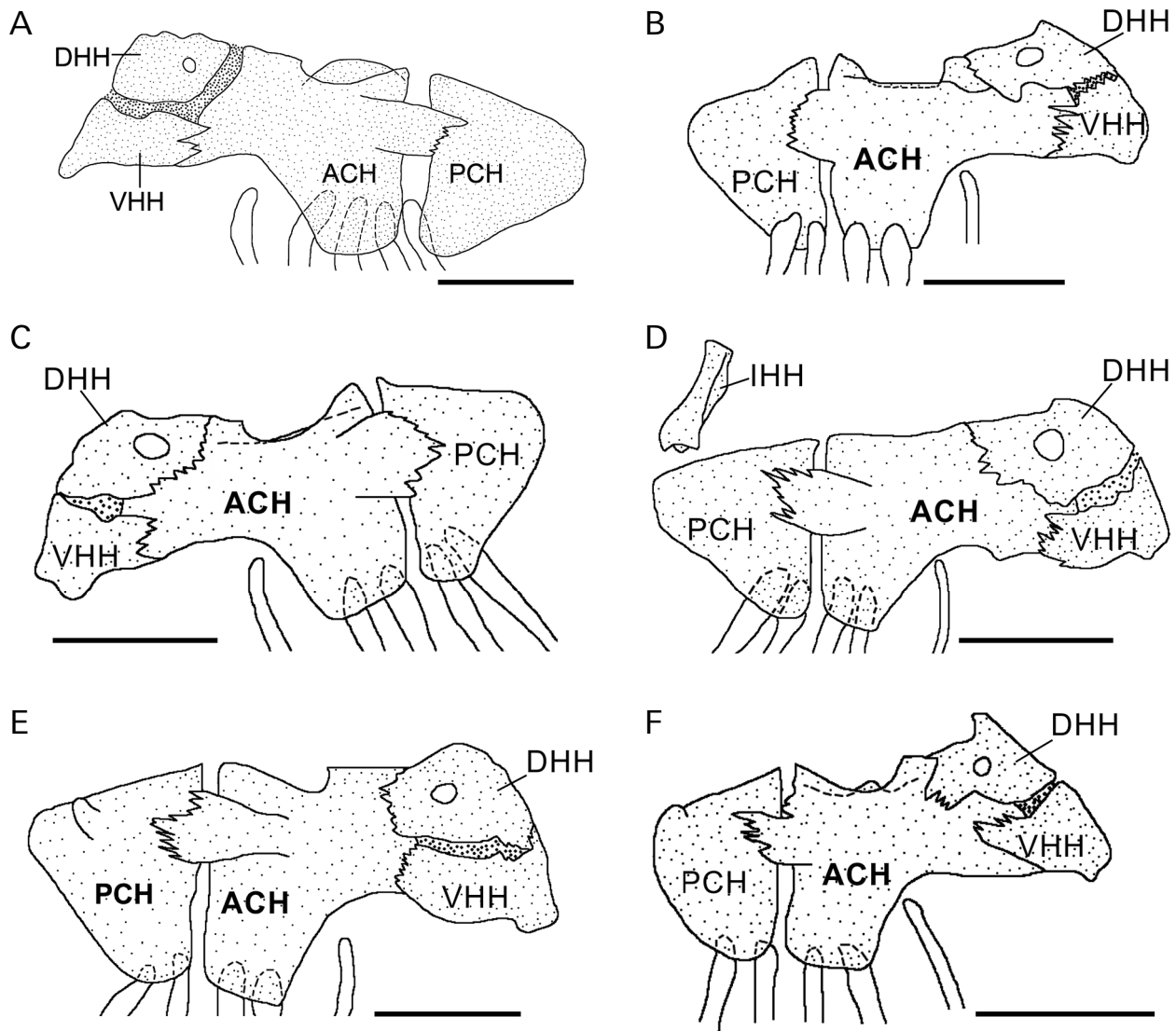


Fig. 2. Hyoid arch of species of *Laetacara*. (A) medial view of right hyoid of *L. araguaiae* (UFRJ 6094); (B) lateral view of right hyoid of *L. araguaiae* (UFRJ 7659); (C) medial view of right hyoid of *L. araguaiae* (UFRJ 7659); (D) medial view of left hyoid of *L. araguaiae* (UFRJ 8345); (E) medial view of left hyoid of *L. curviceps* (UFRJ 7522); and (F) medial view of left hyoid of *L. dorsigera* (UFRJ 7521).

ACH – anterior ceratohyal; DHH – dorsal hypohyal; IHH – interhyal; PCH – posterior ceratohyal; VHH – ventral hypohyal.

SL; island on tributary of the rio Daraã, Santa Isabel do Rio Negro municipality, 00°27'17.3" S 064°46'01.4" W; F. Ottoni, P. Bragança and P. Amorim, 15 Nov. 2012. MZUSP 58648, 13 (2 C&S), 28.7–45.8 mm SL; Rio Negro, lake on the Rio Aiuanã; Expedição Permanente da Amazônia, 29 Oct. 1972.

Laetacara thayeri (STEINDACHNER, 1875): Brazil: Amazonas state: MNRJ 29471, 15 (1 C&S), 41.8–59.1 mm SL; Petit Igarapé, tributary of Jacitara river, Grande de Manacapuru lake; Mission Amazonie, 12 Nov 1962. MZUSP 6845, 160 (3 C&S), 25.7–60.3 mm SL; Manaus, tributary of Tarumazinho, north of Manaus; Expedição Permanente da Amazônia, 18 Nov. 1967. UFRJ 9078, 1, 64.9 mm SL; Igarapé do Cajarazinho tributary of Caurés river in the community of Balaio, Barcelos municipality, 01°06'17.2"S 62°58'42.3"W; F. Ottoni, P. Bragança and P. Amorim, 17 Nov. 2012. UFRJ 9077, 1, 62.9 mm SL; Tibarrá river, Santa Isabel do Rio Negro municipality, 02°24'46.8"S 64°56'57.3"W; F. Ottoni, P. Bragança and P. Amorim, 14 Nov. 2012.

Mesonauta sp.: Brazil: Amazonas state: UFRJ 6130, 1, 33.9 mm SL; Zé-Açú lake, Amazonas river base, near comunidade Bom

Socorro, Parintins municipality; C. Figueiredo and C. Condeço, 13 Sep. 1996.

Nannacara aureocephalus ALLGAYER, 1983: Brazil: Amapá state: UFRJ 8869, 4, 17.8–25.3 mm SL; Igarapé Pataúá, Oiapoke; P. Bragança and E. Henschel, 29 Jul. 2012.

Petenia splendida GÜNTHER, 1862: Guatemala: UFRJ 6127, 1, 72.2 mm SL; Petenalong lagoon on airfield, Peten; Hubbs and Vander Shalie, 08 Feb. 1935.

Pterophyllum sp.: Brazil: Amazonas state: UFRJ 6100, 1, 49.7 mm SL; Máximo lake, Amazonas river basin, Parintins; C. Figueiredo and C. Condeço, 14 Sep. 1996. UFRJ 6101, 1, 54.6 mm SL; Máximo lake, Amazonas river basin, Parintins; C. Figueiredo and C. Condeço, 14 Sep 1998.

Symphysodon sp.: UFRJ 4845, 1, 85.8 mm SL; 85.8 mm SL; aquarium material; 12 May 1999.

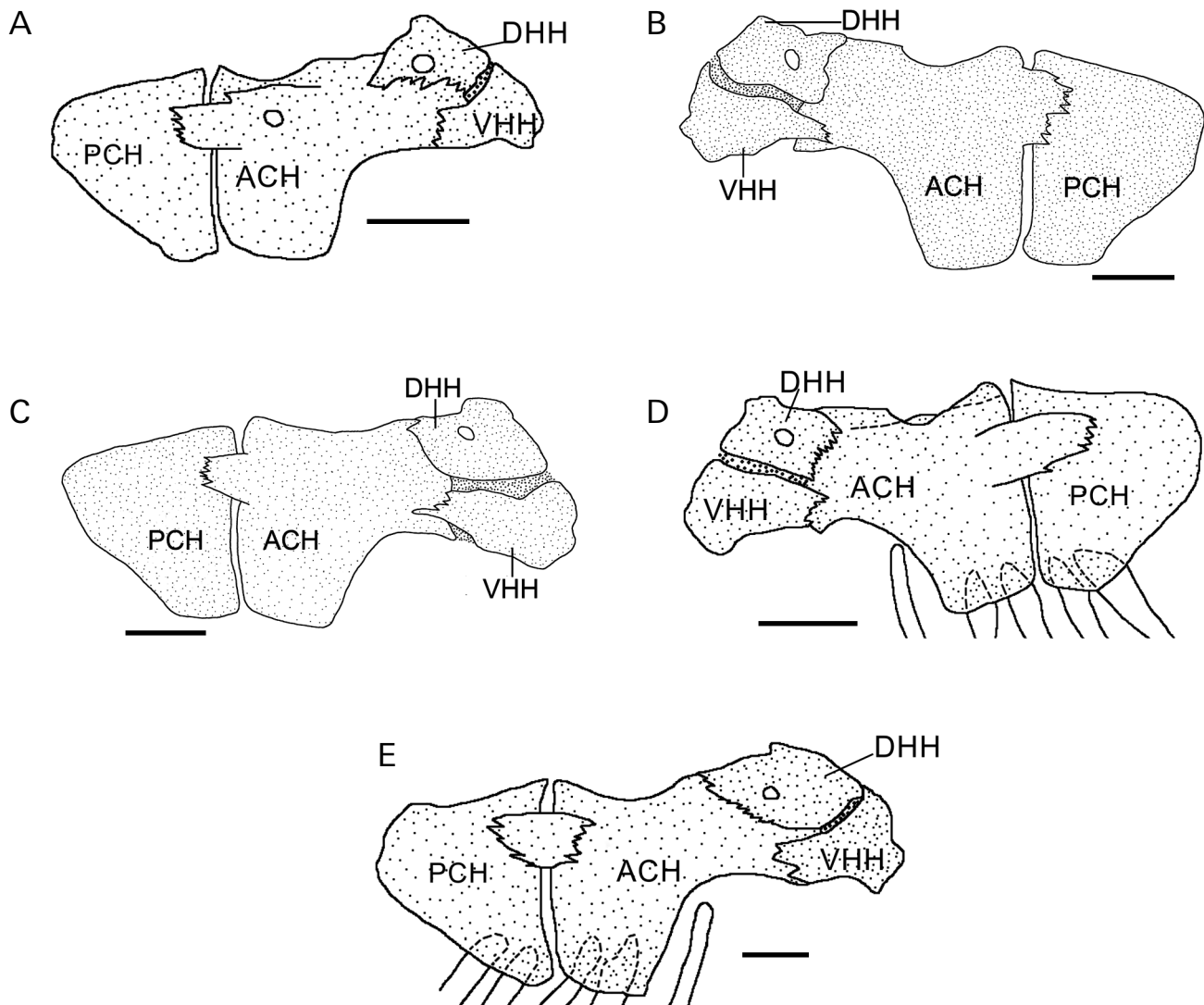


Fig. 3. Hyoid arch of species of *Laetacara*. (A) medial view of left hyoid of *L. fulvipinnis* (MZUSP 58648); (B) medial view of right hyoid of *L. thayeri* (MZUSP 29471); (C) medial view of left hyoid of *L. thayeri* (MZUSP 29471); (D) medial view of right hyoid of *L. thayeri* (MZUSP 6845); and (E) medial view of left hyoid of *L. thayeri* (UFRJ 9078).

ACH – anterior ceratohyal; DHH – dorsal hypohyal; IHH – interhyal; PCH – posterior ceratohyal; VHH – ventral hypohyal.

Results

Pattern 1: dorsal margin with a lean or slightly concave surface, without notch (Figs. 1A, D, and F; and Figs. 4A, B, C and D).

Pattern 2: dorsal margin with conspicuous deep notch, and laminar ledges not surpassing margin of deep notch (Fig. 1C; Fig. 2E; Fig. 3B).

Pattern 3: dorsal margin with conspicuous deep notch, and laminar ledges clearly surpassing margin of deep notch (Figs. 1B and G; Figs. 2A and F; Fig. 3D; and Fig 4G).

The distinguishing morphological patterns of the anterior ceratohyal found in each species of *Laetacara* herein

examined are presented in Table 1, and in other Cichlasomatini and Heroini species are presented in Table 2.

Discussion

The three morphological patterns of the anterior ceratohyal previously described in the literature (e. g. KULLANDER, 1986; KULLANDER & NIJSSEN, 1989), and herein re-characterized, were variable among species and specimens of the Cichlasomatini. Among species of *Laetacara* all the three morphological patterns were found (Figs. 2 and 3; Table 1), and variability was recorded even in the same specimen, which had hyoids of

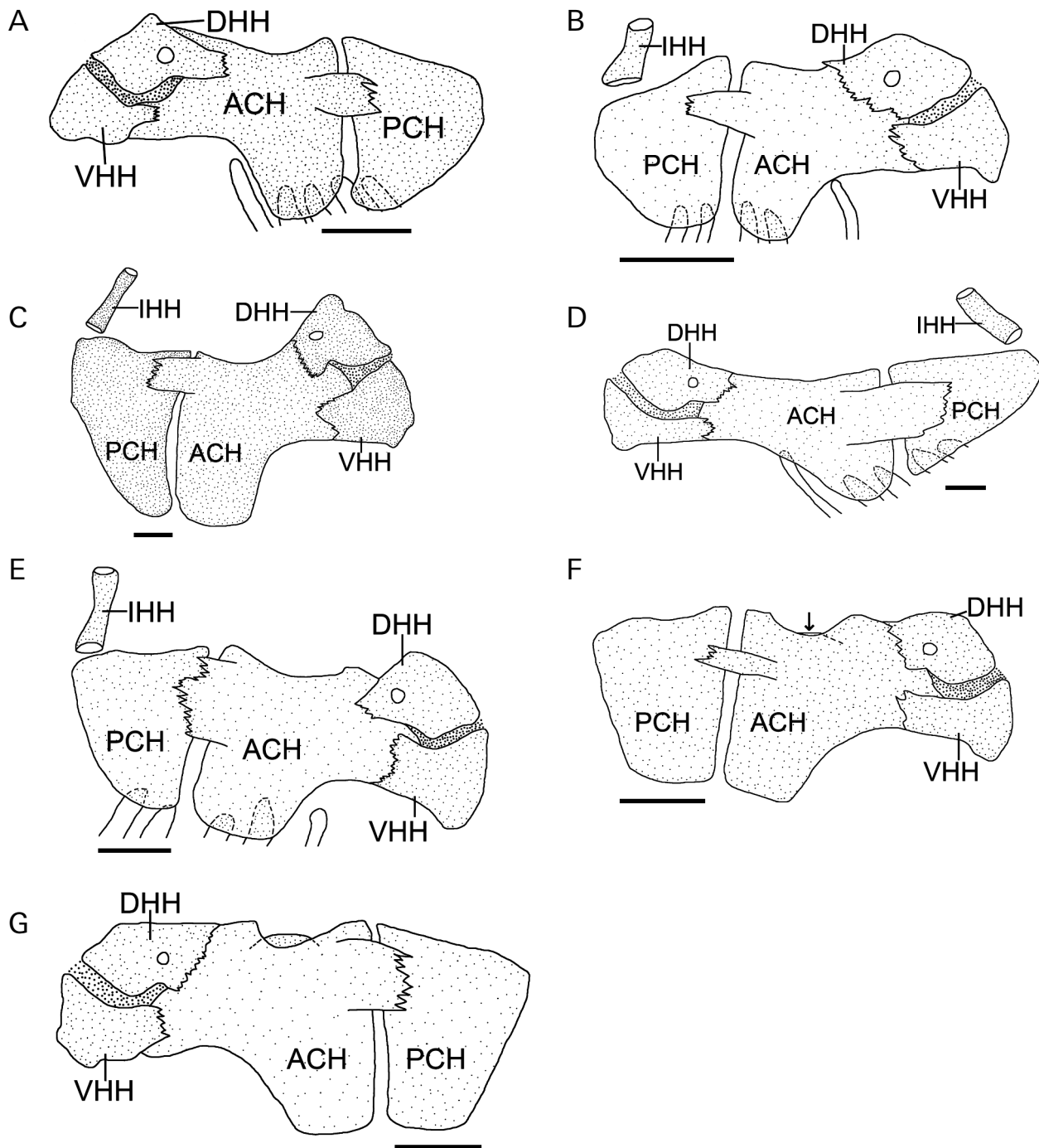


Fig. 4. Hyoid arch of species of the Heroini. (A) medial view of right hyoid of *Australoheros autrani* (UFRJ 6115); (B) medial view of left hyoid of *Mesonauta* sp. (UFRJ 6130); (C) medial view of left hyoid of *Symphysodon* sp. (UFRJ 4845); (D) medial view of right hyoid of *Petenia splendida* (UFRJ 6127); (E) medial view of left hyoid of *Pterophyllum* sp. (UFRJ 6101); (F) medial view of left hyoid of *Pterophyllum* sp. (UFRJ 6100); and (G) medial view of right hyoid of *Pterophyllum* sp. (UFRJ 6100).

ACH—anterior ceratohyal, DHH—dorsal hypophyal, IHH—interhyal, PCH—posterior ceratohyal, and VHH—ventral hypophyal.

each side exhibiting distinguish morphological patterns on dorsal margin of anterior ceratohyal (e.g. Figs. 3B and C; and OTTONI *et al.*, 2009). In addition, intermediate stages among the three morphological patterns of the anterior ceratohyal were also frequently recorded among specimens herein analyzed: some specimens exhibited a slight notch, very inconspicuous in some cases, instead

of a clear deep notch, being difficult to classify it on patterns 1 or 2 (an intermediate stage between patterns 1 and 2) (e.g. Fig. 3E); and others specimens exhibited laminar ledge only reaching or slightly surpassing the margin of notch, being difficult to classify it on patterns 2 or 3 (an intermediate stage between patterns 2 and 3) (e.g. Figs. 2B and C).

Table 1. Occurrence of morphological patterns of the anterior ceratohyal among species of *Laetacara*. LH = left hyoid; RH = right hyoid; BH = both hyoids.

Species	Patterns	Figures
<i>L. araguaiae</i>	· Three specimens - intermediate stage between patterns 2 and 3 (BH) · One specimen - intermediate stage between patterns 1 and 2 (BH) · One specimen – pattern 1 (LH), and pattern 2 (RH) · One specimen – pattern 2 (LH), and pattern 3 (RH) · One specimen – pattern 2 (RH), and pattern 3 (LH) · Five specimens – pattern 1 (BH) · 10 specimens – pattern 2 (BH) · Eight specimens – pattern 3 (BH) · Two specimens – inconspicuous pattern 3 (BH) · Two specimens – inconspicuous pattern 2 (BH) · Two specimens - pattern 2 (LH), and intermediate stage between patterns 1 and 2 (RH) · One specimen – pattern 2 (LH), and intermediate stage between patterns 2 and 3 (RH) · One specimen – pattern 2 (RH), and inconspicuous pattern 3 · One specimen – pattern 3 (LH), and intermediate stage between patterns 2 and 3 (RH) · One specimen – pattern 3 (RH), and intermediate stage between patterns 2 and 3 (LH)	(Figs. 2A, B, C and D)
<i>L. curviceps</i>	· One specimen – pattern 2 (BH) · One specimen – pattern 2 (RH), and pattern 1 (LH) · One specimen – pattern 2 (LH), and pattern 1 (RH) · One specimen – pattern 2 (BH), however left hyoid with notch less evident · One specimen – pattern 2 (LH), and intermediate stage between patterns 1 and 2 (RH) · One specimen – pattern 1 (RD), and intermediate stage between patterns 1 and 2 (LH)	(Fig. 2E; OTTONI <i>et al.</i> , 2009, fig. 4)
<i>L. dorsigera</i>	· Two specimens – pattern 2 (BH) · One specimens – pattern 3 (BH) · One specimens – pattern 1 (LH), and pattern 2 (RH), however notch not deep (inconspicuous) · One specimen – intermediate stage between patterns 2 and 3 · One specimen – pattern 2 (RH), and intermediate stage between patterns 1 and 2 (LH)	(Fig. 2F)
<i>L. flamannellus</i>	· Two specimens – pattern 2 (BH) · One specimen – pattern 3 (RH), left hyoid broken · Two specimens – pattern 2 (RH), and intermediate stage between patterns 1 and 2 (LH)	—
<i>L. flavilabris</i>	· Three specimens- conspicuous pattern 2 (BH) · One specimen – pattern 3 (BH), however laminar ledge of right hyoid just slightly surpassing the notch	(KULLANDER, 1986; fig. 149)
<i>L. fulvipinnis</i>	· One specimens – pattern 1 (BH) · One specimen – inconspicuous notch, intermediate stage between patterns 1 and 2 (BH) · One specimen – pattern 2 (LH), and pattern 1 (RH) · One specimen – pattern 2 (LH), and intermediate stage between patterns 2 and 3 (RH)	(Fig. 3A, and STAECK & SCHINDLER, 2007; fig. 6)
<i>L. thayeri</i>	· One specimen – pattern 1 (LH), and pattern 2 (RH) · One specimen – intermediate stage between patterns 1 and 2 (BH) · One specimens – pattern 2 (BH) · One specimen – pattern 3 (RH), and pattern 2 (LH) · One specimen – pattern 1 (BH) · One specimen – pattern 2, however with notch not evident, and laminar ledges almost surpassing the notch	(Figs. 3B, C, D and E)

In some of the other genera of Cichlasomatini this character was also polymorphic. The results proposed by KULLANDER (1986) and KULLANDER & NIJSSEN (1989) were herein confirmed for *Acaronia nassa* (Fig. 1A), *Bujurquina vittata* (Fig. 1B), and *Cleithracara maronii* (Fig. 1C). However, it was not confirmed for *Krobia guianensis* (Figs. 1G and H) due to pattern 1 was also recorded for this species. In addition, *Nannacara aureocephalus* exhibited patterns 1 and 2 (Fig. 1I and J), and “*Aequidens*” *hoehnei* exhibited patterns 1 (Fig. 1D) and 2, however the notch was less evident, in some cases very inconspicuous. Both cases also do not corroborate the information presented by KULLANDER (1986) and KULLANDER & NIJSSEN (1989). In *Cichlasoma araguaense* the presence of morphological pattern 1 was confirmed (Fig. 1F), however the anterior ceratohyal was also recorded exhibiting a total irregular shape of dorsal margin (Fig. 1E), making classification in any of the three morphological pattern described above impossible.

Some species of the tribe Heroini were also examined in the present work. The results proposed by KULLANDER (1986) and KULLANDER & NIJSSEN (1989) were herein confirmed for *Australoheros autrani*, *Mesonauta* sp., *Petenia splendida* and *Symphysodon* sp. (Figs. 4A, B, D and E). However, it was not confirmed for *Pterophyllum* sp. (Figs. 4E, F and G).

KULLANDER (1986; p. 321) affirmed for *Laetacara*: “A synapomorphy of these species is the shape of the hyoid, with a deep notch in the dorsal margin of the anterior ceratohyal, which is not margined by laminar ledges” and “The particular ceratohyal notch is shared only with ‘*Aequidens*’ *maronii* (STEINDACHNER) among cichlids.” However, after the exhaustive comparison of the shape of the anterior ceratohyal among species of *Laetacara*, it can be concluded that it is not a useful character to diagnose *Laetacara*. This character is highly polymorphic in this genus, exhibiting all three morphological patterns.

We can also conclude that the traditional use of

Table 2. Occurrence of morphological patterns of the anterior ceratohyal among species of Heroini and Cichlasomatini. LH = left hyoid, RH = right hyoid, and BH = both hyoids.

Species	Patterns	Figures
Cichlasomatini		
<i>Acaronia nassa</i>	· One specimen - pattern 1 (BH)	(Fig. 1A)
<i>"Aequidens" hoehnei</i>	· One specimen (larger one) – pattern 1 (BH) · Two specimens – slight notch observed, apparently an inconspicuous patterns 2 (BH)	(Fig. 1D)
<i>Bujurquina vittata</i>	· Three specimens – pattern 3 (BH) , larger specimen with notch less evident	(Fig. 1B)
<i>Cichlasoma araguaense</i>	· Two specimens – pattern 1 (BH) · One specimen - totally irregular shape (BH)	(Fig. 1E and F)
<i>Cleithracara maronii</i>	· One specimens patter 2 (BH)	(Fig. 1C)
<i>Kribia guianensis</i>	· Two specimens – pattern 3 (BH) · One specimen – pattern 1 (BH)	(Figs. 1G and H)
<i>Nannacara aureocephalus</i>	· One specimen - pattern 2 (BH) · One specimen – pattern 1 (RH), and apparently an inconspicuous pattern 2 (RD) · One specimens – pattern 1, without conspicuous notch (BH)	(Figs. 1I and J)
Heroini		
<i>Australoheros autrari</i>	· Two specimens – pattern 1 (BH)	(Fig. 4A)
<i>Mesonauta</i> sp.	· One specimens – pattern 1 (BH)	(Fig. 4B)
<i>Petenia splendida</i>	· One specimens – pattern 1 (BH)	(Fig. 4D)
<i>Pterophyllum</i> sp.	· One specimen – pattern 2 (BH) · One specimens – pattern 3 (RH), and apparently and intermediate stage between patterns 2 and 3 (LH)	(Figs. 4E, F and G)
<i>Symphysodon</i> sp.	· One specimens – pattern 1 (BH)	(Fig. 4C)

this bone morphology in the taxonomy of the tribe Cichlasomatini at present stage of knowledge seems not to be appropriate due to the polymorphism occurring in the species analyzed herein, and until a similar work is done for the whole tribe. Better and more embracing investigations of transformation series of this character among different linages of Cichlidae and ontogenetic stages are highly recommended.

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