

S1. Revised list of characters 106 characters used in the present analysis revised from Poyato-Ariza *et al.* (2010). Numbers in the data matrix from that article are indicated below in brackets after their actual number in the present list.

Endocranium

- 1(1). Orbitosphenoid: present [0], absent [1].
- 2(2). Basisphenoid: present [0], absent [1].
- 3(3). Pterosphenoids: well developed and articulating with each other [0], slightly reduced, not articulating anteroventrally but approaching each other anterodorsally [1], greatly reduced and broadly separated both anteroventrally and anterodorsally [2].
- 4(4). Posterolateral expansion of exoccipitals: absent [0], present [1].
- 5(5). Exoccipitals: posteriorly smooth with no projection above the basioccipital [0], with a posterior concave-convex border, and a projection above basioccipital [1].
- 6(6). Cephalic ribs: absent [0], present and all articulating with the exoccipitals [1], present and articulating with both the exoccipitals and basioccipital [2]. (Obs.: it was not possible to observe if the cephalic ribs also contact the basioccipital in *D. moraesi*).
- 7(16). Supraoccipital crest: small, short in lateral view [0]; long and enlarged, projecting above occipital region and first vertebrae, forming a vertical, posteriorly deeply pectinated blade [1]. In *D. moraesi* the supraoccipital crest is bifurcated and presumably long, resembling the condition observed in *Chanos chanos*.
- 8(17). Foramen magnum: dorsally bounded by exoccipitals [0]; enlarged and dorsally bounded by supraoccipital [1].
- 9(7). Brush-like cranial intermuscular bones (*sensu* Patterson, Johnson, 1995): absent [0], present [1]. The coding of this character has been changed to 1 in *Chanos* following Amaral, Brito (2012).

Ethmoid region & skull roof

- 10(18). Mesethmoid: wide and short [0]; long and slender, with anterior elongate lateral extensions [1]; large, with broad posterolateral wing-like expansions [2].
- 11(19). Wings (extensions) of lateral ethmoids: absent [0]; present [1]. The wings are not completely preserved, but the remains in lateral view in specimens of *Dastilbe moraesi* suggest a lateral extension of the lateral ethmoids.
- 12(8). Nasal bone: small but flat [0]; just a tubular ossification around the canal [1].
- 13(9). Frontals: wide through most of their length, narrowing anteriorly to form a triangular anterior border [0]; elongate and narrow except in postorbital region [1]; wide, anteriorly shortened,

anterior border roughly straight [2].

14(10). Interfrontal fontanelle: absent [0]; present [1].

15(11). Frontal bones: paired in adult [0]; co-ossified, with no median suture [1].

16(12). Foramen for olfactory nerve in frontal bones: absent [0]; present [1].

17(13). Relative position of the parietals: medioparietal (in full contact with each other along their midline) [0]; mesoparietal (*sensu* Poyato-Ariza, 1994); partly separated by the supraoccipital, posteriorly, and partly in contact with each other, anteriorly) [1]; lateroparietal (completely separated from each other by the supraoccipital) [2].

18(14). Parietal portion of the supraorbital canal: absent [0]; present [1]. Coded [1] in *Chanos* following Amaral, Brito (2012).

19(15). Parietals: large [0]; reduced but flat and blade-like in shape [1]; highly reduced [2]; absent as independent ossifications [3].

Orbital region

20(68). Number of infraorbitals: five or more [0]; four [1]; three or fewer [2].

21(69). Infraorbital bones not including lacrimal: well developed [0]; reduced to small, tubular ossifications [1].

22(70). Lacrimal: flat and comparable in length to subsequent infraorbitals [0]; flat, long and large, with keel near lower edge [1].

23(71). Supraorbital: present [0]; absent [1].

Upper jaw

24(20). Teeth in premaxilla, maxilla, and dentary: present [0]; absent [1].

25(21). Premaxilla: consisting of one solid element [0]; premaxilla consisting of two distinct elements, with a shorter, non-osseous element lying ventral to a much longer osseous portion, which in turn articulates with the maxilla [1].

26(22). Premaxillary “gingival teeth”: absent [0]; present [1].

27(23). Premaxilla: small, flat and roughly triangular [0]; large, very broad, concave-convex, with long oral process [1]; narrow and elongated, its length more than one half of the length of the maxilla [2].

28(24). Premaxillary ascending process: present [0]; absent [1].

29. Morphology of maxillary articular process: thin and pointed [0]; robust and bulky [1]; flat and hypertrophied, higher than the main body of the bone [2]. The morphology of the maxillary process is treated independently from its length because a short or long process can be either robust or thin (all combinations are possible). Among the ingroup genera, this character is [0] in

Gordichthys and *Rubiesichthys* only; it is [1] in the Chaninae where it can be verified and in *Gonorynchus*, and [2] in *Kneria* only. It is [1] in *Nanaichthys*; unlike stated by Amaral, Brito (2012: p. 4), the maxillary articular process is neither thin nor small in this genus. As illustrated by those authors, it is robust, very similar to that of *Parachanos* and quite dissimilar to that of either the outgroup or *Rubiesichthys*; see Amaral, Brito (2012: fig. 4).

30. Length of maxillary articular process: short, less than 30% of the total maxillary length [0]; long, 30%-40% of the total maxillary length [1]; very long, about 50% of the total maxillary length [2]. State is [1] in *Chanos*, *Parachanos*, and *Tharrhias*; [2] in *Dastilbe*, *Gonorynchus*, *Gordichthys*, and *Rubiesichthys*. In *Nanaichthys*, state is [1], as in *Dastilbe moraesii* [1]. As shown in Figure 4, the relative length of the maxillary articular process in *Nanaichthys* is similar to that in *Dastilbe elongatus* and quite different from that in the Rubiesichthyinae.
- 31(25). Dorsal and ventral borders of the maxillary articular process: straight or slightly curved [0]; very curved, almost describing an angle [1]. Unlike the coding of Amaral, Brito (2012), the maxillary articular process of *Nanaichthys* (Amaral, Brito, 2012: fig. 4) is just slightly curved, quite similar in relative curvature to that of *Dastilbe* or *Parachanos*, and very different from that of *Gordichthys* and *Rubiesichthys*. As consequence, the coding of this character in *Nanaichthys* was changed from [1] as in Amaral, Brito (2012) to [0] in the present study. See Figure 3 for comparison of this structure in *Dastilbe elongatus*, *Nanaichthys*, and *Rubiesichthys*. *Dastilbe moraesii* [0].
- 32(26). Maxillary process for articulation with autopalatine: absent [0]; present [1].
- 33(27). Posterior region of the maxilla: slightly and progressively expanded to form a thin blade, with roughly straight posterior border [0]; very enlarged, swollen to a bulbous outline, with curved posterior border [1].
- 34(28). Supramaxilla(e): present [0]; absent [1].

Lower jaw

35. Symphysis: low, pointed [0]; higher than immediately posterior part of the dentary, robust [1].
The primitive state is the typical condition observed in teleosts in relation to the anterior shape of the dentary, which is progressively lower anteriorly, and forming a symphysis that is pointed or slightly rounded. The derived state is the condition where the anterodorsal border of the dentary is slightly concave and forms a relatively high symphysis, higher than the remaining portion of the bone. It is found in *Chanos*, *Dastilbe*, *Kneria* (where it is especially high), and *Tharrhias* (respectively, Grande, Poyato-Ariza, 1999, fig. 10A, B; Poyato-Ariza *et al.*, 2008: fig. 7.6A; Grande, 1994: fig. 3B; and Blum, 1991b: fig. on p. 287). *Nanaichthys* [0]; *Dastilbe moraesii* [0].
- 36(29). Notch between the dentary and the anguloarticular bones: absent [0]; present [1].

- 37(30). Articulation between dentary and angulo-articular: strong, dentary not V-shaped posteriorly [0]; loose, with a posteriorly V- shaped dentary [1].
- 38(31). Notch in the anterodorsal border of the dentary (“leptolepid” notch): absent [0]; present [1].
- 39(32). Mandibular sensory canal: present [0]; absent [1].

Palate & suspensorium

- 40(39). Dermopalatine: present [0], absent [1].
- 41(40). A patch of about 20 conical teeth on endopterygoid and basibranchial 2: absent [0]; present [1].
- 42(41). Ectopterygoid: well developed, ectopterygoid overlapping with the ventral surface of the autopalatine by at least 50% [0]; reduced, articulating with the ventral surface of the autopalatine by at most 10% through cartilage, resulting in a loosely articulated suspensorium [1].
- 43(42). Teeth on vomer and parasphenoid: absent [0]; present [1].
- 44(43). Anterior portion of vomer: horizontal [0]; anteroventrally inclined, nearly vertical [1]; dorsally curved [2].
- 45(44). Spatial relationship between vomer and mesethmoid anteriorly: vomer and mesethmoid ending at about the same anterior level [0]; mesethmoid extending anteriorly beyond the level of anterior margin of vomer [1]; vomer extending anteriorly beyond the level of anterior margin of mesethmoid [2].
- 46(38). Metapterygoid: large, broad and in contact with quadrate and symplectic through cartilage [0]; reduced to a thin rod [1].
- 47(34). Quadrate: with posterior margin smooth [0]; elongated forked posterior process [1].
- 48(35). Quadrate-mandibular articulation: below or posterior to orbit, no elongation or displacement of quadrate [0]; anterior to orbit, quadrate displaced but not elongate [1].
- 49(36). Symplectic: elongated in shape but relatively short [0]; very long, about twice the length of the ingroup [1].
- 50(37). Symplectic and quadrate: articulating directly with each other [0]; separated through cartilage [1].
- 51(45). Articular head of hyomandibular bone: double, with both articular surfaces placed on the dorsal border of the main body of the bone [0]; double, with the anterior articular surface forming a separate head from the posterior articular surface [1].
- 52(46). Metapterygoid process of hyomandibular bone: absent [0], present, anterior [1]; present, ventral [2].
- 53(47). Ossified interhyal: present [0]; absent as an independent ossification [1]. Coded [1] in *Chanos* following Amaral, Brito (2012). The state of preservation in *Nanaichthys* as shown in

Amaral, Brito (2012: fig. 4) does not allow to be certain of the absence of this bone, so it is coded as [?] instead of [1] in this genus.

Opercular series

54(52). Size of opercular bone: normal, about one quarter of the head length [0]; expanded, at least one third of the head length [1].

55(53). Shape of opercular bone in lateral view: rounded/oval [0]; triangular [1].

56(55). Opercular apparatus on external surface of opercle: absent [0]; present [1].

57(56). Opercular borders: free from side of head [0]; partly or almost completely connected to side of head with skin [1].

58(57). Angle formed by preopercular limbs: obtuse [0]; approximately straight [1]; acute [2]. The criterion to measure the angle formed by the preopercular limbs in chanids, as originally defined, is “to measure the angle formed by the anterior borders of the limbs” (Poyato-Ariza, 1996: p. 22). According to this criterion, the character has been re-coded as [1] in *Nanaichthys*, instead of [2] as in Amaral, Brito (2012: fig. 4).

59(58). Posterodorsal limb of preopercular bone: well developed [0]; reduced, correlated with expansion of anteroventral limb that meets its fellow along the ventral midline [1].

60(59). Ridge on anteroventral limb of preopercular bone: absent [0]; present [1].

61(60). Preopercular expansion distal to the terminal openings of the preopercular canal branches: absent, preopercular bone not enlarged [0]; present, restricted to the posteroventral corner [1]; present in posteroventral corner and part of the posterodorsal limb [2].

62(61). Suprapreopercular bone: absent [0]; present as a relatively large, flat bone [1]; present as tubular ossification(s) [2]. The state of preservation in *Nanaichthys*, as indicated by Amaral, Brito (2012: fig. 4) does not allow to confirm the absence of this bone, so it is coded as [?] instead of [0] in this genus. This character is particularly relevant because the small suprapreopercular bone, typically present in gonorynchiforms can be easily lost during fossilization. Only in well-preserved fossils it is possible to observe the anterodorsal region of the opercular bone lacking the small, shallow concavity for the articulation with the suprapreopercular bone. Therefore, we consider that absence of the suprapreopercular bone cannot be ruled out in any fossil gonorynchiform.

63(63). Major axis of subopercular bone in lateral view: inclined [0]; subhorizontal [1].

64(64). Subopercular clefts: absent [0]; present [1].

65(67). Posterodorsal ascending process of interopercular bone: absent [0]; present [1].

Branchial arches

- 66(48). Teeth on fifth ceratobranchial: present [0]; absent [1].
- 67(49). First basibranchial in adult specimens: ossified [0]; unossified [1].
- 68(50). Fifth basibranchial in adult specimens: cartilaginous [0]; ossified [1].
- 69(51). First pharyngobranchial in adult specimens: ossified [0]; unossified [1].

Vertebrae

- 70(72). Two anteriormost vertebrae: as long as posterior ones [0]; shorter than posterior ones [1].
- 71(74). Autogenous neural arch anterior to first vertebra: present [0]; absent [1].
- 72(75). Neural arch of first vertebra and exoccipitals: separate [0]; in contact [1].
- 73(76). Neural arch of first vertebra and supraoccipital: separate [0]; in contact [1].
- 74(77). Spine on neural arch of first vertebra: present, well developed [0]; present but reduced [1].
- 75(78). Anterior neural arches: no contact with adjoining arches [0]; abutting contact laterally with adjoining arches, no overlapping [1]. The neural arches of the four anterior vertebral centra are concealed by the opercular bone in *Nanaichthys* (Amaral, Brito, 2012: p. 4, fig. 4), so this character is coded [?] instead of [0] in this terminal.
- 76(79). Neural arches 5–10 in adults: fused to centra [0]; autogenous, at least laterally [1].
- 77(80). Neural arches to vertebrae posterior to the dorsal fin in adults: fused to centrum [0]; autogenous, at least laterally [1].
- 78(81). First two anterior parapophyses: autogenous [0]; fused to centra [1].
- 79(82). Rib on third vertebral centrum: similar in size and shape to posterior ones [0]; widened and shortened [1]; modified into Weberian apparatus [2].

Intermuscular bones

- 80(83). Paired intermuscular bones consisting of three series: epipleurals, epicentrals, and epineurals: absent (at least one complete series is absent) [0]; present (three series) [1].
- 81(84). Anterior (first six) epicentral bones: unmodified, no differences in size from others [0]; highly modified, much larger than posterior ones [1].
- 82(85). Shape of anterior supraneurals 1 and 2: narrow and separated [0]; large and in contact [1].
- 83(86). Posterior process on the posterior border of first supraneural: absent [0]; present [1].
- 84(87). Number of supraneurals: several supraneurals in a long series [0]; two or fewer supraneurals [1].

Girdles and fins

- 85(88). Postcleithra: present [0]; absent [1]. *Nanaichthys* [?]; *Dastilbe moraesii* [1].
- 86(89). Lateral line and supracleithrum: supracleithrum pierced through dorsal region [0];

supracleithrum pierced all through its length [1]; lateral line does not pierce supracleithrum [2].

Kneria is coded as 2 following Amaral, Brito (2012).

87(90). Fleshy lobe of paired fins: absent [0]; present [1].

88(91). Caudal fin morphology: elongated, posteriorly forked [0]; higher than long, slightly incurved posteriorly [1].

89(92). Fringing fulcra in dorsal lobe of caudal fin: present [0]; absent [1].

90(93). Caudal scutes: absent [0]; present [1].

Caudal endoskeleton

91(94). Ural centra (u1, u2), preural centrum one (pu1), and uroneural one (un1): autogenous [0]; fused [1]. These elements are described as autogenous in *Nanaichthys* by Amaral, Brito (2012: p. 5), but the state of preservation, as illustrated in the only described specimen, does not allow precise assessment because the borders of pu1, u1-2 and un1 are unclear (Amaral, Brito, 2012: fig. 7; actually, the anterior border of u1 in their fig. 7B is depicted as if fused to pu1). Consequently, this character is coded as [?] instead of [0] in *Nanaichthys*; observations in additional specimens are necessary to confirm this character in this taxon. *Dastilbe moraesii* [0].

92(95). Neural arch and spine of preural centrum one: both well developed, spine about half as long as preceding ones [0]; arch complete and closed, spine rudimentary [1]; arch open, no spine [2].

93(96). Uroneurals (regardless of number): arranged in a linear series [0]; arranged in a double series [1]. Uroneurals arranged in a double series only in *Tharrhias*, where an “extra” uroneural laterally crosses previous uroneurals (e.g., Poyato-Ariza, 1996: UN3 in fig. 18). All other genera have one linear series of uroneurals, including *Nanaichthys* [0] (unlike Amaral, Brito, 2012, where it is coded [1]).

94(97). Total number of uroneurals regardless of their fusion to other elements of the caudal endoskeleton (dealt with in character 92 above): three [0]; two [1]; one [2]. Because of the indecisive character polarity assessment in Poyato-Ariza *et al.* (2010), and according to the variation observed in chanids, the character states have been modified. Among the outgroup, three uroneurals are present in *Diplomystus* (e.g., Poyato-Ariza *et al.*, 2000: fig. 9) and *Brycon* (one fused, two autogenous; e.g., Weitzman, 1962: fig. 15); *Opsariichthys* has two (e.g., Fink, Fink, 1981: fig. 23B). This results in three uroneurals as being the primitive state [0], present only in *Aethalionopsis* and *Tharrhias* among ingroup genera. *Chanos* and most other chanids have two uroneurals (state 1; e.g., Poyato-Ariza, 1996a: figs. 16, 17, 19). *Gonorynchus* and *Kneria* have one uroneural (state 2; e.g., Poyato-Ariza, 1996a: fig. 20).

95(98). Anterior extent of first uroneural: to anterior end of first preural [0]; to anterior end of second preural [1]; to anterior end of third preural [2]; uroneural fused to caudal fin complex [3].

The anterior end of the first uroneural is not preserved in *Nanaichthys*, so it is not possible to be certain that it reached the anterior end of a preural centrum or is fused to any ural centrum (Amaral, Brito, 2012, fig. 7); it is therefore coded as [?] instead of [0] in this genus, pending further confirmation in this taxon.

96(99). Uroneural two and second ural centrum: in contact [0]; separated [1]; uroneural two absent as an autogenous ossification [2]. Only very partial remains of the ural centra are preserved in the only specimen of *Nanaichthys*, as depicted by Amaral, Brito (2012: fig. 7), so this character is coded as [?] instead of [0] in this genus.

97(100). Parhypural and preural centrum 1: independent in adults [0]; fused only in large adults [1]; fused since early ontogenetic stages [2].

98(101). Reduction in the number of hypurals: six [0]; fewer than six [1].

99(102). Hypurals 1 and 2: autogenous [0]; partly fused to each other [1].

100(103). Hypural 1 and terminal centrum: articulating [0]; separated by a hiatus [1]; fused [2].

101(104). Hypural 2 and centrum: fused [0]; autogenous [1].

102(106). Hypural 5 and second ural centrum: separate [0]; articulating [1]. There are no problems of homology in this character, unlike commented by Amaral, Brito (2012: fig. on p. 7), because the second ural centrum is conservative in morphology, regardless of the possible separation and contact of hypural 5 with it. This means that the second ural centrum always articulates with hypurals 3-4 in all chanid genera in all ontogenetic stages. As a matter of fact, the contact of hypural 5 with the second ural centrum is, according to Poyato-Ariza *et al.* (2010), a secondary modification (reversion) in the caudal endoskeleton of *Gordichthys*, whose caudal fin is modified into a very short and high fin. The apomorphic state is not observed in *Rubiesichthys*, as noted by Amaral, Brito (2012: p. 7; *e.g.*, Poyato-Ariza, 1996b: fig. 4). Indeed in all genera of the Chanidae, with the exception of *Gordichthys*, the second ural centrum articulates with uroneurals 3 and 4 only; in *Gordichthys*, the second ural centrum articulates with uroneurals 3-4 and also with uroneural 5. The partial preservation of the caudal endoskeleton in the only specimen of *Nanaichthys* described by Amaral, Brito (2012: p. 5, fig. 7) does not allow confirmation of the character state, therefore state is coded as [?] instead of [0] in this genus.

103(107). Hemal arch in preural centrum 2: fused to the centrum [0]; autogenous [1].

104(108). Posterolateral process of caudal endoskeleton: absent [0]; present [1].

Scales and lateral line

105(110). Type of scales: cycloid [0]; modified ctenoid [1]. *Nanaichthys* [0]; *Dastilbe moraesii* [0].

106(111). Lateral line: not extending to posterior margin of hypurals [0]; extending to posterior margin of hypurals [1].